TWENTY-FOURTH ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND,

Being for the Year 1905.

IN THREE PARTS.

PART I.—GENERAL REPORT.
PART II.—REPORT ON SALMON FISHERIES.
PART III.—SCIENTIFIC INVESTIGATIONS.

PART II.—REPORT ON SALMON FISHERIES.

Presented to both Houses of Parliament by Command of His Majesty.

GLASGOW:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE
BY JAMES HEDDERWICK & SONS LIMITED,
AT "THE CITIZEN PRESS," ST. VINCENT PLACE.

And to be purchased, either directly or through any Bookseller, from
OLIVER & BOYD, EDINBURGH; or
WYMAN & SONS, LTD., FETTER LANE, E.C., and
32 ABINGDON STREET, WESTMINSTER, S.W.; or
E. PONSONBY, 116 GRAFTON STREET, DUBLIN.

1906.

[Cd. 3042.] *Price* 1*s*. 1½*d*.

SALE OF GOVERNMENT PUBLICATIONS.

The under-mentioned Firms have been appointed sole Agents for the sale of Government Publications, including Parliamentary Reports and Papers, Acts of Parliament, Record Office Publications, &c., &c. (*excepting* Ordnance Maps and Geological Maps and Memoirs, the Hydrographical Works of the Admiralty, the Journal of the Board of Agriculture, and Patent Office Publications), and all such works can be purchased from them either directly or through retail Booksellers, who are entitled to a discount of 25 per cent. from the selling prices :—

IN ENGLAND :—Messrs. Wyman & Sons, Ltd., Fetter Lane, E.C.
IN SCOTLAND :—Messrs. Oliver & Boyd, Edinburgh.
IN IRELAND :—Mr. E. Ponsonby, 116 Grafton Street, Dublin.

Hydrographical Works of the Admiralty are sold by Mr. J. D. Potter, 145 Minories, E.

The Journal of the Board of Agriculture is sold by Messrs. Laughton & Co., Ltd., No. 3 Wellington Street, Strand, W.C.

Patent Office Publications are sold at the Patent Office.

The Publications of the Ordnance Survey and of the Geological Survey can be purchased from Agents in most of the chief towns in the United Kingdom, through any Bookseller, or from the Director-General of the Ordnance Survey, Southampton, or, in the case of Ireland, from the Superintendent, Ordnance Survey, Dublin. In addition, Ordnance Survey Publications can be obtained through Head Post Offices in towns where there are no accredited Agents.

The following is a list of some of the more important Parliamentary and Official Publications recently issued :—

Parliamentary:

Statutes—

Public General Acts, 1906. In course of issue.
Local and Personal Acts, 1905, published separately ; 3*d*. per 4 pp.
Army Act—Consolidation—including amendments to 1906. In the press.
Public General, Session 1905. With Index, Tables, &c. Cloth. Price 3*s*.
Index to Local and Personal Acts, 1801-1899. Price 10*s*.
Index to Local and Personal Acts, 1900-1905. Each year may be purchased separately.
Second Revised Edition. 1235-1886. XVI. Vols. Price 7*s*. 6*d*. each.
Revised Editions. Tables showing subsequent Repeals, effected by Acts of Session 2 Edward VII. 1902. Price 6*d*.
Statutes in Force. Chronological Table and Index of. 21st Edition. To the end of the Session 5 Edward VII. (1905.) 2 Vols. Price 10*s*. 6*d*.
The Statutory Rules and Orders Revised. Statutory Rules and Orders, other than those of a Local, Personal, or Temporary Character, in force on December 31, 1903. Vols. I. to XIII. Price 10*s*. each.
Statutory Rules and Orders, other than those of a Local, Personal, or Temporary Character. With a List of the more important Statutory Orders of a Local Character arranged in classes; and an Index. Roy. 8vo. Boards. Issued in 1890 to 1904. Price 10*s*. each.
Statutory Rules and Orders in force on 31st December 1903. Index to. Price 10*s*.

Historical Manuscripts. Reports of the Royal Commissioners. In course of issue.

[Cd. 2817.] Egypt and the Soudan. Lord Cromer's Report on Finances and Condition ; 1905. Price 1*s*. 5*d*.

[Cd. 2825-2826.] Trades Disputes. Report of Royal Commission, with Evidence and Appendix. Price 4*s*. 9*d*.

[Cd. 2852, 2891, 2892.] Vagrancy. Report of Departmental Committee ; with Evidence, Appendix, and Index. Labour Colonies Abroad, &c. Price 10*s*. 3*d*.

[Cd. 2932, 2933, 2934.] Louping-ill and Braxy. Report of Departmental Committee, and details of Investigation. Price 4*s*. 5½*d*.

[Cd. 2959, 2960.] Railway Rates. Preferential Treatment for Foreign and Colonial Produce. Report of Departmental Committee, with Evidence, &c. Price 3*s*. 4*d*.

[Cd. 2961.] Licensing Statistics, 1905. Operation and Administration of Laws for the Sale of Intoxicating Liquors. Price 1*s*. 7*d*.

[Cd. 2963.] School Training for Home Duties for Women in Foreign Countries. Price 1*s*. 6*d*.

[Cd. 2978, 2979.] Agricultural Settlements in British Colonies. Report of Departmental Committee, with Evidence, &c. Price 3*s*. 6*d*.

[Cd. 3040.] Ecclesiastical Discipline. Report of Royal Commission. Price 9*d*.

Endowed Charities, England and Wales. Separate Parishes. Reports thereon ; in course of issue.

Mines. Reports of H.M. Inspectors for 1905, with Summaries of the Statistical portion under the provisions of the Coal Mines Regulation Act, 1887 ; Metalliferous Mines Regulation Acts, 1872-1875 ; Slate Mines (Gunpowder) Act, 1882, Districts Nos. 1 to 12. Price 9*s*. 9½*d*.

Mines in the United Kingdom and the Isle of Man. List of, for 1905. Price 3*s*. 7*d*.

Quarries Ditto. ditto. ditto. 1905. Price 4*s*. 10*d*.

Mines Abandoned. Plans of, List of the. Corrected to 31st December 1905. Price 1*s*.

[Cd. 3042]—750—7/1906—H. & Sons Ltd.

TWENTY-FOURTH ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND,

Being for the Year 1905.

IN THREE PARTS.

PART I.—GENERAL REPORT.
PART II.—REPORT ON SALMON FISHERIES.
PART III.—SCIENTIFIC INVESTIGATIONS.

PART II.—REPORT ON SALMON FISHERIES.

Presented to both Houses of Parliament by Command of His Majesty.

GLASGOW:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE
BY JAMES HEDDERWICK & SONS LIMITED,
AT "THE CITIZEN PRESS," ST. VINCENT PLACE.

And to be purchased, either directly or through any Bookseller, from
OLIVER & BOYD, EDINBURGH; or
WYMAN & SONS, LTD., FETTER LANE, E.C., and
32 ABINGDON STREET, WESTMINSTER, S.W.; or
E. PONSONBY, 116 GRAFTON STREET, DUBLIN.

1906.

[Cd. 3042.] *Price* 1*s*. 1½*d*.

TABLE OF CONTENTS.

TWENTY-FOURTH ANNUAL REPORT OF THE FISHERY BOARD FOR SCOTLAND.

	PAGE
Table of Weights of Salmon carried by Scottish Railways and Steamships,	vi
Curves showing approximately the Tons of Salmon carried by Scottish Railways and Steamships,	vii
Reports from District Fishery Boards and others,	vii
Rentals of Districts,	viii
Table of Boxes of Salmon sent to Billingsgate from Scotland, years 1884 to 1903 inclusive, showing comparison of two periods of ten years, and of last two years,	viii
Table of Boxes of Scottish Salmon sent to Billingsgate from all sources during 1905,	ix
Inspections during 1905,	x
Results of Investigations by Salmon Marking,	x
Autumn Migration of Smolts in Scotland,	xi
Rearing of Smolts in Sea-water Pond,	xi
Hatching of Fry from Smolt Ova,	xi
Captures of Salmon at Sea by Trawlers,	xi
"The White Spot" affecting Salmon in Island of Lewis,	xi
Salmon Sealed to secure Legitimate Sale in Close Time,	xi
Rateable Value of Salmon Fishery Districts,	xii
Annual Close Times,	xii
Chairmen and Clerks of District Fishery Boards,	xii
Annual Report of Mr. W. L. Calderwood, Inspector of Salmon Fisheries for Scotland, and Appendices (*see* separate Table of Contents),	3

TWENTY-FOURTH ANNUAL REPORT.

TO THE RIGHT HONOURABLE

JOHN SINCLAIR, M.P.,

His Majesty's Secretary for Scotland.

OFFICE OF THE FISHERY BOARD
FOR SCOTLAND,
EDINBURGH, 26*th May* 1906.

SIR,

In continuation of our Twenty-fourth Annual Report we have the honour to submit—

PART II.—REPORT ON SALMON FISHERIES.

The weight of Salmon carried by Scottish Railways and Steamships during the fishing season 1905 exceeds that reported for season 1904 by 183 tons, and exceeds the last quinquennial average by 246 tons. The total is 2280 tons. From the following Table, which shows the actual weights in the four divisions of the coast usually adopted, and more clearly from the chart of curves also given, it will be seen that this satisfactory improvement is confined to the East Coast in the division of Berwick to Cairnbulg Point at the entrance to the Moray Firth :—

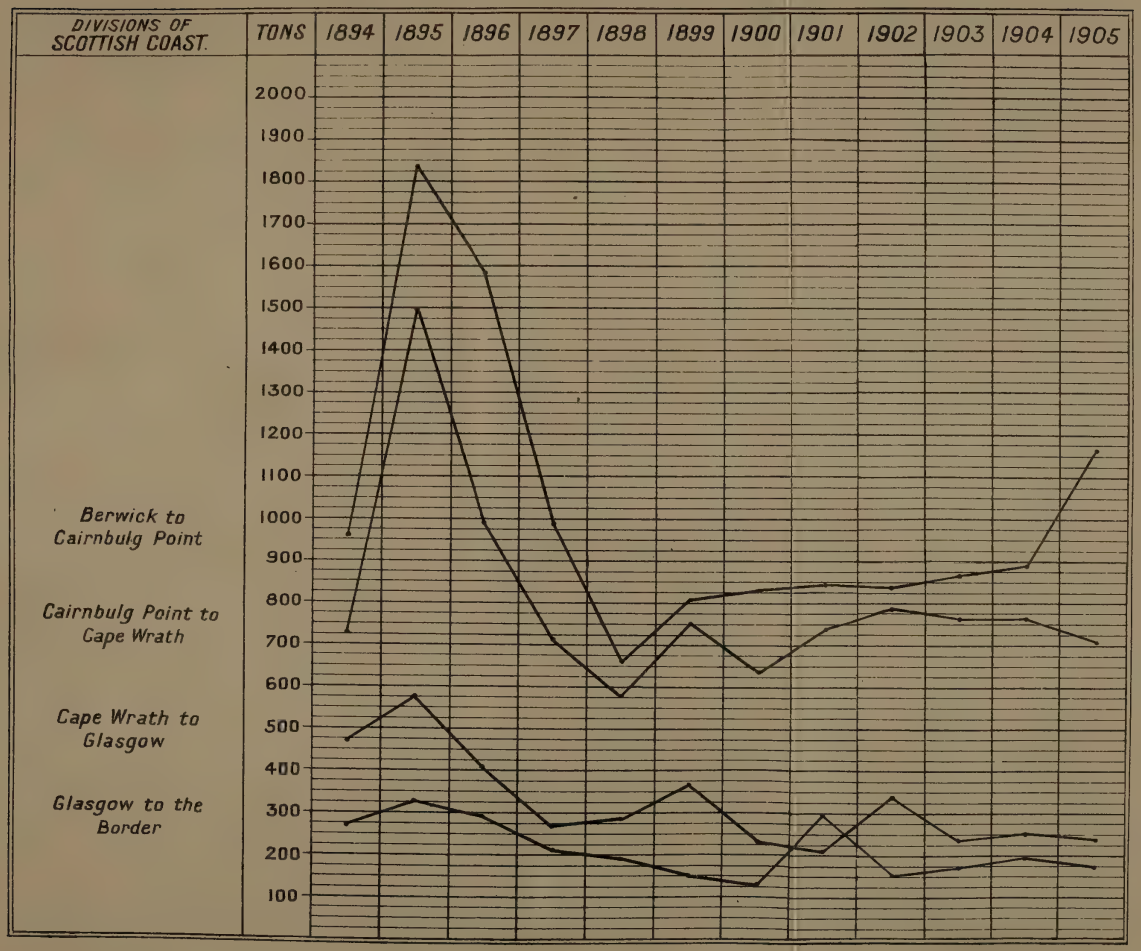
TABLE showing the Weights of Salmon Carried by Scottish Railways and Steamships.

District.	1894—Weight.				1895—Weight.				1896—Weight.				1897—Weight.				1898—Weight.				Average Weight.			
	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.
Berwick to Cairnbulg Point, .	963	8	2	23	1,834	1	3	24	1,583	6	1	26	987	5	1	4	666	8	3	13	1,206	18	1	1
Cairnbulg Point to Cape Wrath,	729	2	3	17	1,492	12	..	7	987	13	1	8	717	4	..	7	577	16	2	20	900	17	3	6
Cape Wrath to Glasgow, . . .	471	13	3	4	576	7	..	10	414	2	3	5	270	15	..	1	283	18	2	1	403	7	1	21
Glasgow to the Border, . . .	273	6	..	..	326	..	1	17	293	3	..	1	219	8	..	21	189	..	..	20	260	3	2	6
Total, . . .	2,437	11	1	16	4,229	1	2	2	3,278	5	2	12	2,194	12	2	5	1,717	4	..	26	2,771	7	..	6

District.	1899—Weight.				1900—Weight.				1901—Weight.				1902—Weight.				1903—Weight.				Average Weight.			
	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.
Berwick to Cairnbulg Point, . .	819	17	2	6	826	17	3	26	845	10	1	3	835	3	2	23	867	18	1	14	839	1	2	9
Cairnbulg Point to Cape Wrath,	753	12	2	..	639	4	..	16	740	18	3	23	786	5	1	17	767	13	2	..	737	10	3	17
Cape Wrath to Glasgow, . . .	365	12	..	3	232	15	1	16	203	8	3	16	332	8	0	8	240	8	..	10	275	..	1	5
Glasgow to the Border, . . .	152	18	1	19	137	14	1	25	296	16	1	21	157	13	3	1	171	9	..	2	183	6	1	19
Total, . . .	2,092	..	2	..	1,836	11	3	27	2,086	14	2	7	2,111	10	3	21	2,047	8	3	26	2,034	19	0	22

District.	1904—Weight.				1905—Weight.			
	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.
Berwick to Cairnbulg Point, . .	881	17	2	27	1,158	1	..	24
Cairnbulg Point to Cape Wrath,	768	1	3	23	708	6	..	24
Cape Wrath to Glasgow, . .	251	6	..	20	241	13	..	21
Glasgow to the Border, . . .	196	4	2	6	172	18	..	12
Total, . . .	2,097	10	1	20	2,280	18	2	23

CURVES SHOWING APPROXIMATELY THE TONS OF SALMON CARRIED BY SCOTTISH RAILWAYS & STEAMSHIPS SINCE 1894.



The reports from District Fishery Boards, and others, received by the Inspector of Salmon Fisheries, and included in Appendix I. to Mr. Calderwood's Report, show further that on the East Coast the improvement recorded is the result of successful fishing by means of bag nets on the coast. This branch of the Scottish salmon industry is now chiefly relied upon for the supply of fish to the market. The dry summer of 1905 no doubt contributed to the success of the fixed net fishing, since, through the lowness of many of the rivers, there was no great inducement for fish to ascend from the sea. For the same reason the sweep-net fishing in the estuaries, and the rod fishings in the rivers, are, for the most part, reported as below the average. In a river of large volume like the Tay the influence of the dry season was apparently less felt. Here the sweep-net fishing is reported as having been above the average, no very great success having been noticed in the fishings of the coast of the district. In the Moray Firth the sea nets, with the exception of those in the Deveron and Findhorn districts, are reported as above the average. The Deveron results are reported as being for all methods of fishing much below the average; the district appears to be in a very backward state owing largely to peculiar physical conditions, to which the Inspector makes special reference in his report. There are now no sea nets fished on the east coast of Sutherland, but the nets on the north coast maintained a good average. In the West Highlands the fishings of Skye and the neighbourhood are reported as having been very poor in 1905. In the Clyde area good reports come from the Doon district, but from other Clyde districts and from the Cree, Dee, and Annan, in the Solway, reports state that the netting was below the average. With regard to angling it may be said in general that, while the low water conditions already referred to prevented good results being obtained in very many excellent localities, rivers of large volume, such as the Tay, Dee, and Beauly, maintained their high reputations. In Sutherland, where, as reported last year, the system of storing the head waters against the advent of dry summer conditions has been adopted by the Helmsdale tenants, the success of this system was again fully borne out. The water stored above the Badanloch dam was sufficient to keep the river in good ply all through the summer. The Helmsdale has always been a good spring river, but the summer fishing was considered practically valueless. The results of the storing and control of the head water seem to be that the spring angling has, if possible, improved, over a thousand spring fish having been taken in the six beats below Kildonan, while in addition to this a good summer fishing has apparently developed.

Reports from Districts.

Since the date of our last Report a District Fishery Board has been created at Thurso to regulate the fisheries of the Thurso river and sea coast. Sir J. G. Tollemache Sinclair of Ulbster, Bart., is chairman. An alteration of the close time for rod fishing has since been granted in this district. Arrangements are also almost completed for the formation of a District Board for the Bladenoch area in the Solway.

New District Fishery Boards.

Rentals of Districts.

With regard to the rentals of the principal districts, the following brief statement is sufficient to show that the high standard previously referred to has been well maintained :—

Year.	Tweed.	Tay.	N. Esk.	Dee.	Spey.
	£	£	£	£	£
1900, . . .	...	22,548	6,510	18,989	...
1901, . . .	...	22,558	6,466	19,418	8,608
1902, . . .	...	22,663	6,494	19,455	8,146
1903, . . .	15,338	22,648	6,494	18,393	8,147
1904, . . .	15,439	23,099	6,494	19,078	7,396
1905, . . .	15,499	22,675	6,489	19,332	8,364

The assessable rental of the East Coast fishery districts, exclusive of the Beauly and including a sum for East Sutherland which does not express the value, owing to the difficulty of separating angling from other sporting values, is now £107,771. In 1904 it was £106,691, in 1903 £104,815.

Boxes of Salmon sent to Billingsgate.

While, as has been seen, the weight of Scottish salmon carried by train and steamer is greater than that for the last six years, the decrease in the number of boxes of salmon sent to Billingsgate continues. This decrease has previously been referred to as meaning simply that an increasing proportion of Scottish salmon is being sent to markets other than Billingsgate. As compared with the last quinquennial average, the figures for 1905 show a decrease of 2792 boxes; as compared with the figures for 1904, a decrease of 485 boxes. Totals are given in the following Table :—

	Total No. of Boxes.
Average for 10 Years—1884–1893, - -	23,749
Average for 10 Years—1894–1903, - -	17,160
Total for Year 1904, - - - . -	14,753
Total for Year 1905, ...	14,368

The detailed Table, kindly furnished by the Fishmongers' Company, showing the supplies from all sources, and the average monthly prices, here follows, from which it will be noticed that, in spite of the decrease of supplies above referred to, the number of salmon sent to London from Scotland still very largely exceeds the number sent from any other source :—

[Table.

SALMON

Delivered at BILLINGSGATE during the year 1905, and average MONTHLY price per lb.

Month.	BOXES.									PRICES.							
	English.	Scotch.	Irish.	Dutch.	Norway.	French.	Danish.	Canadian.	Total.	English.	Scotch.	Irish.	Dutch.	Norway.	French.	Danish.	Canadian.
										s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
January, . . .	..	..	37	35	..	8	..	2	82	..	..	4 9	4 10	..	4 9	..	0 9½
February, . . .	186	348	432	27	..	3	..	..	996	2 0	2 1	2 1	2 0	..	2 0	..	..
March, . . .	269	677	483	37	..	..	..	15	1,481	2 4½	2 4½	2 5½	2 4½	..	..	..	0 9½
April, ...	181	903	787	21	..	..	..	19	1,911	2 3	2 3	2 3	2 3	..	..	..	0 9
May, ...	515	1,931	1,114	8	89	..	8	..	3,665	1 6½	1 6½	1 6½	1 6½	1 6½	..	1 6½	..
June, ...	880	2,980	2,267	..	669	..	7	..	6,803	1 4	1 4	1 4	..	1 4	..	1 4	..
July, ...	596	5,171	800	4	471	..	..	110	7,152	1 2½	1 2½	1 2½	1 2½	1 2½	..	..	0 8
August, . . .	520	2,104	59	..	3	..	..	59	2,745	1 4	1 4	1 4	..	1 4	..	..	0 9½
September, . . .	245	254	..	9	..	..	..	59	567	2 1	2 1	..	2 1	..	..	..	0 9½
October, . . .	2	..	..	16	..	..	..	30	48	3 7½	..	..	2 11½	..	..	..	0 10
November, . . .	..	..	..	43	..	..	..	16	59	..	..	..	2 4½	..	..	..	0 9½
December, . . .	..	..	..	79	..	..	..	19	98	..	..	..	3 4	..	..	..	0 9
Total, . . .	3,394	14,368	5,979	279	1,232	11	15	329	25,607	..	..	..	..	..	..	..	..

Inspections in 1905.

The inspections made in 1905, which are reported upon separately by Mr. Calderwood, were of the Bladenoch, Girvan, Doon, Ayr, Loch Lomond and River Leven, and Deveron Districts.

Results of Investigations by Marking Salmon.

In order to obtain fuller information as to the migratory habits of the salmon, its increase in length and weight, and the relative times spent in fresh and salt water, the marking of fish, by the attachment of a silver label to the dorsal fin, has been continued since 1896. In the three reports which have been made by Mr. Calderwood on these investigations, particulars of 277 recaptured fish are given (20th, 22nd, and 24th Annual Reports). The greatest number of these are from the Spey (115) and the Tay (77), but important results have also been obtained from fish marked in the Deveron, Kyle of Sutherland, Brora, Helmsdale, Thurso, and Annan. At the present juncture it may be profitable to attempt a brief summary of the results obtained.

(1) *Return of Fish to their own Rivers.*—The great majority of river recaptures confirm the belief that the salmon after visiting the sea returns to its own river. The exceptions to this rule represent about $8\frac{3}{4}$ per cent.

(2) *Movements of Fish along the Coast.*—Recaptures in sea nets on the North and East Coasts, and in rivers other than those in which the fish were marked, seem to indicate that, when fish forsake their own rivers, they travel for the most part in an easterly and southerly direction, as from the Moray Firth to the neighbourhood of Aberdeen (*vide* Chart in Appendix II. *infra*).

(3) *Descent of Kelts.*—In small streams descent is more rapid than in large rivers. In the Tay, the river of greatest volume, grilse of both sexes descend at once after spawning; male salmon kelts descend more rapidly than females, and the latter, especially when large fish, may take as long as three months to descend forty miles of river. Kelts of both sexes frequently remain for some time in brackish water, and, after rapid descent, may even occasionally re-ascend to fresh water.

(4) *The Time of Return from the Sea.*—A two-fold habit of short and long periods of marine sojourn exists. Young kelts, of uniform class, marked in January or February, return as clean salmon in the summer or autumn of the same year, or as spring fish of the year succeeding. The same two-fold habit continues throughout the life of the adult salmon. This habit does not imply two distinct strains of fish. The length of time spent in the sea is subject to great variation. The grilse stage is passed in the sea by many fish. Some salmon spawn in consecutive breeding seasons, many at longer intervals. Throughout each winter a considerable proportion of clean salmon remain in the sea.

(5) *Increase in Weight.*—Fish marked as kelts and recaptured as clean salmon show great variation in growth and increase of weight. This is chiefly influenced by the length of time spent in the sea, but also to some extent by locality. A grilse kelt may double its weight in 88 days or longer. A Tay kelt of 6 lbs., remaining in the sea during the next spawning season, may enter the Tay, after fourteen months, as a spring salmon of 19 lbs., having increased to fully three times its kelt weight. A record

of minimum increase is exemplified by a clean Brora fish with an interval in the sea of only 108 days, and an increase of 2 lbs. Fish caught as kelts in two consecutive seasons (Brora and Deveron) have shown increases of only ½ lb. to 6½ lbs. To estimate the condition properly it is necessary to classify records according as the fish show short or long periods of sojourn in the sea, and to select records from one river district alone; variation in weight is then found to be not great. The following examples are of Tay fish:—

Short Period.		Long Period.	
Interval.	Increase.	Interval.	Increase.
176 days.	6½ lbs.	346 days.	9 lbs.
191 ,,	8¾ ,,	387 ,,	11 ,,
196 ,,	6¼ ,,	429 ,,	12¾ ,,
214 ,,	6 ,,	448 ,,	11 ,,
255 ,,	8½ ,,	556 ,,	19 ,,

The average of the long period is here double that of the short period. Records from other districts show that while actual weights of Tay fish are apparently not equalled, the ratio of increase is similar.

(6) *Change of Weight of Clean Fish in Rivers.*—Clean fish marked on entering a river and recaptured during their ascent of fresh water show decrease in weights of from 0 to 2 lbs.

(7) *Habits of Spring Fish in ascending Rivers.*—When the temperature of the river water is low the ascent is not rapid, and on approaching swift and rough streams or small falls salmon usually pause till suitable thermal conditions obtain. Floods may cause fish to drop down stream. Fish marked a few miles up a river have, after such winter floods, been recaptured in the warmer estuary.

Autumn Migration of Smolts.

Investigations have also been made by the Inspector, through the instrumentality of the Tay Salmon Fisheries Company, as to the presence or absence of migrating smolts during the autumn and winter months. A report on this subject forms Appendix III.

Natural History Notes.

In Appendix IV. Mr. Calderwood records the attempts recently made to rear salmon smolts in salt-water ponds; the artificial spawning and hatching of ova taken from smolts; and occasional captures of salmon by fishing vessels out at sea.

In Appendix V. reference is made to a singular ailment which affects salmon in the sea round the Outer Hebrides, locally named "The White Spot." It appears to occur only at the height of summer and to disappear when, after rain, the salmon are able to ascend to the streams and lochs.

In Appendix VI. is given a statement showing the number of salmon recently sealed by the officers of the Fishmongers' Company

of London to secure the identification of fish which are taken out of cold stores for sale during the close season.

The remaining three Appendices give—VII., the Rateable Values of Scottish Salmon Fisheries; VIII., the Annual Close Times at present in force; and IX., a List of Chairmen and Clerks of District Fishery Boards.

We have the honour to be,

Sir,

Your most obedient servants,

ANGUS SUTHERLAND, *Chairman.*
D. CRAWFORD, *Deputy-Chairman.*
D'ARCY W. THOMPSON.
W. R. DUGUID.
L. MILLOY.
D. MEARNS.
H. WATSON.

WM. C. ROBERTSON, *Secretary.*

SALMON FISHERIES.

TWENTY-FOURTH ANNUAL REPORT

OF

THE INSPECTOR OF SALMON FISHERIES FOR SCOTLAND.

TABLE OF CONTENTS.

	PAGE
ANNUAL REPORT OF MR. W. L. CALDERWOOD, Inspector of Salmon Fisheries for Scotland,	3
Inspections of the following Districts—	
Bladenoch,	3
Girvan,	6
Doon,	7
Ayr,	11
Loch Lomond,	13
Endrick,	13
River Leven,	15
Deveron,	19

APPENDICES.

I.	Reports from District Fishery Boards and others,	24
II.	A Contribution to the Life-History of the Salmon—Results of Marking Fish (3rd paper),	64
III.	Autumn and Winter Migration of Salmon Smolts,	70
IV.	Natural History Notes,	75
V.	Note on the Salmon Disease called "The White Spot" occurring in the sea round Island of Lews,	78
VI.	The Sealing of Foreign and Home Salmon for Sale during Close Season,	80
VII.	Rateable Values of Salmon Fisheries,	81
VIII.	Annual Close Times applicable to Salmon Rivers in Scotland,	84
IX.	List of Chairmen and Clerks of District Fishery Boards,	87

MR. CALDERWOOD'S REPORT.

FISHERY BOARD FOR SCOTLAND,
February 1906.

I have the honour to submit my report of inspections during the year 1905.

BLADENOCH.

The river Bladenoch and its tributary the Tarff drain the extensive moorlands of Wigtownshire. No District Fishery Board has at any time been in existence in the interests of the salmon fisheries, and, perhaps as a consequence, considerable neglect of those fisheries has resulted. At and above Wigtown, and near Kirkcowan, on both Bladenoch and Tarff, the water of the river is used to create power for various works, and the lack of supervision in the interests of the salmon fisheries is seen in the almost total disregard of the bye-laws of the Salmon Acts. I am informed that fish begin to ascend in March, but that the principal fishing is in the autumn. Netting is regularly carried on in the lowest reaches of the river, and an occasional shot of the net is made in the upper waters. The natural features of this river are such as to induce the conclusion that, given suitable attention and regulation, a material increase in the value of the fisheries would result.

I inspected the district on 1st June.

I first examined the dam-dyke and fish-pass at New Mills, about a mile above Wigtown, being accompanied by Mr. James Drew, Commissioner to Lord Galloway, and Mr. Andrew Thomson, Clerk of Works, also by gamekeepers representing the interests of Captain Hamilton, and Sir Wm. Dunbar, Bart., upper proprietors.

The dam-dyke is 275 feet long and 3 feet 9 inches high, the down stream face being about 12 feet. The structure has the appearance of having been heightened, and is distinctly leaky in places. By reference to a report made in April 1896 by my predecessor, it appears that the dyke was carried away by floods in the winter of 1894-95, and when rebuilt was not restored to quite the former height. The sill of the weir was, however, afterwards raised to the former height by the placing of a beam along the crest. This beam still remains, and, owing to the irregularity of the stone and cement work of the down stream face, is in places rather obstructive to the passage of salmon which may surmount the weir. No objections had, however, been made, so far as I am aware, to the abrupt nature of the sill of the weir. I had, however, been informed

that an obstruction existed in the fish-pass itself, concerning which objection had been raised. The pass itself I found to be a simple shoot faced with cement and containing two breaks placed in an alternate manner, as in the old-fashioned Smith's and Cail's structures. In breath it was 3 feet 11¼ inches at the sill, and in depth 1 foot 7½ inches or thereby. The depth of the opening or slap at the sill of the weir had, however, been reduced by the introduction of a stout wooden board measuring 13 inches in height, so that the actual slap for the passage of water down the pass at the sill of the weir was 6½ inches. This board had been introduced for the purpose, not of preventing the passage of salmon, but of securing to the adjoining meal mill a better supply of water. The actual result, from a salmon fishing point of view, was, in my opinion, to nullify the existence of the pass, because any fish trying to ascend the pass after entering and swimming through the unnecessarily rough and broken water, would be brought up against the perpendicular board. To leap the obstruction was impossible, there being no "take off" in a shallow pass of quick water. Such a fish would, in my opinion, be forced back to the foot of the weir, and any subsequent ascent, if successful, would be over the crest of the dam-dyke itself during times of moderate flood. The gradient of the down stream face is one in three. Without the board in the pass, and also, in my opinion, without the breaks in the pass, fish would not experience much difficulty in making the ascent, but if it is necessary to restrict the water flow, I consider that it would be better to construct a new pass than to resort to the present device of an obstructing board, or to level up the already too steep gradient of the existing pass.

After discussing the matter with Mr. Drew, as representing the owner of the dam-dyke, I suggested that the rather higher level of river bed which forms the channel near the right bank should be utilised for the construction of the new pass. The gap in the sill of the dyke might with advantage be close to a large rock which protrudes through the substance of the weir near the right bank. The course of the pass would then curve slightly towards the centre of the channel in conformity with the bank below the dyke, thus enabling a length of 30 feet to be easily obtained. The gradient of such a pass would be one in ten. I subsequently entered into details respecting the requirements which seemed to me necessary for a suitable pass in the position referred to.

On the day of my inspection the sluices at the intake of the mill-lade were being renewed, and I noticed that a very satisfactory heck had been provided to protect this intake. I understand that a heck on the tail-race below the mill-wheel is also to be erected.

I also inspected the four dam-dykes which appear to exist above this weir in this district—one in the Bladenoch proper, and three in the tributary Tarff. The dyke in the upper Bladenoch is at the *Borhoise Meal Mill*, the property of Captain Hamilton. It is a structure of loose stones varying in height from 2 to 4 feet. At the date of my visit the whole water of the river, exclusive of the water in the lade, was passing through the structure of the dyke, the level of the pool above the dyke being more than a foot below the uneven crest of the weir. There is a shallow slap in the

down stream face of the dyke near the left bank, but it is so blocked with the loose stones above and below as to be inoperative. This dyke should be made water-tight, and a more suitable fish-pass introduced. The most suitable position for such a pass is, in my opinion, about 7 yards nearer the centre of the dyke than the present slap. The dyke is sufficiently low at this point to make ascent easy through a simple but well-defined gap; and the rocks slightly to the left below the dyke could be readily utilized by a junction with the weir so as to cause a good lead up for fish.

Since the date of my visit I have been informed that a pass in this dyke has been constructed.

The Tarff water I found to be seriously interfered with. The three dykes are in the neighbourhood of Kirkcowan. Mentioned in order of ascent of the river, they are the Tarff Saw Mill Dyke, Milroy's Wool Mill Dyke, and Armstrong's Wool Mill Dyke. All are serious obstructions. The drainage area of the Tarff is 42·5 square miles.

The *Tarff Saw Mill Dyke* is an irregular concrete structure. There is no fish-pass, nor are there hecks on the lade. At the date of my visit the whole stream (which was then low) was passing down the lade. The water in the pool above the dyke was, however, lipping the crest of the weir.

Milroy's Wool Mill Dyke is a low structure compared to the last, but is really a much more serious obstruction. A deep pool exists immediately above the dyke, and the natural bed of the river is rocky at this point. The dyke is built on the rocks below this pool and is rendered water-tight by cement. The bed of the Tarff below the dyke was quite dry, since the crest of the dyke, which has no pass, was some 10 or 12 inches above the level of the pool above the dyke. It follows that even with a pass and six-inch slap in the crest of the dyke no water would have been flowing down the river. The natural channel is towards the right bank, but, as I have indicated, the abstraction of water constitutes a serious difficulty. The left bank at the time of my visit was being built up so as to enclose and strengthen the end of the dyke near the lade entrance; this being done, I was informed by Mr. Milroy, to prevent the destructive action of floods. The lade was without hecks.

Armstrong's Wool Mill Dyke. This dyke is fully half a mile above the mill, and is about 3 feet high. It is a cement-faced structure similar to the Tarff Saw Mill Dyke. At the date of my visit the water in the pool above was finding its way in a thin stream down the weir. From the great length of the lade it follows that a correspondingly long stretch of the stream is deprived of water, and I noticed that in this stretch several cascades and rapids occur, and that at two places all sorts of rubbish, including waste chaff, from Kirkcowan seem to be emptied freely over the steep left bank. The dyke has no pass, nor are there hecks on the lade. The mill stands a considerable height above the stream, and power is chiefly developed by means of a turbine. The manager informed me that the drop of the water at the turbine and bye-washes was 21 or 22 feet. The outflow enters the upper part of the deep pool referred to in describing Milroy's Dyke. I noticed also an impure

steaming effluent—from wool-scouring—pouring down the bank from a pipe. The yellowish fluid seemed to be boiling.

Speaking of the Tarff, one may say that, owing to the marked and complete abstraction of water which obtains, and which has apparently been permitted to occur without remonstrance for many years, it is clear that at all ordinary levels of water this tributary of the Bladenoch is closed to fish, and that even if fish run up as they appear to do during floods they are liable to be left dangerously exposed when the water falls.

Since the requirements of the Salmon Acts for the providing of salmon passes, sluices, and hecks are incorporated in Bye-law G of the Salmon Fisheries (Scotland) Act, 1868, active measures for obtaining compliance can only be put in force at the instance of a clerk to a District Fishery Board. I am of opinion that much good would result to the fisheries, whether sporting or netting, of the whole district if, after suitable arrangement of the roll entries, a Board could be formed which, through their clerk, could satisfactorily attack the difficulties which have been allowed to arise in the district, and by whom water bailiffs, or local keepers sworn in as bailiffs, could prevent poaching and other illegal practices.

I have since been informed that in all probability a Board will shortly be constituted.

Girvan.

From reports previously made, the Fishery Board is aware that in February 1902 a most disastrous pollution occurred in this river from the pumping of accumulated water from the Dalquharran Coal Pit. The water was pumped into a burn which flows into the Girvan near Dailly, and from the mouth of this burn to the sea every fish in the Girvan died. After a fire in the pit in question, the water which was allowed to flood the pit, and to accumulate after the pit was temporarily shut down, became highly charged with metallic salts, especially sulphate of iron. When this water was at length pumped out into the burn adjoining the pit a copious precipitate of a bright orange colour was formed. Certain remedial measures were tried, as described in my report for the year 1903, but finally, by the continual process of pumping, the poisonous qualities which had accumulated were gradually got rid of, and the Girvan returned to its former state. In June last I visited the Dalquharran Pit and inspected the burn between the pit and the river. The bed of the burn I found to be thickly crusted with the precipitate of iron, and still of the bright orange colour, but the water itself was running clear. I saw also the six settling ponds which had been specially constructed to combat the evil, but without effect. For two seasons now the reports reaching me have been to the effect that salmon were returning to the river and a small number spawning in the upper reaches.

On 8th November I received a letter from the Clerk to the District Fishery Board informing me that a meeting of the Board had been held for the purpose of considering what steps should be taken to improve the river in view of the cessation of the pollution above referred to, and asking advice as to proposals for artificially

restocking the river and for removing the sea nets of the district and impounding the head waters so as to allow an increased run of fish to ascend. On 9th November I replied at considerable length with respect to the various proposals made advocating more especially the removal of nets which are fished close to the mouth of the river, and the impounding of head waters for the purpose of augmenting the natural flow of water during summer conditions.

Doon.

The Doon, like the rivers on either side of it, has passed through periods when its salmon fisheries were greatly reduced in value and almost, it might be said, annihilated by the combined action of pollution and over-netting. Discharges from coal pits or iron works producing evil effects upon the river were especially noticeable in 1870, 1889, and 1893, but since the last-mentioned date the fisheries seem slowly to have improved. In 1896 a District Fishery Board was formed which has since continued, and which has materially assisted the recovery of the local fisheries; but, in spite of fixed net fishings on the coast and a run of spring fish to the anglers in the river, the rental of the district has never risen above £498.

I went over this district from the mouth of the river to Loch Doon, being much facilitated in my inspection by the kindness of Mr. Macrorie, the Clerk to the District Board.

The mouth of the river offers a rather peculiar question for consideration. The action of the sea, in throwing forward gravel and sand, appears to result in the gradual turning northwards of the channel of the river. At the time of my inspection, the tide being out, it was noticeable that the fresh water found its way down the beach by two rather shallow channels, and that there was a tendency for the water to break away into subsidiary channels. I was informed that the more southerly of the two channels which now exist was some years ago the only channel. Of the two now existing the northerly one appeared to me to hold the more water, and its oblique direction along the beach appeared to bear out the probability of the statement that the actual mouth of the river is slowly moving northwards. In defining limits of estuaries to such rivers as run directly into the sea without inlets or natural estuaries, the Administrative Commissioners, under the Salmon Fisheries (Scotland) Act, 1862, commonly directed that a part of a circle was to be drawn with a specified radius from a point in the mid-channel of the river-mouth at low water. In this way the prescribed estuarial area was secured to a river with a shifting mouth. The estuary of the neighbouring river Stinchar is so defined, and the same is true of the Girvan, although in the latter case the action of the waves coming from the south-west is entirely checked by the harbour pier. Well-marked cases of rivers with changing mouths, and where the estuaries have to be drawn in the way described, are the North Esk, the Deveron, and the Spey. The Commissioners under the Salmon Fisheries (Scotland) Act of 1862 originally proposed a conjoint estuary for the rivers Ayr and Doon, from the Deil's Dike about

1600 yards south of the mouth of the Doon to the Bell Rock about a mile and a third to the north of the mouth of the Ayr. This estuary, proposed in 1862, is shown in Appendix XII. to the Report of 1871, as well as the separate estuaries for each river afterwards fixed upon in April 1864. This delimitation was, however, not adhered to, and two rocks lying on either side of the river-mouth in the case of the Doon apparently induced the Commissioners to define the estuary without reference to the shifting mouth of the river. It is directed that the limits of the estuary are—"A Segment of a Circle of "400 Yards Radius, drawn from a Centre placed Half Way between "the nearest End of the Two Rocks on the opposite Sides of the River "Mouth . . . . . ." So we have a fixed estuary for a river with a shifting mouth. Immediately to the north of this artificially defined estuary fixed nets are fished. Hence it follows that as the river mouth moves northwards it approaches more and more closely to the line of fixed nets, and the purpose of defining the estuary in order to mark the distance from the river the Commissioners considered fixed nets might be allowed is nullified. The original distance of 400 yards does not seem excessive, but it has now been considerably reduced, and no provision exists for recasting the definition of the boundary. It is conceivable that in a case such as this a river might in course of time, unless artificially controlled, enter the sea outwith the limits of its own estuary and have bag nets fishing directly in the river-mouth. I am glad to be able to report that a movement is now on foot amongst the fishing proprietors to lease and remove the fixed nets near the Doon mouth. Sweep nets used also to be worked in the tidal pools of the river, but these were removed a few years ago. Some sweep-net fishing is, however, still carried on, I understand, in the upper reaches of the river. This fishing is in three pools, and is for spring fish alone. To continue this practice is, in my opinion, contrary to the best interests of the river. If by reducing netting at the river-mouth the stock of spring fish is increased—and this may be reasonably expected in a few years—the removal of such fish in any numbers from the upper waters cannot but be most unfortunate in the best interests of the river. On ascending the river I inspected first the dam-dyke of Alloway Mill. This I found to be a smooth cement-faced structure, about four feet in height with a simple shoot-like fish-pass. The crest of the weir was rather lower at the right bank than that at the left. The gradient of the down-stream face was too steep. The toe of the down-stream face had a slight upward curve, and as the bed of the river immediately beyond had been washed away to some extent, a rather abrupt termination to the pass resulted, which, in low-water conditions, was against the success of fish attempting to ascend. The weir is the property of the Marquis of Ailsa, and I have, since the date of my inspection, had some correspondence with the estate factor, Mr. Thomas Smith, as to the best means of modifying the structure, and also as to the repairing of the lade intake which I found so undermined by the action of the water as to admit a full complement of water even when the sluice was shut. I have, since the date of this inspection, had an opportunity of again examining this weir, and, the water being more suitable than on my

previous visit, of wadeing round the obstruction and in the salmon pass so as to note the action of the water and to take accurate measurements. As a result, I have suggested alterations which provide for the prolongation of the pass into the pool above the weir so as to secure a gradient of one in ten and the more adequate checking and concentration of descending water.

I also inspected the Skeldon Mills—a blanket manufactory—in order to see the provision made to prevent the escape of the scouring waste wash from injuring the river, concerning which complaints were previously made, and to inspect the weir and lade in connection with the works. The scouring is done by the use of soap alone and the scour wash is the only waste material allowed to pass from the works. This is run into a pond, where the soapy material is allowed to settle, and the fluid from the pond is run off into the river by a sluice under the control of the river watcher who uses his discretion so as to make use of high river levels for the discharge. At the time of my visit the pond was full and emitted an evil smell from the decomposition of the soap and the escape of noxious gases. I was informed that the pond had been standing full for six weeks owing to the long continued low water conditions. A slight amount of leakage was noticeable. I cannot but regard the discharge of this soapy waste as most injurious to the river; at the same time it was very obvious that the manager of the mills did all in his power to minimise any evils arising from the existing conditions. The dam dyke above the mill was a not very serious obstruction of loose stones. Towards the left bank the obstruction vanished in the bed of the river. Towards the right bank, where fish are most likely to ascend, a bye-wash exists in the sill of the weir which could very easily be opened and used as a fish pass when the state of the water is suitable for fish running, and when the mill lade intake is closed.

At the Dalmellington Iron Works a discharge of polluted hot water takes place. The water appears to be used in the works for cooling purposes. In its discharge from the works, however, it first appears to receive a considerable amount of impurity, then passing below the roadway and a number of cottages it is grossly polluted by domestic sewage, and is run into a few roughly constructed ditches in a marsh between the cottages and the river. It is then joined by water coming in a comparatively pure though heated state from other parts of the works and is carried in a built ditch to the river. At the outfall an examination trap has been fitted. Here the actual foulness of the discharge is not obvious. It is probable, however, that the percentage of oxygen is small. By means of a pocket thermometer I ascertained the temperature to be 96° F., while the water of the Doon above and at Loch Doon was 55° F.

About a hundred years ago the outflow of the river from Loch Doon was sluiced and a great barrier of rock tunnelled by Earl Cassilis and Mr. Macadam of Craigengillan. The level of the loch was thereby diminished and an attempt made to regulate the flow of the river. Two sluices were constructed, each 6 ft. wide and 6 ft. 8 in. high. The tunnels cut through the rock were 66 feet long. One sluice was kept open all the year round; the other, which was at a

different level, was seldom opened. The rush of water through the tunnels was found to be very great, and the sluices appear to have been unapproachable during floods. In a report on the Doon prepared by Mr. James Leslie, C.E., and Mr. Shaw, Drumlanrig, dated 1855, the area of Loch Doon is stated to be 1240 acres, and a recommendation is made "both for the sake of the mills and of "the fisheries that the storage of Loch Doon should be increased "by raising its high water level; by which means, without any "damage to property beyond flooding a small portion of moorland "on its shores, there might be an available depth got of 20 feet. "This would give a storage of 1080 millions of cubic feet, which "would give 4000 cubic feet a minute for six months in the year, "in addition to the natural flow of the river. This quantity would "fill a rectangular channel of 12 feet wide and 2 feet 8 inches deep, "falling 1 in 4000, or nearly 16 inches per mile.

Extensive alterations were proposed for the outlet, but these were not carried out, I am informed by Mr. Thomas Brown, the forester at Craigengillan, till the year 1885, or thirty years after the report above referred to. Instead of a tunnel 66 feet long, the principle salmon pass is now 155 feet long, 17 feet of which is in the form of a deep level canal at the upper end. The difference of level is reported to be 7 feet, so that the gradient of the pass below the canal-like portion is practically 1 in 20. The only portion of the pass now in tunnel is that which is traversed by the roadway at the foot of the loch. I consider that the flow of water in the pass could be improved and checked by the introduction of suitably placed stones to act as brakes to the descending current. This is particularly the case towards the foot or entrance of the pass, where the gradient is a little uneven, and where the water at one part becomes thin and shallow. Fish are apparently prevented at times from ascending the other channel. As in the case of the Helmsdale, upon which I reported last year, I consider that conditions are here ready to hand by which all evils following upon long-continued dry weather in summer, and consequent shrinkage of the river, may be overcome by the storage of water and the regulation of the sluices. In the Helmsdale the tenants act conjointly in the interests of the river, and fish each the other's water by rotation, the river being divided into beats. The benefit derived from releasing water during low level conditions, by cleansing the river bed, drawing fish from the sea, and inducing fish to move from pool to pool and rise more fully to the fly, is, I consider, most marked in the case of the Helmsdale, and might in the same way, I believe, be marked in the Doon, if agreement could be come to in the matter of storing the water and regulating the openings of the sluices. In Ness Glen, at Craigengillan, sufficient rough water exists to check the ascent of early-running fish till the temperature of the water has warmed from its wintry conditions. Fish should, therefore, accumulate in the pools below Ness Glen, and at a later date and for a shorter time in the pool below the fish-pass. With the suitable regulation, by the District Board, of the various points requiring attention in the Doon, I am convinced that the stock of fish would in a few years greatly increase and the value in the fisheries rise accordingly.

Ayr.

I am informed that since the erection of the fish-pass at Over Mills Dam the number of fish noticed in the river at and above Auchincruive has greatly increased. It is necessary, however, also to remember that Mr. Oswald, the chief proprietor of the district, has removed all the nets which formerly used to be worked at the mouth of the river and on the coast on either side. There are now, in fact, no nets fished in the whole district. The Ayr has a catchment basin of 220 square miles, being therefore considerably larger than the Doon, Girvan, or Stinchar, which drain respectively 126, 96, and 129 square miles (the drainage to Loch Ryan being included in the Stinchar district). The comparatively small rental of the Ayr continues, however, because the upper part of the Ayr district is quite valueless owing to the impassable dam-dykes which have been erected, and apparently allowed to remain unchallenged, at Catrine. The upper spawning grounds, the natural breeding places for early-running fish, are entirely cut off, and even the water some distance below Catrine, as well as the Lugar tributary, have till recently been left to the will of the local fish-catcher, who, I have had evidence to show, is not at all particular either as to his methods or as to the season of his operations. During my visit to the district last June I made a special inspection, in company with the Clerk of the District Fishery Board, of the obstructions at Catrine, and before leaving the district I also inspected the Lugar water, an important tributary which drains 86 square miles of country, *i.e.*, only 10 miles less than the whole river Girvan. The river was at summer level during my visit, and I, therefore, had ample opportunity not only of inspecting the obstructions but also the bed of the river in the neighbourhood. At Catrine the large works of Messrs. James Findlay & Co., spinners, bleachers, &c., are situated; and in taking power to these works an extensive lade and an aquaduct have been constructed to lead the water to the famous Catrine wheels. These two water-wheels develope, I am informed, 500 h.p. They work side by side in unison, each wheel being 50 feet in diameter and 12 feet wide. I was able to view the wheels in the lofty power-house, and anyone doing so could not fail to be impressed not only by the enormous structures themselves, but by the great quantity of water used in driving them. At the time of my visit the river between the intake and outfall of the lade was practically dry; indeed, Mr. Macrorie and I walked up the bed of the river for a distance of, I suppose, about three-quarters of a mile, to inspect the dam-dykes. We could cross freely from side to side as no water was descending the river, and only pools remained here and there, in which shoals of minnows sported. The whole river Ayr at this point was carried through Messrs. Findlay's lade. I have only once previously witnessed the total abstraction of a river of any size, and this at Messrs. Pirie's, Stoneywood Works, on the river Don, recently the subject of important litigation. On ascending the river, towards the intake of the lade already mentioned, one first comes upon a dam-dyke about four and a half feet high, situated at an iron foot-bridge some 150 yards below the main weir which turns the water into Messrs. Findlay's

lade. This first dam-dyke is a most substantial structure about 70 feet long. The sill is of iron. The down-stream face is an abrupt concave slope of smooth cement, and the lower margin of this slope is bound with a broad flange of iron similar to the sill. There is no apron, and immediately below the lower iron beam a very deep pool occurs. There is no gap or fish-pass, nor is there any lade passing off from the dyke or water available for such lade. The structure stands as a sheer iron-shod wall right across the river, and has apparently been erected merely for the purpose of protecting the very long paved apron of the weir above. In my opinion it is a total obstruction to the ascent of salmon, and as such is the more objectionable since it is not of service in diverting water. I understand it was erected only some ten years ago in place of a less serious obstruction which previously existed here, and which had the same function as the present dyke. It seems to me clear that in allowing such an obstruction to remain, the general interests of the salmon fisheries of the district are seriously injured, and that the structure should either be entirely removed or be provided with an efficient fish-pass.

From this to the main weir above, the river was also dry, since it is from the main weir that the river Ayr is, in low water conditions, sent down Messrs. Findlay's lade.

The main weir is not thrown directly across the river but at a slant, so that the intake of the lade which is on the right bank is considerably further down the river than the left extremity of the weir. The crest of the weir is approximately 230 feet long. The down-stream face is 24 feet long, and is succeeded by the long paved apron already referred to. The height of the weir is about 6 feet. The structure is most solidly put together and bears signs of having been repaired and altered from time to time, and of being supervised with care. It would appear that the original weir was not so high as at present, since a massive iron copeing with a rounded up-stream surface and a perpendicular down-stream surface about a foot in height rests on what appears to have been the original sill. Close to the left bank there is a large sluiced bye-pass cut down to the level of the bed of the river. It is 14 feet across, and is securely closed by a sluice gate with rack and pinion action. From the presence of a large bank of sand close to and just above the sluice, I formed the opinion that the bye-wash had not been used for some time. There is also a large scour pipe some 18 or 20 feet further out the weir. This appears to be more frequently used. The pipe is about 3 feet in diameter, and passes through the substance of the weir. Close to the right bank there is further a wooden slap or gap in the sill of the weir so arranged that it can apparently be boarded up. All these openings are provided for the conveyance of water down the natural river channel at such times as it is not wanted in the lade or when the lade sluices may require repairing. They have apparently no connection with the possible ascent of fish. The lade sluices are four in number, one being at a higher level than the others. The sluices are protected by two wide-sparred hecks. There is no attempt to conform in any way to the bye-laws of the Salmon Acts which provide for the ascent and descent of fish. With the re-

moval or modification of the lower dyke at the footbridge it will be necessary to modify the crest of the upper weir also. Fish would have no difficulty in swimming up the down-stream face when there is sufficient water in the river, but the perpendicular iron copeing on the sill would act as a most serious obstruction to further progress. By those two obstructions at Catrine, 15 miles of the upper river are rendered inaccessible to spawning fish, besides about 5 miles in the Greenock water.

Loch Lomond District.

My inspections in this district were confined to the river Endrick, the chief spawning stream for salmon which enters the loch, and to the river Leven which flows out of Loch Lomond and enters the estuary of the Clyde at Dumbarton.

The Endrick.

This river rises in the high undulating country to the south-east of Loch Lomond, and after a hill course of a few miles descends the Loup of Fintry by three falls, calculated as 94 feet in height. From this total obstruction to the ascent of salmon to the mouth of the river the distance is about 21 miles. For a distance of 10 miles or so below the Loup, the river presents a fine succession of pools and streams with much beautiful spawning ground, then for a few miles the bed is rather deeply cut in steep pastoral and at times highly wooded land where, in the neighbourhood of Gartness, two rocky barriers are passed which require special mention, then lower down where the railway viaduct crosses west of Drymen station, the river passes through flat meadows and the beautiful woods round Buchanan Castle; here the course of the river becomes highly tortuous and the current gentle.

The two obstructions at Gartness are, in descending order, first the double obstacle of a dam-dyke and fall at the village of Gartness, and second, beyond an extensive loop of the river course, The Pot of Gartness. That salmon manage to surmount both obstructions was sufficiently evident to me by the sight of a number of fish in the pool above the dam-dyke, but certainly the ascent must be accomplished with difficulty, especially at The Pot of Gartness. Both might with great advantage be modified or provided with efficient fish-passes so that the splendid spawning grounds above might be rendered of greater utility. This is the more desirable in the interests of the whole district's fisheries since in proportion to the size of Loch Lomond the other available spawning streams are comparatively small and rocky. At the time of my visit (28th and 29th June) the river was very low, and I was, therefore, able to inspect very fully the formation of the obstructions referred to. The dam-dyke at the village of Gartness is for the purpose of supplying water-power to a small wool mill. The dam is above the fall, and the mill is below the fall, hence the fall is deprived of the water carried down the lade. At the time of my visit the mill was not working, owing apparently to the progress of some repairs, but the lade was running full, and the water-fall as a result was practically dry. The lade was unprovided with hecks.

A very deep pool exists immediately below the fall, and at the time of my visit the actual rise from this pool to the sculptured rocks above was barely three feet. These rocks extend for some little distance, and the stream from above has worn a well-defined S-shaped channel to the edge of the fall. It would not be difficult to lower the crest of the fall and to improve the channel above for some 30 to 40 feet, so as to secure a much easier ascent to the fish.

The dam-dyke just above, I estimated as about 5½ feet high, with a down-stream face of about 53 feet, constructed of irregular stones. The length is about 75 feet, and the sill of smooth cement. There is no gap or fish-pass of any kind. Neither in the matter of the weir, therefore, nor of the lade, are the bye-laws of the Salmon Fisheries (Scotland) Act, 1868, observed.

At the Pot of Gartness the obstruction to the ascent of fish is, as I have said, more serious. The pool immediately below is large and deep, and at times, I am informed, holds a very large number of fish waiting or trying to ascend. At the time of my visit the minimum leap which it was necessary for any fish to take was about 5½ feet. In times of flood this will no doubt be sensibly lessened, but the entire face of the rock is precipitous and difficult of ascent. The natural lead up for fish is by the left bank, and on this side of the river the rock has been worn away to a greater extent than elsewhere, so that the actual barrier slants in a curving outline across the river. Above the precipitous face of the barrier the bed of the river is rocky and much broken into ledges for a distance of about seventy yards, with an additional rise of about 7 feet. A wool mill, now apparently disused, is situated on the left bank above The Pot, and is provided with a lade drawing water from the upper extremity of the rocky area. The outlet of the lade (which has a high bye-wash falling into The Pot) is at the lower end of the pool, and is provided with a heck. An old disused meal mill stands on the right bank. No attention seems to be paid to the sluices at the intakes of both lades, and all water entering is wasted in being carried beyond the fall.

To make a suitable pass at this obstruction without very great outlay it is necessary, in my opinion, to construct a channel in the rocky ledges above the fall, and to concentrate and direct the water-flow in a wide zig-zag direction, culminating at a cleft in the main rock face near the centre of the river. Owing to the lowness of the water I was able to walk all over the rocks from bank to bank, and to take careful note of the possible line of ascent.

The proposal to open up this obstruction to the passage of fish has repeatedly been present to the minds of those interested in the salmon fisheries of the district. The actual ownership of the fall is shared between Col. Blackburn on the left bank, and the trustees of the late Mr. Govane on the right bank. The fact that a body of trustees rather than a responsible proprietor have to be consulted seems the cause of the delay in opening up the fall. From correspondence with the agents who act for Mr. Govane's Trust, I learn that the trustees hesitate to take the responsibility of permitting any alteration on the rocks because of the impossibility of saying definitely what effect such an alteration would have upon the fishing or the volume of water thrown upon the proprietors below,

including the trustees in question. It respectfully seems to me that if the trustees would consent to be advised respecting this matter a definite conclusion might be arrived at with respect to the question upon which they very properly hesitate, and a material benefit secured not only to the fishings under their charge but to the general salmon fisheries of the district.

River Leven (from Loch Lomond).

With the rise of the important dyeing and calico-printing industries of the Vale of Leven, and the advent of a large population connected with those industries, the salmon fisheries of this neighbourhood have declined. Yet the very insignificant level to which the fisheries shrank a number of years ago has been improved upon. The pollutions of the river, which were without doubt the cause of the decline, are not now so gross, it is stated, as formerly; and everything is being done to develope the fisheries which remain to the beautiful loch and tributaries from which the river takes it rise. The improvement is due no doubt to the erection of settling tanks in some of the works, and to the fact that analysis of the various effluents are made at regular intervals under the auspices of the Dumbarton County Council. Unfortunately, from a fishing point of view, the conditions of the river at the present day are very far from satisfactory. All the works discharge great quantities of colouring matter, much of which is no doubt comparatively harmless but which coats the bed of the river with a greasy sludge; some of the works also allow actively toxic liquors to escape. All the works boil and discharge immense quantities of water which is thus deprived of its oxygen, the gas indispensible to the proper respiration of the fish; and in addition to these disabilities the sewage of this thickly-populated valley, with towns like Alexandria, Renton, and Dumbarton, is poured straight into the ever-convenient river.

I visited the district in the month of June, when no doubt I was able to see the worst aspect of the pollution, since the river was then at its summer level. Yet the Leven is always a river of considerable volume and well able in its lowest state to hold and allow the free ascent of salmon and sea-trout. I have no hesitation in saying that were it in a purer state salmon would run into Loch Lomond in spring (as to a limited extent they have been doing of late), as well as through summer and autumn, and that the value of the fisheries would soon become very considerable. At the present time the chief run of salmon to the mouth of the river is in June, while grilse and sea-trout run in July. In Loch Lomond the greatest number of salmon are taken in May, and the greatest number of sea-trout in August. The opening up of the obstructions on the Endrick, to which I have already referred, is a step, in addition to the purification of the Leven, necessary for the adequate distribution of the breeding stock. The Leven, in the condition in which I saw it, was quite unsuitable for the ascent of fish, indeed one could scarcely imagine that in the lower reaches fish could survive for any length of time. Certain spots there were where apparently sick fish sought respite from their unhealthy surround-

ings, and from the movements of groups of men and boys I noticed here and there it was evident that the unfortunate fish were then harassed by other dangers. In the very turbid waters of the lower river it is, however, very difficult to see fish. The only specimen I myself noticed was a dead sea-trout floating down the centre of the stream.

In my inspection I proceeded downwards from Balloch to Dumbarton, and in two consecutive days visited each of the nine works concerned in the staple industry of The Vale. I should like here to acknowledge the courtesy of the various managers in showing me everything connected with the various processes which in anyway affected the effluents to the river. In the present report I do not propose to enter into a detailed description of each work and its particular pollutions. Such a report would necessarily have to consist largely of analysis more exhaustive than those given in the reports of the Dumbarton County Council, and would be somewhat out of place here. I desire rather to deal with the general question of the impurities as they affect the salmon fisheries, and as they seem to occur in certain of the works.

In considering the *colouring matter* which finds its way into the river, it is at once apparent that while certain dyes are always present, such as alizarin, which gives turkey red, chrome yellow, which is a chromate of lead fixed by dilute acid, or prussian blue, containing nitrate of iron, stannious chloride, and yellow prussiate of potash, &c., the operations of calico-printing as carried on in this district for the supply of both the home and the eastern markets, involve an almost infinite variety of colour mixtures and mordants used at different times. Some colouring matter which gives a most evil appearance to the river may nevertheless be comparatively innocuous to fish life, while others which may be combined with bleaching liquors, and which may be less noticeable to the eye, may be much more injurious to the fish. In this way it appears to me that those works of The United Turkey Red Co., Limited, which were formerly owned by Messrs. Archibald Orr Ewing & Co., and which are concerned primarily in simple turkey red dying operations, are less harmful than the works of the United Co., concerned in bleaching and printing, as also the works of The Calico Printing Association, Limited. The former also are noticeable as being the works at which purification by means of settling tanks is invariably attempted, while in the works from which the most injurious effluents seem to flow the same attempt at purification is not apparent. In treatment by *settling tanks* it unfortunately is the case that much of the highly-coloured waste liquid is of practically the same density as water, so that any sedimentation is necessarily slow and imperfect. In spite, therefore, of the retention of the grosser solids and the skimming of fats, it was in every case noticeable that the discharge to the river was almost as high in colour as the inflow to the settling tanks. The most elaborate series of tanks exist at the Croft Works of The United Turkey Red Co. There are four sets of tanks at these the largest works in the district. At the time of my visit the first set contained a dense green colour and were provided with gratings and beds of ashes. The ashes, I was informed, are renewed every three months.

The second set, composed of four large tanks, contained a turbid alizarin waste where the fatty matter was skimmed off. The next set contained a fluid of a dense brown colour principally composed of a substance, not a dye, used in the after-treatment of dyed material. The remaining set of tanks were so subdivided that the waste fluids travelling slowly through them took a most tortuous course, and so prolonged the operation of settling. Fats were freely thrown up and all soapy wash was curded. Yet the discharge pipe showed a bright red fluid. The manager of those works informed me that in their laboratory the coloured washes had repeatedly been reduced to colourless fluids, but that this could not be accomplished in practice without great expense. With regard to more perfect filtering he also informed me that an experiment with a special filter had resulted in complete clogging in two hours, and that operations of purification in his work were therefore confined to settling as completely as the difficult nature of the bye products allowed, and to the rendering of the effluents as nearly neutral in reaction as possible. As a rule the reaction seems to be slightly alkaline. Compared with such endeavours to purify the effluents, the conditions observed elsewhere seemed unfavourable. At The Ferryfield Printing Co.'s Works, for instance—an old work—the only tanks which could be shown me were two small receptacles for waste wash situated under the floors of two of the dye houses; and at the works of The Calico Printers' Association, Limited (formerly J. Black & Co.), no settling tanks, properly so-called, exist, although an old dye-vat is used to catch mixed colour waste. The old dye-vat appears to be cleaned out once in 12 or 18 months. At the last-mentioned work three outfalls into the river and one into the lade carry off most of the waste fluids, although after washing the printing rollers the sediment is reported to be removed. I here saw two tanks of hyper-chloride of lime, but the chemist of the works maintained that practically none reached the river. At the time of my visit one of the discharge pipes from the printing house was passing into the river a very bright yellow, of chrome and olivine. The bed of the river below such discharges becomes thickly coated with various colours, red, green, blue, yellow, as the last discharge determines. At Dalquharn Works, the lowest on the river, where dyeing alone is carried on, but where no clearing or settling seems to be attempted, a thick deposit of chromate of lead was upon the stones of the river edge (the dead body of a dog, another waste product given to the river, was partly bright yellow and partly red). From this point downwards the river presents the appearance of a large open sewer, yet at this point we are barely five miles from Loch Lomond, being about one mile from the mouth of the river.

With regard to *bleaching mixtures*, I was particularly struck with what I saw at the Cordale Works of the United Turkey Red Co., which formerly belonged to Messrs. Wm. Stirling & Sons. A lime tank at the back of the premises I could not regard but with apprehension as a source of chlorine. It discharged into a section of the lade passing out below the works. The outfall of this section of the lade was suspiciously clear, stones beneath the water being sharply outlined and without the appearance of either natural sedi-

ment or pollution. There seemed, moreover, to be a considerable amount of evidence pointing to the presence of chlorine in the water, although, no doubt, the amount varies considerably from time to time. The presence of chlorine is most injurious to fish life, and, even when not sufficiently strong to be fatal, gives a marked "iodoform flavour." I had good proof given me during last summer that fish taken in the Clyde just outside the mouth of the Leven were uneatable owing, apparently, to this characteristic taint from chlorine or some kindred substance, such as iodine or bromine. I am informed also that the fish netted at this spot were found to be unmarketable about the time of my visit. A very small percentage of chlorine is sufficient to taint fish, and it is extremely important that the escape of this and of any kindred substances into the river be entirely prevented. Otherwise injury to the salmon fisheries is inevitable.

The remaining point to which I desire to refer is the quantity of boiled and therefore unoxygenated water which passes into the Leven. This affects the river in two ways—(1) in depriving the fish of oxygen necessary for their respiration and incidentally making it less possible for various substances found in the pollutions to be rendered inocuous by union with the river water, and (2) in locally raising the temperature of the river to an abnormal degree. The first is the more important. All the works pump large quantities of water for use in the dye vats and for washing dyed material and apparatus. It may be said that most of the works require all the water they can get, and that the works on the lower river cannot get this water in a very satisfactory condition owing to the pollutions above. In one or two of the works a certain amount of washing is done in the lade as it passes below the wash-houses, but in the majority this appears to be impossible. At some works the coloured discharges occur in the lades, where steam from the pumping engines may also be blown, in others the discharge pipes are carried out on the bed of the river as far as mid-stream. From the processes employed in the various works it is inevitable that most of the water lifted from the river is raised to a very high temperature. In dyeing, 120° to 130° F. is usual, and in the clearing and fixing processes 190° to even about 200° F. may be reached. With such high temperatures, all air is expelled from the water, and a fluid results which, even without the introduction of impurities, is quite incapable of supporting any animal life. But for the fact that the river Leven contains a large volume of pure water from Loch Lomond, the many discharges from the works would have a much more serious effect. I was informed by the Manager of one of the works that about three and a half million gallons were passed through his work in twenty-four hours. From the similarity of the processes in all the works, excepting the Millburn Chemical Works, where the distillation of wood spirit is conducted, and, I understand, the acids and lime, &c., used in processes of the other works are made, we may, I think, fairly estimate that not less than twenty-five million gallons of water are used in the Vale of Leven dyeing and printing works each day, and that almost all this, plus much impurity, is returned quite destitute of oxygen to the river.

With regard to the effect which the high temperature of those discharges has upon the river I was able to make only very imperfect observation, by taking an occasional reading with a thermometer dipped from the river bank. Daily readings were, however, taken for me during May, June, and July, in the river at Dumbarton and in the Clyde outside the river mouth. The means for those months are :—

1905.	Leven.	Clyde.
May, . . .	51°	53°
June, . . .	59°	59°
July, . . .	59°	62°

On the two days during which my inspection of the Leven lasted, the readings at the above places were :—

	Leven.	Clyde.
29th June, . . .	64°	65°
30th ,, . . .	63°	65°

My own observations, taken as described in proximity to the works, showed a temperature of from 68° to 69°, and below the last of the works (Dalquhurn), but not more than 100 yards below the outfalls, I obtained a reading of 72°. The weather was extremely hot at the time, and this, no doubt, must be taken into consideration; but the inference seems to me to be that the temperature of the water in the Leven is materially affected by the discharges from the works, although, no doubt, markedly high temperatures such as above are very local. Some accurate observations as to the proportion of oxygen in the water at different parts of the river would be of value, as well as analysis for some of the more toxic pollutions. I am strongly of opinion, however, from what I have seen, that while some polluters of the river make reasonable and fair attempts to reduce the evil effects of their bye-products, others do not do so, and that if an equitable share in works of purification were borne by the various companies involved a material improvement would be seen in the condition of the river. With the great variety of substances which are introduced into the effluents it is more than likely that with a more complete system of mixing, and the possibility of greater time being given to the process of settling, much greater sedementation would result. It might, I think, very fairly be considered, for instance, whether or not some system could be adopted by which the waste liquors of certain works could be combined and treated collectively on each side of the river. And I consider that the particular works at which little or no treatment is at present existant might be reasonably required to purify their effluents. And in connection with a more systematic purification it would, I consider, be valuable that by analysis of the effluents and by agreement between the parties concerned a standard of purity should at the same time be established.

Deveron.

In February 1898 the cruive dyke, formerly situated about two miles from the mouth of this river, was removed, and a marked

improvement in the stock of fish in the river was very naturally looked for after the lapse of a few years. In 1897 the assessable rental of the district was £2658. The reports which I have received from the clerk to the District Fishery Board since the year 1897 may, as regards rental and general results of fishing, be summarised as follows:—

Year.	Rental.	Netting.	Rod Fishing.
1898	£2,979	Below the avearge.	A failure.
1899	3,078	Average.	Below average.
1900	3,186	Above average.	1,113 fish.
1901	3,186	Average.	824 fish.
1902	3,048	Average.	950 fish.
1903	3,104	Average.	1,235 fish.
1904	3,387	Below average.	Below average.
1905	3,368	Much below average.	Much below average.

It is clear from a glance at these statements that no improvement is claimed, and from conversations I have had with those who habitually fish the water near Turriff by rod, I am forced to believe that the recent seasons have been very bad indeed. In connection with the annual marking of salmon during close season I organised, *inter alia*, a netting expedition to the Deveron. By the kindness of various proprietors, and especially of Mr. Milne, of Ardmiddle, netting was conducted from the Bridge of Marnoch to the Turriff Bridge. Much of the water was too rocky to allow of satisfactory netting, and it may be that for this and other reasons the test was not altogether a searching one; but the result satisfied me and, I think, all those who were present at the netting, that the stock of fish was distinctly limited during last breeding season. Mr. Kennedy, the superintendent, informed me also that all over the district the stock of fish seemed lower than he had ever known it.

With regard to what may be regarded as usual causes of such a reduction of the fisheries, such as overnetting, pollution, &c., I may state that sweep netting is carried on in the Deveron from the mouth of the river to the Bridge of Alvah, a distance of three miles. In the early part of the season this extent of water is fished by one boat's crew alone, there being a crew at work by day and another at work by night. From July onwards this amount of netting is doubled, two crews fishing by day and two by night. On the coast outside the river bag nets may be set, in accordance with the limits of the estuary, within 400 yards of the river mouth. An estuary of 400 yards radius is perhaps not excessive, but yet it is difficult to regard it as too small since it is precisely the radius of estuary prescribed for the river Dee—a thoroughly well-stocked river. Another factor which must be taken into consideration is the presence of seven distilleries in the upper waters which have been estimated as distilling over 6000 bushels per week during the

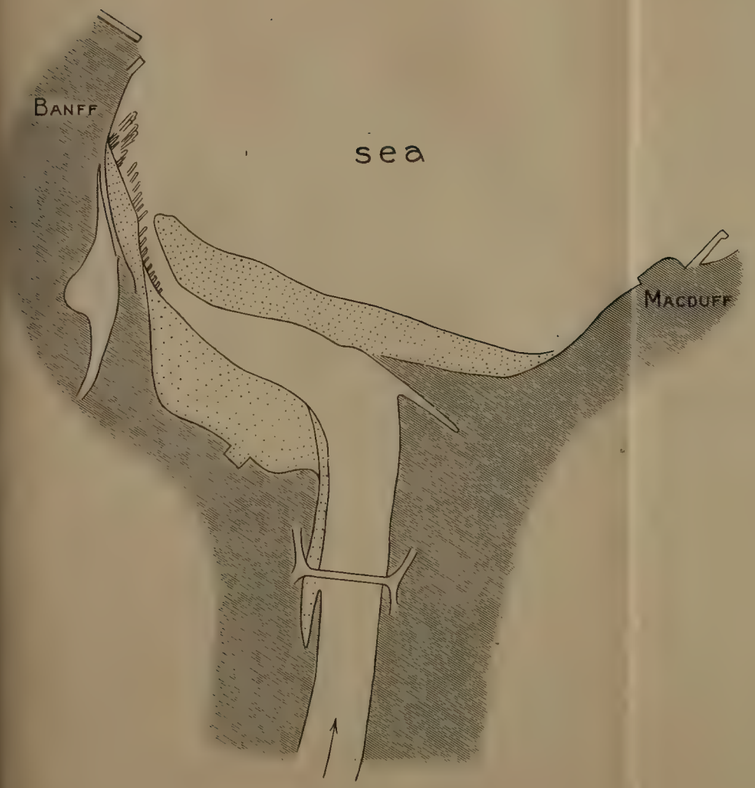
six or seven months the industry is annually carried on. If the Deveron were a thoroughly well-stocked river a limited amount of netting could be allowed without injury and the netting be much more valuable than at present. The conditions of each river have to be considered on their own merits in this respect, the object aimed at being to secure to the unnetted waters a proportion of every run of fish which enter the river mouth. If the netting is carried on too far up the river, the weekly close time becomes of no value, since the upper nets catch on Monday and Tuesday the fish which passed the lower net stations on the Sunday; if physical conditions cause all ascending fish to pause at certain points and to congregate—and when the river is cold in the early part of the season fish are easily checked in their ascent—the use of a net at such points may remove whole runs of fish with a result injurious to the best interests of the river.

In the Deveron, however, there appears to be a cause of the falling away of the stock other than the causes mentioned, although in all probability various causes contribute in varying proportion; I refer to the unusual conditions noticeable by the silting up of the river mouth by the opposing actions of the river on the one hand and the sea on the other. I made short reference to the barrier of gravel so formed in the Twentieth Annual Report. The action of north-easterly gales appears to be to force the river mouth to the westward, yet the condition is ever an unstable one. At the time of my visit, last December, the actual mouth of the river was as far to the westward as the limits of Banff Bay and a retaining wall at a street called Low Shore in the town of Banff would permit. I have no doubt that this is the usual point of outlet, as although from time to time breaches are made in the gravel barrier of the beach—as had occurred just before my visit—the overmastering force is that of the sea acting from a north-easterly direction. Instead of flowing straight into the sea from the direction of Banff Bridge, therefore, the water of the river is turned to the westwards by the gravel barrier referred to, and a long tidal basin or lagoon is formed, separated from the sea by the barrier. At the retaining wall of Low Shore the water is turned seawards through an opening grudgingly allowed, as it were, by the sea. In December last this opening, even at high tide, was only about 30 yards across, and when the river is low the sea is apt to make it shallow by the formation of small deltas of sand and fine gravel when the force of the fresh water current diminishes. Many have confidently informed me that at such times the mouth of the river is practically closed up and that no fish can possibly enter. The tidal basin, while it gives storage room for a few old fishing boats and is a suitable launching place for new boats built, is a most unfortunate feature from the point of view of salmon fishery interests, for two reasons: first, the natural flow and force of the river is lost on entering this basin, and second, much water finds its way into the sea by percolation through the gravel, so that the actual volume of water at the outflow of the river is diminished. The result is that a very poor lead in for fish is offered. I have no hesitation in saying that for a river like the Deveron, with a course of between 50 and 60 miles and a drainage area of 472

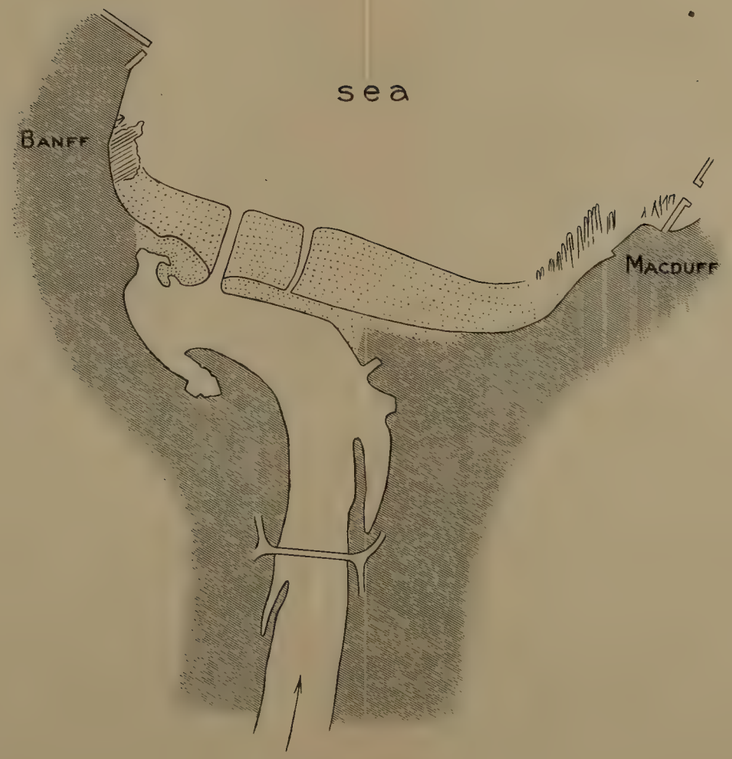
square miles, the mouth is extraordinarily poor and insignificant, and that, in my opinion, this is probably the most important factor to be considered in the present depleted condition of the district fisheries. Mr. Francis George, the Town Clerk of Banff, who is also the Clerk to the District Fishery Board, has kindly sent me for perusal an old map of Banff prepared from a survey made in 1823. From this, and from the Admiralty chart of Banff and Macduff prepared in 1834, and the Ordnance Survey plan showing what is practically the present condition, I have prepared the accompanying illustration of three phases in the appearance of the river mouth. From the 1834 chart it will be seen that a straight mouth was open in the barrier some distance to the east of the present mouth and that, apparently, a similar mouth had previously been open still further to the east and more in a line with the natural and direct outflow of the river. I understand, also, that shortly after 1834 a severe storm so altered the bar that the river found exit at the eastern or Macduff side of the bay, by the rocks called Palmer's Cove. I am, however, unable to represent this condition in the illustration. The Deveron at Banff Bridge is approaching the sea in a direction opposite to the centre of Banff Bay, and one has, I think, to consider this the natural line of approach, since Banff Bay itself was in all probability originally formed by the denuding action of the prehistoric Deveron. If the river still entered the centre of the bay, or say at the more easterly of the two old openings shown in the 1834 chart, it is certain, I think, that not only would the unfortunate conditions inseparable from the present tidal basin be non-existent, but salmon would be much more likely to find the mouth and to freely ascend the river. With an increased stock of fish it is equally certain that the netting, which may at present be excessive for the depleted river, would be vastly improved and be less likely to act injuriously, and that with the satisfactory application of the weekly close time the rod fishing would also be placed on a very much more satisfactory footing. I see no reason why, given suitable modification and attention, the Deveron should not hold a good spring run as well as yield summer and autumn fishing.

At the mouth of the Spey in 1897 a condition obtained exactly similar to the present state of the Deveron mouth, except that no definite limit to the westward extension existed as at Banff. The Spey had then worked its way along behind the beach for about a mile, and was entering the sea in a rather shallow and very slanting manner. On the recommendation of the superintendent, the Spey Board agreed to cut a new and direct mouth for the river. As compared with the Deveron, the Spey is not only a larger river, but, for the last few miles of its course, it is a more rapid river. In spite of its volume and current, however, the sea had raised a shingle barrier of more formidable proportions than that at Banff. This was, however, cut through with complete success. Mr. Wink, clerk to the Spey Board, has kindly given me particulars of the work and shown me the plan. He informs me in his letter—" In the " construction of the cutting the shingle was simply thrown out to " each side and nothing was done to insure the constant flow of " the river through the cutting, the current being found sufficient

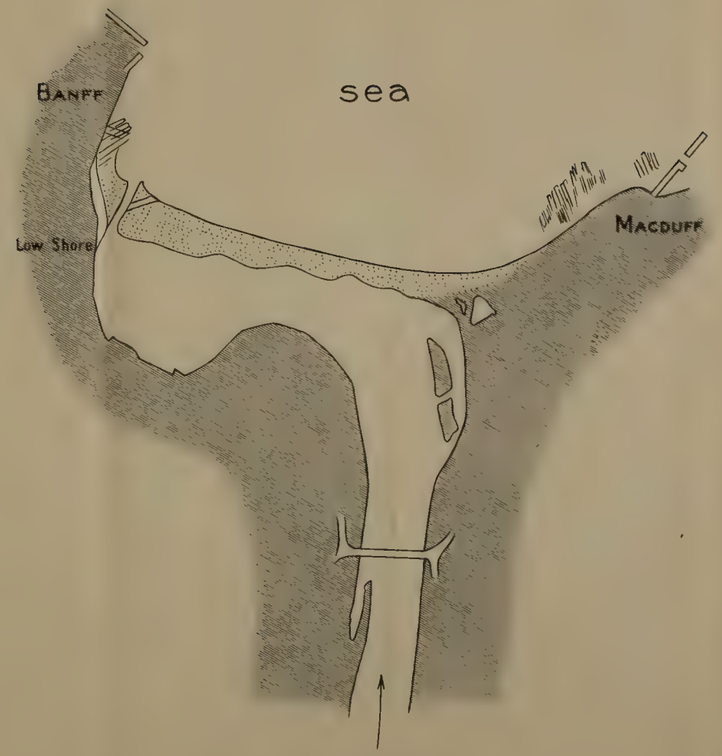
MOUTH OF RIVER DEVERON



1823.



1834.



1905.

"to keep a clear and direct outlet. The operation was a complete "success at the time, but the mouth is always getting more to the "west in consequence of the shingle thrown up by north-east "storms." The cutting was approximately 180 feet long, 60 feet broad at the top, and 30 feet broad at the bottom, the depth being 10 feet.

My opinion is that a similar cutting of the barrier at the mouth of the Deveron would well repay the proprietors of fishings in the district.

The cost of the large Spey cutting was considerable (£232), but it is clear that a suitable cutting of the Deveron bar would be accomplished for a much less sum. At the same time it would, I think, be advisable to secure if possible the keeping open of the mouth by, it might be, causing the sea to form a protecting bank some distance to the east of the mouth, or by some other means suggested by a competent engineer. The present mouth would, I have no doubt, rapidly close up, and the few boats that at present make their way in and out of the river-mouth would be equally able to use the new mouth as the old.

APPENDIX I.

REPORTS FROM DISTRICT FISHERY BOARDS.

As hitherto, the annual reports from District Fishery Boards and others are presented in the form of answers to queries issued after the close of the fishing season. On this occasion the arrangement has been somewhat modified in order to give the reader a more comprehensive result than has previously been possible.

In issuing the queries I have at the same time intimated that, with the replies, I shall be glad to receive communications on matters of special interest which any District Board desire should be brought to the notice of the Fishery Board for Scotland.

Reports from 34 districts are here included.

W. L. CALDERWOOD.

REPORT FROM RIVER TWEED DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been—except by fixed nets—below the average.

   More particularly it has been

   (*a*) By fixed engines in the sea, above the average.
   (*b*) By sweep net in tidal or fresh waters, below the average.
   (*c*) By rod and line, below the average.

2. The actual number of fish caught has been as follows :—

   (*a*) By fixed engine, 13,671
   (*b*) By sweep net, 43,689
   (*c*) By rod and line, 2,019
   } Approximately.

3. Expressed as percentages for each month of the season, so as to show the times of greatest run, the figures are :—

	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
By Fixed Engine, . .	–	–	–	–	14·5	30·0	40·0	15·5 (14 days)	–	–
By Sweep Net, . . .	3·8	2·9	5·5	10·9	16·8	21·2	27·3	11·6 (14 lays)	–	–
By Rod and Line, . .	3·15	5·12	6·12	1·78	0·81	0·08	0·49	4·63	30·54	47·28

Particulars as to the times grilse and sea trout appeared, as included in the above return, are as follows :—The first grilse caught by net was on 15th March. The first grilse caught by rod and line (up the river) was 3rd July. The first sea trout caught in the upper districts was in August. The greatest number of grilse were caught in October and November by rod and line, and in May by nets.

4. The weight of the heaviest salmon taken during the season was 47 lbs. The particulars of time and place of capture are :—Caught on 5th August at Outwater Stell Fishery, near to Berwick Pier.

Protection—

1. The assessable rental for 1905 was £15,499 15s. 5d.
2. The assessment levied was £3099 18s. 5d., or 20 per cent.
3. The water bailiffs employed are—in July 9, August 9, September 18, October 43, November 54, December 54, January 46, February 27, March 21, April 15, May 15, June 9, and 1 engineer during the whole year.
4. Particulars as to prosecutions instituted are briefly as follows :—Prosecutions were instituted against 189 persons during season 1904-05. 62 persons paid fines or were allowed time to pay ; 74 were imprisoned ; 10 absconded ; 19 were acquitted or admonished ; and proceedings were withdrawn in the case of 24 persons. The principal offences were killing salmon by means of illegal nets, cleek and light, and rakehooks ; being in illegal possession of salmon and engines for killing salmon, and assaulting and obstructing bailiffs.

Note.—There were 271 illegal nets seized in the sea and 21 in the river.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—None.
2. With regard to the observance of bye-laws :—Duly carried out and enforced.
3. Fish passes built or in prospect :—None.
4. Natural obstructions not yet dealt with :—None.

Pollutions—

1. The existing pollutions are :—Poisonous matters from mills and dyehouses in Selkirk, Peebles, Innerleithen, Walkerburn, Galashiels, Hawick, Jedburgh, and Chirnside ; household sewage from Biggar, West Linton, Eddleston, Melrose, St. Boswells, Kelso, Coldstream, Sprouston, Ancrum, Lilliesleaf, Earlston, Lauder, &c.
1. Remedial measures :—There are settling tanks connected with all the mills in Peeblesshire which intercept the grosser parts of the mill effluent, but not much good. There are purification works connected with the mills in Galashiels and Selkirk, but those in Galashiels do not appear to be of any use, from the appearance of the water flowing from them. Improved purifying machinery has been erected at Chirnside Mills lately, and satisfactory results are anticipated therefrom. In Hawick there are irrigating tanks in a field, but not worked satisfactorily.

The Salmon Disease—

1. Disease made its appearance during season 1904-05 in the month of October, and reached its height in January.
   The river was free of diseased fish in June.
2. The number of diseased fish taken from the river and destroyed was as follows :—

	Males.	Females.
Kelts, ...	1450	885
Clean, ...	44	64

The Spawning Season—

1. Fish were first noticed spawning on 18th October (sea trout).
2. The greatest number spawned in December and January.
3. Spawning ceased end of February.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as good.

Smolts—

1. Smolts were noticed to be migrating seawards in March, April, and May, and the beginning of June.
2. As a smolt year 1905 was very good.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was 328,000.
2. In securing ova the numbers of male and female fish captured were respectively 41 and 71.

REPORT FROM FORTH DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been above the average.
   More particularly it has been
   (*a*) By fixed engines in the sea, above the average.
   (*b*) By sweep net in tidal or fresh waters, about the average.
   (*c*) By rod and line, below the average.
2. The weight of the heaviest salmon taken during the season was 42 lbs.
   The particulars of time and place of capture are :—By fixed engines at Lundin Links fishing station, on the Fife coast, in the month of March.

Protection—

1. The assessable rental for 1905 was £3274 7s. 11d.
2. The assessment levied was 3s. 6d. per £.
3. The water bailiffs employed are 12 in number, including superintendent.
4. Particulars as to prosecutions instituted are briefly as follows :—Prosecutions were instituted against 32 persons, consisting of attempting to take salmon during the weekly close time with the drift or hang net, attempting to take salmon during the annual close time with the hang net, taking spawning fish from a tributary during the annual close time, drift or hang net fishing, breach of interdict against hang-net fishers, and two cases of assault on the bailiffs in the execution of their duty.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—Craigforth cruive has been allowed to remain open.
2. With regard to the observance of bye-laws :—Not observed.
3. Fish passes built or in prospect :—None have been built ; three in prospect—one at the Glasgow Corporation Waterworks at Loch Vennachar, one at the Airthrey Paper Mill dam dyke, on the river Allan, and one at the Ashfield dam dyke, also on the Allan.
4. Natural obstructions not yet dealt with are :—The Kippenross old cruive.

Pollutions—

1. The existing pollutions are :—The river Forth sewage from Stirling and Alloa. The rivers Allan, Devon, Airth, Pow Burn, and Avon are polluted with chemicals from dye works, bleach works, paper works, and the sewage from coal pits.

The Salmon Disease—

1. Disease made its appearance this year in the month of December, and reached its height in January 1905.
   The river was free of diseased fish about the middle of March 1905.

2. The number of diseased fish taken from the river and destroyed was as follows :—232 for season 1904-05.

	Males.	Females.
Kelts, ...	166	46
Clean or unspawned, . .	No clean fish.	20 unspawned.

The Spawning Season—

1. Fish were first noticed spawning in October.
2. The greatest number spawned in December.
3. Spawning ceased end of January.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as about the average. The rivers were generally high for the whole of the spawning season.

Smolts—

1. Smolts were noticed to be migrating seawards in April, May, and June.
2. As a smolt year 1905 was about the average.

Artificial Propagation of Salmon—

None.

REPORT FROM TAY DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been quite a good average.
   More particularly it has been
   (*a*) By fixed engines in the sea, no improvement in sea fishings.
   (*b*) By sweep net in tidal or fresh waters, better than usual.
   (*c*) By rod and line, about the average.
2. The weight of the heaviest salmon taken during the season was 57½ lbs. The particulars of time and place of capture are :—In the month of July, on the Tay near Newburgh, two salmon were taken in the nets, one 57½ lbs. and one 57 lbs. Quite a number over 40 lbs. were taken throughout the season. One salmon of 51 lbs. was caught in October by rod and line about two miles below Perth. Others by rod and line up to 43 lbs.

Protection—

1. The assessable rental for 1905 was £22,675 12s.
2. The assessment levied was £1587 6s., being at the rate of 7 per cent.
3. The water bailiffs employed are 24 in number in close season and from 5 to 8 in open season. Of these, 7 are in the pay of the Tay Salmon Fisheries Co., Ltd., in close season and 2 in the open season. The company also give the assistance of other men when required.
4. Particulars as to prosecutions instituted are briefly as follows :—Since last report 44 cases have been tried (39 in Perth, 3 in Cupar-Fife, and 2 in Forfar), involving 84 persons. The offences consisted of—cleeking, 12 ; possession of foul fish, 8 ; possession in close time, 7 ; using salmon roe, 5 : fishing without leave of the proprietor, 4 ; possession of cleek with intent to take salmon, 4 ; stoning, etc., 2 ; fishing with small mesh net, 1 ; sniggering, 1. Of the 84 persons involved, 77 were convicted (76 being fined and 1 admonished), 6 not proven, and 1 withdrawn owing to youth. Fines ranging from 3s. 6d. to £4 3s. were imposed. The total fines amounted to £119 16s., being

an average of £1 11s. 6d. for each of the 76 persons convicted. Fines were paid by 23, 32 were imprisoned, and 21 have yet to be dealt with. The alternatives ranged from 1 to 30 days.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—None.
2. With regard to the observance of bye-laws :—No change.
3. Fish passes built or in prospect :—None.
4. Natural obstructions not yet dealt with are :—Falls of Tummell, Falls of Garry, Falls of Keith.

Pollutions—

1. The existing pollutions are :—Bleachfields at Luncarty, on Shochie and on Almond. Sewage pollution from Perth city.
1. Remedial measures :—No new measures adopted within the past year.

The Salmon Disease—

1. Disease made its appearance this year in the month of November, and reached its height in January.
   The river was never quite free of disease.
2. The number of diseased fish taken from the river and destroyed is estimated as follows :—

	Males.	Females.
Kelts, ...	600	550
Clean, ...	20	

The Spawning Season—

1. Fish were first noticed spawning on 29th October.
2. The greatest number spawned between 20th November and 25th December.
3. Spawning ceased about end of January.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as fairly favourable. Salmon were very numerous.

Smolts—

1. Smolts were noticed to be migrating seawards in February, March, April, and May.
2. As a smolt year 1905 was a good average. The season was early and the run continued late. There were no extra shoals, but a long, steady run of seaward movement.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was 456,000.
2. In securing ova the numbers of fish captured were respectively—78 females furnished the ova and 96 males furnished the milk.

The total number of salmon landed was 1860.

REPORT FROM SOUTH ESK DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been a fair success as regards net fishing.

More particularly it has been
(*a*) By fixed engines in the sea, a fair average.
(*b*) By sweep net in tidal or fresh waters, rather below the average.
(*c*) By rod and line, very poor owing to low state of river.

2. No reliable information can be given as to actual number of fish caught.
3. Particulars as to the times salmon grilse and sea trout appeared are as follows:—On 16th February first clean fish taken. Grilse and sea trout appeared in beginning of July. Main run of grilse in July. Sea trout below the average. Main take of salmon generally in July and August.
4. The weight of the heaviest salmon taken during the season was—(*a*) by nets, not known; (*b*) by rod, 35½ lbs.

Protection—

1. The assessable rental for 1905 was £3590.
2. The assessment levied was 10 per cent. on rental = £359.
3. The water bailiffs employed are 9 in number during annual close time and generally 3 during fishing season.
4. Particulars as to prosecutions instituted are briefly as follows:—Four prosecutions raised, in which 7 persons were implicated. Offences chiefly for using drags and gaffs. Mostly all resulted in conviction of the accused.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect:—No change.
2. With regard to the observance of bye-laws:—They are well observed and attended to.
3. Fish passes built or in prospect:—Good fish passes in all dam dykes on river.
4. No natural obstructions on the river.

Pollutions—

1. The existing pollutions are:—The pollution arising from the sewage farm below the town of Brechin has for some time given the District Board much anxiety, and especially last year, when the river was for a long period at a low level. In consequence of complaints made by the Board and the county sanitary authorities, the Town Council have the matter under consideration, and have undertaken to devise and carry out remedial measures whereby the pollution complained of may be removed.

The Salmon Disease—

No disease worth noticing has appeared in the river during the year.

The Spawning Season—

1. Fish were first noticed spawning about the middle of November.
2. The greatest number spawned in December and January.
3. Spawning ceased about the middle of January.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as below the average as regards the number of breeding fish. The level of the river was low.

Kelts—

Chief migration took place in March and April.

Smolts—

1. Smolts were noticed to be migrating seawards in April and May.
2. As a smolt year 1905 was a fair average.

Artificial Propagation of Salmon—

No artificial propagation of salmon on the river.

REPORT FROM NORTH ESK DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been good.
2. The actual number of fish caught by rod and line from 31st August, when net fishing closed, to 31st October, when rod fishing also closed, was 207 salmon and 55 grilse—total 262—as recorded by bailiffs. No statistics as to fish caught otherwise.
3. The weight of the heaviest salmon taken during the season by rod and line was 30 lbs., and the place of capture Inglismaldie fishings.

Protection—

1. The assessable rental for 1905 was £6489.
2. The assessment levied was 7 per cent.
3. The water bailiffs employed are 12 in number, including superintendent.
4. No prosecutions instituted.

Obstructions to the Passage of Fish—

1. No dam dykes disused, built, or in prospect.
2. Bye-laws observed.
3. No fish passes built or in prospect.
4. Natural obstructions not yet dealt with are :—"Loups," on North Esk, about 12 miles from mouth. "Loups," on West Water (tributary), about 12 miles from mouth.

Pollutions—

1. The principal existing pollution is the effluent from North Esk Distillery, about a mile from the mouth of the river.
1. Remedial measures :—Filtering tanks.

The Salmon Disease—

1. Disease made its appearance in the month of September 1904, and reached its height in January 1905.
   The river was free of diseased fish in the beginning of March 1905.
2. The number of diseased fish taken from the river and destroyed was as follows :—

	Males.	Females.	Total.
Kelts, ...	488	230	718
Clean, ...	...	...	19
			737

The Spawning Season—

1. Fish were first noticed spawning early in November.
2. The greatest number spawned in December and January.
3. Spawning ceased in the end of January.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as fair; fish were fewer in the upper reaches, and the river was lower than usual.

Smolts—

1. Smolts were noticed to be migrating seawards in March, April, and May.
2. As a smolt year 1905 was good.

No artificial propagation of salmon.

Note.—By a clerical error in the 12th Section of the Act of 1868 the word "less" is used in place of "more," relating to the raising, during the weekly close time, of the Kinnaber lade sluice at the Morphie dyke. This is proposed to be amended by Sub-section (ii.) of Section 29 of the Salmon Fisheries (Scotland) Bill, introduced into the House of Lords at the end of last session by the Secretary for Scotland.

REPORT FROM BERVIE DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been fairly good.
2. Cannot give statistics of the actual number of fish caught.
3. The first grilse were got in the beginning of May.
4. The weight of the heaviest salmon taken during the season was reported to be 25 lbs.

The place of capture was Shieldhill, Kincardineshire.

Protection—

1. The assessable rental for 1905 was £910 13s.
2. The assessment levied was 12½ per cent.
3. The water bailiffs employed are five in number, and superintendent.
4. No prosecutions.

Obstructions to the Passage of Fish—

1. No dam dykes, disused, built, or in prospect.
2. No fish passes built or in prospect.
3. No natural obstructions.

No pollutions.

No salmon disease.

The Spawning Season—

1. Fish were first noticed spawning early in November.
2. The greatest number spawned between the middle of November and end of December.
3. Spawning ceased early in January.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as fair. There was a good number of salmon and sea trout, but few grilse. The river was about average winter level.

Smolts—

1. Smolts were noticed to be migrating seawards in May and June.
2. As a smolt year 1905 was very good.

No artificial propagation of salmon.

REPORT FROM DEE (ABERDEENSHIRE) DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been below an average in the river; in the sea about an average.

More particularly it has been

(*a*) By fixed engines in the sea, good average.
(*b*) By sweep net in tidal or fresh waters, below average.
(*c*) By rod and line, average.

2. Particulars as to the times grilse and sea trout appeared are as follows :—
First grilse caught was in river at Bridge of Dee on 6th March. (This is almost about the earliest date on record in the district.) Sea trout appeared towards the middle of March.
4. The weight of the heaviest salmon taken during the season was 45 lbs.
The particulars of time and place of capture are :—On 10th July at Portlethen station on the coast.

Protection—

1. The assessable rental for 1905 was £19,332 17s. 4d.
2. The assessment levied was at the rate of 5¾ per cent. on the rental.
3. The water bailiffs employed are 23 in number.
4. Particulars as to prosecutions instituted are briefly as follows :—7 cases of prosecution, implicating 10 men—2 for netting river and 8 for having unseasonable fish in possession. Three settled by money payments out of court, 4 came into court—and all convicted. Fines from 10s. to £2, besides expenses.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—No dam dykes.
2. With regard to the observation of bye-laws :—No cause for complaint as to the non-observance of bye-laws either by proprietors or tenants of fishings.
3. Fish passes built or in prospect :—No fish passes.
4. Natural obstructions not yet dealt with are :—There are no natural obstructions in the river itself, but obstructions from rocks exist to some extent in tributaries, such as the Feugh at Banchory and the Luie at Braemar, and these the Board propose to deal with when suitable arrangements can be made.

Pollutions—

1. The existing pollutions are :—Pollution in the Dee is not very aggravated, but has a tendency to increase. Such as it is it arises from the sewage of towns situated near the river, such as Aberdeen (part of), Banchory, the Tarland Burn, Lochnagar Distillery, &c.
1. Remedial measures :—A great sewer has been in course of construction for the last five years, which will have the effect of clearing the lower river of all sewage from the city of Aberdeen, directing it into the sea near Girdleness. The work is now approaching completion, but the sewer is not yet in operation. Pollution from sewage, &c., exists to certain extents at various places in the upper waters, and these, so far as above the point where the existing water supply for Aberdeen is taken from the river, are presently under the consideration of the Aberdeen Town Council, who, it is understood, intend taking steps to have the pollution removed.

The Salmon Disease—

No disease in 1905.

The Spawning Season—

1. Fish were first noticed spawning on 12th October 1904.
2. The greatest number spawned in upper reaches between 12th October and 30th November 1904 ; in lower reaches from 1st December 1904 to 1st February 1905.
3. Spawning ceased towards middle of February.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as very good—indeed the best that has been experienced for some years. During the whole of the spawning season the river was low.

Smolts—

1. Smolts were noticed to be migrating seawards on 1st March 1905.
2. As a smolt year 1905 was very good.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was 1,000,000 put into the hatching boxes at Drum Hatchery between 23rd and 28th October 1904.
2. In securing ova the numbers of male and female fish captured were respectively 182 and 246. Of the 1,000,000 ova, there were subsequently removed from the boxes about 39,600 addled or dead. The remainder appeared to be successfully hatched and were deposited in burns or tributaries of the Dee, viz., the Baddoch Burn, the Clunie, the Geldie, and the Bynnoch Burn—all in the vicinity of Braemar—on dates from the 10th to the 25th of May 1905, apparently in a healthy and thriving condition.

REPORT FROM DON (ABERDEENSHIRE) DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been slightly above an average on coast, slightly below an average in river.
   More particularly it has been
   (*a*) By fixed engines in the sea, slightly above average.
   (*b*) By sweep net in tidal or fresh waters, slightly below average.
   (*c*) By rod and line, about an average.
2. Particulars as to the times grilse and sea trout appeared are as follows :—First grilse caught at Berryhill station on the sea-coast on 10th April. Sea trout appeared in beginning of March.
3. The weight of the heaviest salmon taken during the season was 60 lbs.
   The particulars of time and place of capture are :—Berryhill station on the sea-coast in end of July 1905. A good many fish caught in July 1905, ranging from 40 to 45 lbs. weight.

Protection—

1. The assessable rental for 1905 was £4153.
2. The assessment levied was at the rate of 15 per cent. on the rental.
3. The water bailiffs employed are 15 in number.
4. Particulars as to prosecutions instituted are briefly as follows :—13 cases of prosecution, implicating 26 men—7 for taking unclean or unseasonable salmon, 4 for using gaff or other illegal instrument, and 2 for trespassing with intent. 25 of the men implicated were convicted. 15 of the convicted men went to prison, 10 settled fine and expenses, and 1 not convicted. Fines ranged from 5s. to £10, besides expenses.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—None.
2. With regard to the observance of bye-laws :—No cause for complaint as to the non-observance of bye-laws either by owners or tenants of fishings.
3. Fish passes built or in prospect :—None.
4. Natural obstructions not yet dealt with are :—Practically there are no natural obstructions on the Don requiring attention.

Pollutions—

1. The existing pollutions are from paper mills and wool mill on the banks of the lower river, and sewage matter from the northern district of the city of Aberdeen, extending also beyond the limits of the city boundary into the country.
2. Remedial measures :—The construction of a large sewer is commenced (or to be commenced immediately) along the north bank of the river from Grandhome Bridge, about three miles from the sea, which is the northern extremity of the city boundary, which, it is hoped, will clear the river of all deleterious matter within the city boundary, discharging it into the sea about 2 miles south of the river mouth.

The Salmon Disease—

1. Disease made its appearance this year in the month of November, and reached its height in December 1904.
   The river was free of diseased fish in February 1905.
2. The number of diseased fish taken from the river and destroyed was as follows :—

	Males.	Females.
Kelts, ...	102	58
Clean, ...	–	–

The Spawning Season—

1. Fish were first noticed spawning early in November.
2. The greatest number spawned during December.
3. Spawning ceased practically by the middle of February.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as not very satisfactory. Owing to the low state of the river and so many obstructions by dam dykes in the lower river, the fish did not reach the upper waters, where the best spawning beds have always been. Consequently the spawning season cannot be called good.

Smolts—

1. Smolts were noticed to be migrating seawards in the middle of March.
2. As a smolt year 1905 was below an average.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was about 2,000,000 in December 1904, carried to and deposited in some of the tributaries in the middle reaches ; this done as the low state of the river prevented the fish from getting past the mill dykes.*
2. In securing ova the numbers of male and female fish captured were :— Exact figures not taken note of at the time, but the proportions would be about 2 female fish to 1 male.

REPORT FROM YTHAN DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been rather above the average.
   More particularly it has been
   (*a*) By sweep net in tidal waters, rather under the average.
   (*b*) By rod and line, rather under the average.
2. The actual number of fish caught by rod and line has been 150 salmon.
3. The weight of the heaviest salmon taken during the season was 41 lbs., caught in a bag net at Port Erroll fishings in July. Heaviest salmon caught by rod and line, 27 lbs., in Upper Haddo House Water in October.

Protection—

1. The assessable rental for 1905 was £1369.
2. The assessment levied was £175 14s. 11d.
3. The water bailiffs employed are 5 in number during the winter, and 1 all the year round.

* Further, about 80,000 ova put into the hatchery at Fish Street on 22nd December 1904. About 60 per cent. of these were successfully hatched and put into the middle reaches of the Don and the Dee in the first week of June 1905.

4. Particulars as to prosecutions instituted are briefly as follows :—Augustus Herring fined 6d. and £2 of expenses for a contravention of Salmon Fisheries (Scotland) Act, 1844, Section 1 ; F. Wallace fined £1 15s. for a contravention of Section 15, Sub-section 1, of Salmon Fisheries (Scotland) Act, 1868 ; William H. Innes fined £1 and expenses £1 1s. 6d. for contravention of Section 15, Sub-section 1, of Salmon Fisheries (Scotland) Act, 1868 ; J. H. M. Neish fined £1 10s. and 9s. 2d. of expenses ; James Watson and William Stephen, fined 10s. and 9s. 2d. each of expenses for contravention of Salmon Fisheries (Scotland) Act, 1868, Section 17.

Obstructions to the Passage of Fish

1. Dam dykes disused, built, or in prospect :—None
2. With regard to the observance of bye-laws :—Observed.
3. Fish passes built or in prospect :—None.
4. Natural obstructions not yet dealt with :—None.

The Salmon Disease—

1. Disease made its appearance this year in the month of January, and reached its height in February.
   The river was free of diseased fish in April.
2. The number of diseased fish taken from the river and destroyed was 91, being 69 males and 22 females.
   The return for the previous season, which could not be included in last year's report, is as follows :—97 salmon, 11 sea trout—85 males and 23 females. 94 fish were diseased ; 14 not diseased—100 kelts, 8 not spawned.

The Spawning Season—

1. Fish were first noticed spawning on 10th November 1904.
2. The greatest number spawned between 14th December and 14th January.
3. Spawning ceased in February.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as very favourable.

Smolts—

1. Smolts were noticed to be migrating seawards in April and May.
2. As a smolt year 1905 was very good.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was about 70,000.

REPORT FROM UGIE DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been slightly improved.
   More particularly it has been
   (*a*) By fixed engines in the sea, slightly improved.
   (*b*) By sweep net it tidal or fresh waters, about the average.
   (*c*) By rod and line, about the average.
2. The actual number of fish caught has been as follows :—
   (*a*) By fixed engine, 900 salmon ; 800 grilse.
   (*b*) By sweep net, 600 sea trout.
   (*c*) By rod and line, 27 salmon ; 5 grilse ; 1500 finnock and sea trout.
3. The weight of the heaviest salmon taken during the season was 43 lbs.
   The particulars of time and place of capture are :—The fish was taken at Boddam in the month of August 1905.

Protection—

1. The assessable rental for 1905 was £778.
2. The assessment levied was 15·635d. per £.
3. The water bailiffs employed are five in number; Mr. George Anderson, who devotes his whole time; and, when on their beat, the assistance of four gamekeepers in the employment of Colonel Ferguson, of Pitfour.
4. No prosecutions were instituted.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect:—There have been no alterations on dams during the year 1905, and no new ones built.
2. With regard to the observance of bye-laws:—The dams are worked in accordance with the provisions of the bye-laws (Sch. F and G) regulating the same. The cruives are only worked for the capture of fish for hatchery purposes.
3. Fish passes built or in prospect:—None.

Pollutions—

None.

The Salmon Disease—

1. Disease made its appearance this year in the month of December 1904, and reached its height in January 1905.
   The river was free of diseased fish is May 1905.
2. The number of diseased fish taken from the river and destroyed was as follows:—

	Males.	Females.
Kelts, ...	2	3
Clean, ...	–	–

The Spawning Season—

1. Fish were first noticed spawning on 20th November 1904.
2. The greatest number spawned between 26th November and 31st December 1904.
3. Spawning ceased on 1st January 1905.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as good.

Smolts—

1. Smolts were noticed to be migrating seawards in April 1905, and continued up to the end of August.
2. As a smolt year 1905 was good.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was 150,000.
2. In securing ova the numbers of male and female fish captured were respectively 3 and 6.

REPORT FROM DEVERON DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been much below the average.
   More particularly it has been
   (*a*) By fixed engines in the sea, a little below the average.
   (*b*) By sweep net in tidal or fresh waters, much below the average.
   (*c*) By rod and line, much below the average.

2. Expressed as percentages for each month of the season, so as to show the times of greatest run, the figures are :—

	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.
By Fixed Engine, . . .	–	–	–	–	–	–	–	–
By Sweep Net, . . .	6	8	9	8	10·5	50	8·5	–
By Rod and Line, . . .	–	–	–	–	–	–	–	–

Particulars as to the times grilse and sea trout appeared, as included in the above return, are as follows :—First grilse appeared on 2nd May, and principal run occurred in July. Principal run of sea trout occurred in July.

4. The weight of the heaviest salmon taken during the season was 45 lbs. The particulars of time and place of capture are :—Caught by fixed engine at Port Fife station, Gamrie.

Protection—

1. The assessable rental for 1905 was £3368 14s.
2. The assessment levied was £863 4s. 7d.
3. The water bailiffs employed are 11 in number, and superintendent.
4. Particulars as to prosecutions instituted are briefly as follows :—Case against John Rennie for illegal fishing at Huntly. Fined 10s.

No obstructions to the passage of fish.

No pollutions.

The Salmon Disease—

1. The number of dead fish taken from the river was as follows :—

	Males.	Females.
Kelts, ...	69	19
Clean, ...	–	1

The Spawning Season—

1. Fish were first noticed spawning on 16th October 1904.
2. The greatest number spawned between 15th November and 31st December 1904.
3. Spawning ceased on 19th January 1905.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as fair.

Smolts—

1. Smolts were noticed to be migrating seawards in the beginning of April.
2. As a smolt year 1905 was good.

REPORT FROM SPEY DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been about the average.
   More particularly it has been
   (*a*) By fixed engines in the sea, above the average.
   (*b*) By sweep net in tidal or fresh waters, below the average.
1. Percentage of fish taken each month, 1905 :—

	By Net and Coble.			By Fixed Engine.		
	Salmon.	Grilse.	Trout.	Salmon.	Grilse.	Trout.
February, ...	10·3	–	·2	1·7	–	·1
March, ...	7	–	1·	3·6	–	1·7
April, ...	11·2	·1	7·9	4·8	–	6
May, ...	16·8	1·9	15·4	20·8	2·1	24·6
June, ...	12·7	27·7	53·6	25·7	35·8	50
July, ...	21·2	58·4	16·7	22·2	52·1	16
August, ...	20·8	11·9	5·2	21·2	10·	1·6
	100·	100·	100·	100·	100·	100·

Particulars as to the times grilse and sea trout appeared, as included in the above return, are as follows :—First grilse taken 30th March, main take in July ; first sea trout taken 11th February, main take in June.

3. The weights and particulars of the heaviest salmon taken during the season were as follows :—March 23rd—1 salmon, 40 lbs., by net and coble, river "Raik" ; July 3rd—1 salmon, 38 lbs., by net and coble, river "Raik" ; July 7th—1 salmon, 35 lbs., by sea bag nets ; July 22nd —1 salmon, 38 lbs., by net and coble ; July 22nd—1 salmon, 45 lbs., by net and coble ; August 18th and 26th—2 salmon, 38 lbs. respectively, by net and coble.

Protection—

1. The assessable rental for 1905 was £8364 15s.
2. The assessment levied was £1167 11s. 7d. The rate was 2s. 9½d. per £.
3. The water bailiffs employed are 46 in number.
4. Particulars as to prosecutions instituted are briefly as follows :—One man prosecuted before Sheriff Court for attempting to gaff salmon on spawning redds. Fined 10s., with 30s. 6d. expenses, or seven days' imprisonment.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—Much the same as last year. No new dykes built during the year.
2. With regard to the observance of bye-laws :—Fairly well attended to.
3. Fish passes built or in prospect :—No change.

Pollutions—

1. The existing pollutions are principally caused by distilleries.
1. Remedial measures :—Purification works or schemes for such are being provided at almost all of the distilleries in the district.

The Salmon Disease—

1. Disease made its appearance in the month of November 1904, and reached its height in January 1905.
   The river was free of diseased fish in June.
2. The number of diseased fish taken from the river and destroyed was on Fiddich, 32, as follows :—

	Males.	Females.
Kelts, ...	29	3
Clean, ...	–	–

The Spawning Season—

1. Fish were first noticed spawning on 5th October 1904.
2. The greatest number spawned during November 1904.
3. Spawning ceased in March 1905.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as a record good one for 18 years.

Smolts—

1. Smolts were noticed to be migrating seawards in April, May, June, and July.
2. As a smolt year 1905 was very good—above the average.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was 850,000.
2. In securing ova the numbers of male and female fish captured were respectively 35 and 70.

REPORT FROM LOSSIE DISTRICT.

Take of Fish—

1. Bags nets used in sea at Lossiemouth, and occasionally a sweep net at river mouth. Extent of catch not known.
   Particulars as to the times grilse and sea trout appeared are as follows :—Grilse and sea trout run up the Lossie, seeking up to spawning grounds as early as July and August, if spates or freshets occur.

Protection—

1. His Grace the Duke of Richmond and Gordon contributed voluntarily £57 9s. 8d., and Captain Dunbar-Brander £15, to meet expenses for year.
2. The water bailiffs employed are 3 in number during spawning season, and 1 during smolt protection.
3. Particulars as to prosecutions instituted are briefly as follows :—1 prosecution for "sniggering," when 2 men were fined £1 each with expenses.
   Other 2 were reprimanded for taking smolts in ignorance of the law.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—No difference from last year.
2. With regard to the observance of bye-laws :—Fairly well observed.
3. Fish passes built or in prospect :—No difference from last year.
4. Natural obstructions not yet dealt with are rock or linn at Kellas.

Pollutions—

1. The existing pollutions are Elgin burgh sewage, as also some half-dozen distilleries.
1. Remedial measures :—Experimental sewage works at Elgin. Distilleries doing something in way of settling tanks, &c., &c.

The Salmon Disease—

1. Disease made its appearance in the month of November 1904, and reached its height in January 1905.
   The river was free of diseased fish in June.
2. The number of diseased fish taken from the river and destroyed was 41, as follows :—

	Males.	Females.
Kelts, ...	31	10
Clean, ...	–	–

The Spawning Season—

1. Fish were first noticed spawning on 14th October 1904.
2. Spawning ceased middle of January 1905.
3. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as an average one.

Smolts—

1. Smolts were noticed to be migrating seawards in April, May, and June.
2. As a smolt year 1905 was an average one.

REPORT FROM FINDHORN DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been below the average.
   More particularly it has been
   (*a*) By fixed engines in the sea, below the average.
   (*b*) By sweep net in tidal or fresh waters, about an average.
   (*c*) By rod and line, below the average.
2. The actual number of fish caught has been as follows :—
   (*a*) By fixed engine, 15,702.
   (*b*) By sweep net, 5523.
   (*c*) By rod and line, below the average.
3. Expressed as percentages for each month of the season, so as to show the times of greatest run, the figures are :—

	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.
By Fixed Engine, . . .	287	777	1200	2334	3404	6346	1354	–
By Sweep Net, ...	97	253	433	726	1280	2426	108	–
By Rod and Line, . . .	–	–	–	–	–	–	–	–

Particulars as to the times grilse and sea trout appeared, as included in the above return, are as follows :—Sea trout in June and grilse in July.

4. The weight of the heaviest salmon taken during the season was 41 lbs. The particulars of time and place of capture are :—Burghead by bag net.

Protection—

1. The assessable rental for 1905 was £3661.
2. The assessment levied was £300.
3. The water bailiffs employed are 3 in number yearly; 12 extra during close or spawning season.
4. There were no prosecutions.

Obstructions to the Passage of Fish—

1. No dam dykes disused, built, or in prospect.
2. With regard to the observance of bye-laws, they are strictly adhered to.
3. No fish passes built or in prospect.
4. Natural obstructions not yet dealt with :—None.

Pollutions—

None.

The Salmon Disease—

There never was any disease in the river Findhorn.

The Spawning Season—

1. Fish were first noticed spawning on 14th October.
2. The greatest number spawned between 20th October and 20th November.
3. Spawning ceased in 1905 about 25th January.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as very good.

Smolts—

1. Smolts were noticed to be migrating seawards in April, May, and June.
2. As a smolt year 1905 was very good.

REPORT FROM THE NAIRN DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been—Salmon, average ; grilse, rather below average.

   More particularly it has been

   (*a*) By fixed engines in the sea, about the average.

   (*b*) By rod and line, about the average.

2. The actual number of fish caught has been as follows :—

   (*a*) By fixed engine
   (*b*) By sweep net
   (*c*) By rod and line
   } No information available.

4. The weight of the heaviest salmon taken during the season was 35 lbs. The particulars of time and place of capture are :—April 1905, Kingsteps Sea Station, Nairn.

Protection—

1. The assessable rental for 1905 was £1218 10s.
2. The assessment levied was £157 7s. 9d.
3. The water bailiffs employed are 1 permanent and 2 during close season.
4. Particulars as to prosecutions instituted are briefly as follows :—No prosecutions ; one case reported which resolved itself into a charge of assaulting the police ; offenders convicted and sharply punished.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—No changes.
2. With regard to the observance of bye-laws :—No changes.
3. Fish passes built or in prospect ;—No changes.
4. Natural obstructions not yet dealt with :—None.

Pollutions—

No pollution since the town sewage was carried into the sea.

The Salmon Disease—

No salmon disease.

The Spawning Season—

1. Fish were first noticed spawning on 6th November.
2. The greatest number spawned between 12th November and 14th December.
3. Spawning ceased about 20th January.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as very good in all respects.

Smolts—

1. Smolts were noticed to be migrating seawards in April.
2. As a smolt year 1905 was an average year.

REPORT FROM THE NESS DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been below the average.
   Particulars as to the times grilse and sea trout appeared, are as follows :—We sometimes have an occasional grilse in May, but more usually in June, July, and August, July being the biggest run. June and July are the principal months for sea trout. Our biggest takes of salmon are in February and April.
2. The weight of the heaviest salmon taken during the season was 41 lbs. The particulars of time and place of capture are :—River Garry, March.

Protection—

1. The assessable rental for 1905 was £3646 10s.
2. The assessment levied was 1s. 10d. per £.
3. The water bailiffs employed are 8 in number—4 permanent, 4 temporary.
4. Particulars as to prosecutions instituted are briefly as follows :—Two prosecutions for contravention of the weekly close time. *Learnie*—One case, for three nets, fined £18, with expenses (July 1905). *Cromarty*—The other, for one net, £10, with expenses (July 1905). One case of unclean salmon, fine £1, with £1 10s. expenses ; this case was taken at Fort-Augustus, Loch Ness (May 1905).

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—Bught dyke repaired last season, also Dochfour dyke repaired. The fish pass entering Loch Ness from river is an obstruction when the rivers are in a low state, and fish ascending to the upper reaches are stopped there until there is sufficient water to enable them to get over fish pass.
2. Fish passes built or in prospect :—Fish pass on the river Morrison finished last season, with the result that the spawning grounds are pretty well stocked, thus showing that there is now a free passage for fish ascending to those spawning grounds.

Pollutions—

1. The existing pollutions are very slight.

The Salmon Disease—

No disease last season.

The Spawning Season—

1. Fish were first noticed spawning about 1st November or end of October.
2. The greatest number spawned from middle of November to middle of January.
3. Spawning ceased end of January.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as fairly good.

Smolts—

1. Smolts were noticed to be migrating seawards early in April.
2. As a smolt year 1905 was above the average.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season—We did not have any fish striped since 1895.
2. In securing ova the numbers of male and female fish captured were :—In that year in the months of December and January there were 4 males to 1 female.

REPORT FROM CONON DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been an average one.
   More particularly it has been
   (*a*) By fixed engines in the sea, considerably above the average.
   (*b*) By sweep net in tidal or fresh waters, below the average.
   (*c*) By rod and line, below the average.
2. The actual number of fish caught has been as follows :—
   (*a*) By fixed engine
   (*b*) By sweep net
   (*c*) By rod and line
   } It is impossible to obtain accurate information from the lessees of salmon fishings.
3. Expressed as percentages for each month of the season, so as to show the times of greatest run, the figures are :—

	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
By Fixed Engine, . . .	1	9	10	13	15	40	12	-
By Sweep Net, . . .	2	7	9	8	17	43	14	-
By Rod and Line, . . .	3	15	14	7	13	18	13	10

Particulars as to the times grilse and sea trout appeared, as included in the above return, are as follows :—The main run of sea trout was in March and April. The first run of grilse was about the middle of May.

4. The weight of the heaviest salmon taken during the season was 30 lbs. The particulars of time and place of capture are :—Shandwick Fishery, in June.

Protection—

1. The assessable rental for 1905 was £2974 10s.
2. The assessment levied was 1s. 4d. per £.

3. The water bailiffs employed are 4 in number—3 temporary and 1 permanent.
4. Particulars as to prosecutions instituted are briefly as follows:—There were 2 prosecutions for failure to observe the weekly close time. (1) In the first case the respondents were Messrs. George Paterson & Sons, salmon fishers, Portmahomack, and they were charged for failure to slap the leaders of their bag nets at several fishing stations on two or three successive weeks. A conviction was obtained on one or two of the charges. and a fine of £12 was imposed. (2) The other prosecution was against Mrs. Margaret Tough, lessee of the Geanies Fisheries, also for failure to observe the weekly close time. A conviction was obtained and a fine of £5 imposed. In addition to the above, a prosecution was instituted in London by the Fishmongers' Company on our behalf against J. Finlayson, fisherman, Cromarty, for sending foul fish to the London market. The trial took place in London, and defendant was convicted and fined £10 15s., being 5s. for each fish taken, with £10 10s. of expenses, or, in default, two months' imprisonment.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect:—No dam dykes have been disused nor built, or are any in prospect.
2. With regard to the observance of bye-laws:—All the bye-laws have been strictly observed.
3. Fish passes built or in prospect:—No fish passes have been built, nor are there any in prospect.
4. Natural obstructions not yet dealt with are:—Falls of Orrin, Falls of Scatwell, Falls of Conon, Falls of Rogie, and Falls of Garve.

Pollutions—

None.

The Salmon Disease—

None.

The Spawning Season—

1. Fish were first noticed spawning about the middle of October.
2. The greatest number spawned between 5th November and 18th November.
3. Spawning ceased about the middle of December.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as about the average.

Smolts—

1. Smolts were noticed to be migrating seawards in March, April, and May.
2. As a smolt year 1905 was fairly good.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was nil. Owing to the very heavy floods during the time spawning salmon were on the redds, it was not practicable to put a net on the river.

REPORT FROM ALNESS DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been below the average.

More particularly it has been

(*a*) By fixed engines in the sea—No fixed engines in Alness district.
(*b*) By sweep net in tidal or fresh waters, below the average.
(*c*) By rod and line, below the average.

2. The actual number of fish caught has been as follows :—
   (*a*) By fixed engine—No fixed engines.
   (*b*) By sweep net, not known.
   (*c*) By rod and line, not known.
3. Grilse appear about middle of June, and best run is in July ; sea trout June and July. Finnochs can be got near mouth of river nearly all the year round. A few salmon are to be found running up the Alness from April to October.
4. The weight of the heaviest salmon taken during the season was 16 lbs., taken by rod and line ; cannot say the weight of heaviest landed by net, but several were got over 20 lbs.

Protection—

1. The assessable rental for 1904-05 was £735 15s.
2. The assessment levied was 3s. per £.=£110 7s. 3d.
3. The water bailiffs employed are as follows :—1 permanent head water bailiff, with temporary assistant watchers as may be found necessary during the spring and autumn months. During spring of 1905 2 temporary assistants were employed, and during autumn of 1905 1 temporary assistant.
4. Particulars as to prosecutions instituted :—None in 1905.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—No change.
2. With regard to the observance of bye-laws :—There has been no breach of bye-laws.
3. Fish passes built or in prospect :—No change.
4. Natural obstructions not yet dealt with :—No natural obstructions in the district.

Pollutions—

1. The existing pollutions are :—Sewage from the villages of Alness and Bridgend, and also from some mansion-houses in the vicinity of the river. This matter is under the consideration of the local authorities.
1. Remedial measures :—The Easter Ross District Committee and the Mid Ross District Committee, as the local authorities within whose districts the said villages are situated, are at present discussing a joint scheme under which the sewage of both villages will be carried direct into the sea.

The Salmon Disease—

1. The river was free of diseased fish in 1905.

The Spawning Season—

1. Fish were first noticed spawning on or about 20th October. Sea trout, salmon, and grilse were first noticed spawning in end of October.
2. The greatest number spawned about the middle of November.
3. Spawning ceased generally about Christmas.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as below the average. The water was heavy in flood most of the season, which made it difficult to ascertain the numbers of spawning fish.

Smolts—

1. Smolts were noticed to be migrating seawards in May and June.
2. As a smolt year 1905 was good.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was nil, but over 40,000 were got from Helmsdale river with a view to getting earlier salmon to run up the river Alness.

REPORT FROM KYLE OF SUTHERLAND DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been very good.
   More particularly it has been
   (*a*) By fixed engines in the sea, above the average.
   (*b*) By sweep net in tidal or fresh waters, above the average.
   (*c*) By rod and line, average.
2. Grilse and sea trout appeared in June.
3. The weight of the heaviest salmon taken during the season was 38 lbs.
   The particulars of time and place of capture are :—May, sweep net, Bonar Bridge.

Protection—

1. The assessable rental for 1905 was £3514 10s.
2. The assessment levied was 2s. 1d. per £.
3. The water bailiffs employed are 17 in number.
4. Particulars as to prosecutions instituted are briefly as follows :—There were 2 prosecutions on sea coast for failure to comply with the weekly close time, viz. :—(1) Against George Main, lessee of Dornoch net fishings, in Dornoch Sheriff Court, on 26th June 1905, when accused was fined 10s. 6d. with 15s. of expenses; and (2) against George Anderson & Sons, lessees of Portmahomack net fishings, in Tain Sheriff Court, on 27th June 1905, when complaint was found not proven. James Robertson, miller, Grinds, Lairg, was prosecuted in Dornoch Sheriff Court, on 7th November 1905, for taking from the river Shin more water than was necessary for lawful purposes, and was fined £3, with £1 of expenses.

The Salmon Disease—

1. Disease made its appearance this year in the month of October, and reached its height in November.
   The river was free from diseased fish in December.
2. The number of diseased fish taken from the river and destroyed was as follows :—

	Males.	Females.
Kelts, ...	3	1
Clean, ...	–	–

The Spawning Season—

1. Fish were first noticed spawning on 16th October.
2. The greatest number spawned in November.
3. Spawning ceased in the middle of November.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as very good.

Smolts—

1. Smolts were noticed to be migrating seawards in April and May.
2. As a smolt year 1905 was below the average.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was 160,000.
2. In securing ova the numbers of male and female fish captured were respectively 40 and 20.

REPORT FROM SUTHERLAND (EAST AND WEST), BEING FOR HELMSDALE, BRORA, FLEET, KIRKAIG, INVER, LAXFORD, AND INCHARD DISTRICTS.

NOTE.—The particulars printed in italics refer to the West Coast of Sutherland.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been above the average by rods.
2. The actual number of fish caught has been as follows :—
   (*a*) By fixed engine—*Salmon, 646 ; grilse, 4731 ; trout, 211.*
   (*b*) By sweep net—Salmon, 826 ; grilse, 312 ; trout, 125.
   (*c*) By rod and line—Helmsdale, 1325 ; Brora, 382.
3. Expressed as percentages for each month of the season, so as to show the times of greatest run, the figures are :—

		Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	
By Fixed Engine	*Salmon,*	–	–	*3·56*	*3·89*	*30·65*	*36·22*	*23·83*	*1·85*	–	West Coast.
	Grilse,	–	–	–	*·02*	*1·33*	*43·73*	*52·01*	*2·91*	–	
	Trout,	–	–	*·47*	*·47*	*7·58*	*54·97*	*35·09*	*1·42*	–	
By Sweep Net	Salmon,	–	–	32·68	27·60	24·57	7·87	4·35	2·93	–	Brora Net Fishings.
	Grilse,	–	–	–	–	12·82	67·00	13·46	6·72	–	
	Trout,	–	–	–	–	16·00	64·80	16·00	3·20	–	
By Rod and Line, . .		·90	6·80	32·00	17·73	15·54	14·06	7·47	3·09	2·41	Helmsdale River.

Particulars as to the times grilse and sea trout appeared, as included in the above return, are as follows :—On the West Coast grilse were first caught in the month of April and sea trout in March by the bag nets. The river Brora netting did not start till 1st May ; the figures shown for the months March and April were arrived at by including fish netted in Loch Brora during those months.

4. The weight of the heaviest salmon taken during the season was 26½ lbs., by rod and line.

   The particulars of time and place of capture are :—Caught on No. 6 beat (lower) of the river Helmsdale by Frank Sykes, Esq., Borrobol.

Protection—

1. The assessable rental for 1905, according to valuation roll, was, East Coast £2160, West Coast £1317, but angling is mostly let with shootings and not apportioned at full value.
2. The water bailiffs employed are 4 in number, but gamekeepers are bound to assist in watching the rivers and streams.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—The Badanloch dam has been heightened two feet with a view to keeping the river Helmsdale supplied with water for a longer period than formerly.
2. With regard to the observance of bye-laws :—The bye-laws have been observed.

Pollutions—

There is no pollution.

The Salmon Disease—

1. Disease made its appearance last year in the month of June on the river Brora and continued till the spawning season. It has not been noticed since.

2. The number of diseased fish taken from the river and destroyed was 9. Of 5 of these there were 2 males and 3 females; sex of others not known.

The Spawning Season—

1. Fish were first noticed spawning on October 25th, 1905.
2. The greatest number spawned between the 2nd and 10th November 1905.
3. Spawning ceased about the end of November 1905.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as an unsatisfactory one as far as the state of water is concerned. Rivers were in high flood, and observations were difficult.

Smolts—

1. Smolts were noticed to be migrating seawards in the second week of April.
2. As a smolt year 1905 was an exceptionally good year.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was 985,000.
2. In securing ova the proportion of male to female fish captured was 2 males to 3 females.

REPORT FROM THURSO DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been about an average.
2. The actual number of fish caught has been as follows :—
   (*a*) By fixed engine—Salmon, 717 ; grilse, 4350.
   (*b*) By rod and line, 432.

   The particulars showing results of coast fishings by fixed engine are exclusive of the Holborn Head and the Dunnet fisheries.
3. Expressed in numbers for each month of the season, so as to show the times of greatest run, the figures are :—

	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.
By Fixed Engine, . . .	–	–	22	173	2107	2593	172	–
By Rod and Line, . . .	23	91	115	71	18	24	49	41

Particulars as to the times grilse and sea trout appeared, as included in the above return, are as follows :—Grilse in July.

4. The weight of the heaviest salmon taken during the season by rod and line was 25 lbs.

   The particulars of time and place of capture are :—September 5, beat 7 of river.

Protection—

The water bailiffs employed are 2 in number.

Obstructions to the Passage of Fish—

None.

Pollutions—

None.

The Salmon Disease—

No disease.

The Spawning Season—

1. Fish were first noticed spawning on 25th October.
2. The greatest number spawned on November 10th.
3. Spawning ceased about 23rd November.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as poor.

Smolts—

1. Smolts were noticed to be migrating seawards in April and May.
2. As a smolt year 1905 was not good.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was 100,000.
2. In securing ova the numbers of male and female fish captured were respectively regular.

COUNTY OF SUTHERLAND — NORTH COAST (RIVERS HALLADALE, NAVER, BORGIE, KINLOCH, AND HOPE).

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been up to the average. Grilse fell off suddenly about the middle of July.

   More particularly it has been
   - (*a*) By fixed engines in the sea, an average year.
   - (*b*) By sweep net in tidal or fresh waters, an average year.
   - (*c*) By rod and line, an average year.
2. The actual number of fish caught has been as follows :—
   - (*a*) By fixed engine, 446 salmon, 3020 grilse.
   - (*b*) By sweep net, 509 salmon, 2372 grilse.
   - (*c*) By rod and line, 418 salmon and grilse.
3. Expressed as percentages for each month of the season, so as to show the times of greatest run, the figures are :—

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.
By Fixed Engine, .	–	–	–	–	4	40	54	2	–
By Sweep Net, . .	–	–	–	–	8	66	26	–	–
By Rod and Line, .	2	6	25	25	24	3	5	8	2

   Particulars as to the times grilse and sea trout appeared, as included in the above return, are as follows :—First grilse appeared on 28th April; run of sea trout in March and April.
4. The weight of the heaviest salmon taken during the season was 31 lbs. The particulars of time and place of capture are :—
   - (*a*) By fixed engine, 31 lbs., at Halladale in July.
   - (*b*) By sweep nets, 28 lbs., at Naver in May and also in July.
   - (*c*) By rod and line, 21 lbs., at Borgie, May 1, 1905.

Protection—

1. The assessable rental for 1905 was £1315 per valuation roll, but angling mostly let with shootings and not apportioned at fixed value in roll.
2. No assessment was levied.

3. The water bailiffs employed are 4 in number, in addition to keepers who assist in watching.
4. No prosecutions.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—None.
2. With regard to the observance of bye-laws :—None.
3. Fish passes built or in prospect :—None.
4. Natural obstructions not yet dealt with :—None.

Pollutions—

None.

The Salmon Disease—

None.

The Spawning Season—

1. Fish were first noticed spawning on 22nd October.
2. The greatest number spawned between 28th October and 20th November.
3. Spawning ceased early in December.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as favourable.

Smolts—

1. Smolts were noticed to be migrating seawards from 20th April till 20th May.
2. As a smolt year 1905 was fairly good. There was a better appearance of smolts than in the three previous years.

Artificial Propagation of Salmon—

None ; but 25,000 young salmon fry placed in rivers in April.

REPORT FROM BALGAY DISTRICT.

Take of Fish—

1. By rod and line, rather below the previous average.
2. The greatest run of sea trout and grilse was in the month of July.
3. The particulars of time and place of capture are :—The river Balgay and Lochdoule.

Protection—

1. The assessable rental for 1905 was £40.
2. The assessment levied was nil—all expenses paid by Mr. C. J. Murray, of Lochcarron, and Hon. Captain King Noel.
3. One water bailiff is employed.
4. Particulars as to prosecutions instituted are briefly as follows :—One.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—None.
2. Fish passes built or in prospect :—None.

Pollutions—

None.

The Salmon Disease—

None.

The Spawning Season—

1. Fish were first noticed spawning on or about the 14th October, rather later than on the previous two or three years, especially sea trout.

2. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as favourable.

Smolts—

As a smolt year 1905 was apparently good.

REPORT FROM SKYE DISTRICTS (SNIZORT AND SLIGACHAN).

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been much below the average. More particularly it has been
   (*a*) By fixed engines in the sea, much below the average.
   (*c*) By rod and line, below the average.
2. The actual number of fish caught has been as follows :—
   (*a*) By fixed engine, numbers unobtainable.
   (*b*) There is no sweep netting.
   (*c*) By rod and line, numbers unobtainable.
3. The weight of the heaviest salmon taken during the season was 34 lbs. caught in July.

Protection—

1. The assessable rental for 1905 was £540.
2. The total expenditure was £14. This sum was equally divided and paid by the several proprietors, five in number.
3. The water bailiffs employed are 15 in number.
4. Particulars as to prosecutions instituted are briefly as follows :—No prosecutions during 1905.

REPORT FROM LOCHY DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been under the average so far as rod and line fishing is concerned. No netting is carried on.
2. The weight of the heaviest salmon taken during the season was 47 lbs. The particulars of time and place of capture are :—In less than 5 minutes in a small narrow stream.

Protection—

1. The assessable rental for 1905 was £2231.
2. The assessment levied was 1d. per £.
3. The water bailiffs employed are 12 in number.
4. Particulars as to prosecutions instituted are briefly as follows :—1 prosecution against 2 persons salmon poaching in estuary—all convicted ; 2 prosecutions against 2 persons salmon poaching in estuary—all convicted ; 3 prosecutions against two persons poaching in river Nevis—1 convicted.

The Spawning Season—

1. Fish were first noticed spawning on tributaries 20th October.
2. The greatest number spawned from 20th November till 20th December.
3. Spawning ceased by end of June.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as—(1) fair number of breeding fish ; (2) river in flood most of the time ; (3) rather unfavourable spawning season.

Smolts—

1. Smolts were noticed to be migrating seawards about 20th May.
2. As a smolt year 1905 was very poor.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was 80,000.

REPORT FROM AWE DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been an average catch.
   More particularly it has been
   (*a*) By fixed engines in the sea, 23 bag nets.
   (*b*) By sweep net in tidal or fresh waters, 2 sweep nets.
   (*c*) By rod and line, very difficult to estimate. Rods are let out by two hotels in addition to the sporting tenants' rights.
2. The actual number of fish caught has been as follows :—
   (*a*) By fixed engine
   (*b*) By sweep net } No information can be got from tenants.
   (*c*) By rod and line
3. The weight of the heaviest salmon taken during the season was 54 lbs.
   The particulars of time and place of capture are :—Awe, netted, time not known

Protection—

1. The assessable rental for 1905-1906 was £1305 19s.
2. The assessment levied was £163 4s. 10d.
3. The water bailiffs employed are 1 in number, Donald Rankin, Oban.
4. Particulars as to prosecutions instituted are briefly as follows :—(1) Against M'Coll, salmon fisher, Appin, for using a net having mesh not of legal size. Accused pled guilty and was fined £2. Year 1904-1905. (This complaint was at the instance of the Fishmongers' Company of London.) (2) Against Donald M'Millan and John M'Callum, Taynuilt, for night poaching. Accused pled not guilty, but on evidence the charge against M'Millan was found not proven, and M'Callum was found guilty and fined £1, with expenses. (3) Against Alexander Carmichael and 7 others for poaching. Under this charge Alexander Carmichael, John Bell, and William Reid, fishermen, Oban, and Alexander M'Callum, painter, Oban, were found guilty and each fined £2, with the alternative of a month's imprisonment. The net and boat used were confiscated. (4) Against Archibald Macfadyen, salmon fisher, Shuna. Charge—fishing during close time. Accused pled guilty and was fined £1, with expenses. (2), (3), and (4) complaints at instance of Awe Board.)

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—Mill lade on the river Lusragan at Connel. The fish ladder is obstructed by a board at top, prohibiting the fish from ascending or descending. The board has been removed several times at the instance of the Board, and steps are again being taken for its removal. The board has been placed in its position by the owner of an adjacent tweed mill, Mr. D. Cameron MacLachlan.
2. Fish passes built or in prospect :—No necessity for any fish passes in river Awe.
3. Natural obstructions not yet dealt with :—None.

   [*This answer must be regarded as applying exclusively to the Awe, and not to the other streams of the District, such as the Orchy and Etive.*—W.L.C.]

Pollutions—

1. The existing pollutions are :—In the Lusragan river all refuse from a tweed mill goes into the river.
1. Remedial measures :—The taking of the refuse in a pipe to the sea would cure this

The Salmon Disease—

None.

The Spawning Season—

1 Fish were first noticed spawning on 27th October.
2. The greatest number spawned in November.
3. Spawning ceased about the end of December.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as a very good average season, especially in sea trout. Such numbers of the latter have not been seen of recent years.

Smolts—

1. Smolts were noticed to be migrating seawards about 8th March 1905.
2. As a smolt year 1905 was a fair, good year.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was nil. Ova has lately been secured for a hatchery built in October 1905 at the head of Loch Etive for Mr. Ian T. Nelson. Should further particulars be required, these can be got from Mr. Nelson and submitted.
2. In securing ova the numbers of male and female fish captured were nil.

REPORT FROM CLYDE AND LEVEN DISTRICT (INCLUDING LOCH LOMOND).

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been, by net in the Clyde considerably above, and by rod in the Leven and Loch Lomond proportionately below, the average.

   More particularly it has been

   (*a*) By sweep net in tidal or fresh waters of the Clyde and Leven mouth, above the average.

   (*b*) By rod and line in the Leven and Loch Lomond, below the average.

   Note.—There are no fixed engines in this district.
2. The actual number of fish caught has been as follows :—

   (*a*) By sweep net, 297 salmon, 748 grilse, and 5619 sea trout.

   (*b*) By rod and line, approximately, in Loch Lomond only, 38 salmon and grilse and 435 sea trout.
3. Expressed as percentages for each month of the season, so as to show the times of greatest run, the figures are :—

		Feb.	Mar.	April	May.	June.	July.	Aug.	Sept.	Oct.
By Sweep Net	Salmon, .	–	–	–	22	46	32	–	–	–
	Grilse, .	–	–	–	–	14	86	–	–	–
	Sea Trout, .	–	–	–	5	15	80	–	–	–
By Rod & Line	Salmon and Grilse, .	–	3	23	36	20	–	8	10	–
	Sea Trout, .	–	–	2	3	6	–	55	32	2

Particulars as to the times grilse and sea trout appeared, as included in the above return, are as follows :—Grilse, 24th May ; sea trout, 27th April.

4. The weight of the heaviest salmon taken during the season was (1) by rod and line in river Leven, 23½ lbs., and (2) by sweep net in the Clyde, 20 lbs.

The particulars of time and place of capture are :—(1) Caught by minnow on April 1st between Balloch Bridge and the loch ; (2) caught in July in Clyde below Dumbarton.

Protection—

1. There is no District Board for the Clyde and Leven district, but the duties of one are voluntarily undertaken by the Loch Lomond Angling Improvement Association at private cost.
2. The water bailiffs employed vary in number with the season of the year, and the system of watching was fully described in last year's report.
3. Particulars as to prosecutions instituted are briefly as follows :—

1905.		Convictions.
April 24	—Taking parr from river Fruin,	1
June 4	—Otter fishing on Loch Lomond,	4
„ 24	—Netting raid on Leven shots,	4
„ 27	—Gaffing in Leven,	6
„ 30	— Do.	3
July 5	— Do.	1
„ 7	— Do.	1
„ 11	— Do.	2
„ 14	—Netting raid on Clyde shots,	5
Aug. 2	—Gaffing in Leven,	1
„ 14	—Poaching Fruin, roe, parr,	1
Sept. 6	—Hang nets in Loch Lomond,	2
	Total,	31

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—None.
2. With regard to the observance of bye-laws in respect of dams, lades, and hecks, the provisions of the bye-laws are satisfactorily attended to.
3. Fish passes built or in prospect :—None.
4. Natural obstructions not yet dealt with are almost too numerous to mention, as practically all tributaries of the loch are impeded by natural falls, many of which are quite impassable. The most important is the Pot of Gartness, which is only passable in a flood, and which makes about 12 miles of the Endrick spawning ground difficult of access. The proprietors will not consent to the pass being made easier for fish.

Pollutions—

1. The existing pollutions are many and grievous. The Leven is foul with chemicals and dyes from the turkey red and bleach works on its banks, several of which make no effort to clean their effluents. It is also putrid with sewage effluents, none of which are treated before entering the river. During June and July 1905 the river was impassable during the drought for migratory fish, and the flesh of the fish hanging about the mouth of the Leven became tainted and unsaleable. The Clyde is polluted with sewage and other pollutions.
1. Remedial measures :—None are being taken by those at fault, but the Association is attempting to interdict the Western District Committee of the County Council of Dumbarton from discharging the sewage from two new sewers into the Leven at Alexandria without adequate treatment. Interim interdict has been granted.

The city of Glasgow's sewage scheme will take some years yet before it is fully in operation as regards the Clyde.

The Salmon Disease—

Disease is practically unknown, but a case is said to have been observed in the river Fruin.

The Spawning Season—

1. Fish were first noticed spawning :—(1) Sea trout on October 2nd ; (2) salmon in November.
2. The greatest number spawned :—(1) Sea trout in November ; (2) salmon in December.
3. Spawning ceased :—(1) Sea trout by end of November ; (2) salmon by middle of January.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as about the average.

Smolts—

1. Smolts were noticed to be migrating seawards in May.
2. As a smolt year 1905 was an average good one.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was :—(1) Trout, 166,000 ; (2) salmon and sea trout, 144,000.
2. In securing ova the numbers of male and female fish captured were not observed.
3. Out of 21 sea trout marked in October 1904 as many as 9 were observed in 1905, but by mischance none of the labels were obtained for statistical purposes.

REPORT FROM AYR DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been above the average. Fishing during the season has been carried on solely by rod and line.
2. The actual number of fish caught has been as follows :—
   (*a*) By rod and line, about 120, but the information available is not very accurate.
3. Expressed as percentages for each month of the season, so as to show the times of greatest run, the figures are :—

	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.
By Fixed Engine, .	–	–	–	–	–	–	–	–	
By Sweep Net, . .	–	–	–	–	–	–	–	–	–
By Rod and Line, .	–	–	–	–	–	5	40	30	35

Particulars as to the times grilse and sea trout appeared, as included in the above return, are as follows :—Sea trout—First run about end of June. Grilse—About same time. Salmon—First big run occurred during the 5th, 6th, and 7th of August. Before that there had been a spell of very dry weather, and there was no water to allow the fish to get up.

4. The weight of the heaviest salmon taken during the season was 24 lbs. The particulars of time and place of capture are :—This fish was caught by a Mr. M'Intyre, a local angler, when fishing in Gadgirth water. He was fishing with a brown turkey fly. The water was not deep at the place. The fish was in splendid condition.

Protection—

1. The assessable rental for 1905 was £110.
2. The assessment levied was £44.
3. One bailiff only is regularly employed, but during the month of October the Board employed the services of a special constable.
4. Particulars as to prosecutions instituted are briefly as follows :—Three men were fined for fishing with roe and having salmon roe in their possession ; two of these men were also convicted for having parr in their possession. Two men were fined for having parr in their possession, and one of them was also convicted for having a "jigger" in his possession—an instrument for dragging for salmon. One man was fined for fishing without permission of the proprietor ; this case has been appealed, and there are six similar cases awaiting the decision in that appeal.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—The only obstruction to the passage of fish is the dam dyke at Catrine Cotton Works, and the matter is presently receiving the attention of the Board.
2. With regard to the observance of bye-laws :—The bye-laws are pretty generally observed. There are one or two mill lades with hecks which are not satisfactory, but the Board is having them put in order.
3. Fish passes built or in prospect :—There are no fish passes in the dam dyke at Catrine Cotton Works before referred to, but the Board has presently the matter before them.

Smolts—

1. Smolts were noticed to be migrating seawards in end of April, in May, and in the beginning of June.
2. As a smolt year 1905 was an exceptionally plentiful one. The report of the bailiff is that smolts were in larger numbers than during any time during the past six years.

Artificial Propagation of Salmon—

Nothing is being done in this respect.

The Salmon Disease—

The river was free of diseased fish during the whole season.

The Spawning Season—

1. Fish were first noticed spawning on 1st December.
2. The greatest number spawn during December.
3. Spawning ceases about the end of January.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as exceptionally good, especially as regards the increasing numbers of sea trout spawning.

Pollutions—

1. The existing pollutions are :—No cases of pollution came under the notice of the Board during the season. No dead fish were taken out of the water which had been killed by polluting matter.

REPORT FROM DOON DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been smaller on account of the exceptionally dry season.

   More particularly it has been

   (*a*) By fixed engines in the sea, over the average of previous years.

   (*b*) By sweep net in tidal or fresh waters. Fishing in this manner is not now employed.

   (*c*) By rod and line, below the average.

2. The actual number of fish caught has been as follows :—
   (*a*) By fixed engine, not known. The lessees of the fishings refuse to give information.
   (*b*) By sweep net, none.
   (*c*) By rod and line, 78 salmon and 203 sea trout in lower reaches, *i.e.*, from Monkwood water to the sea. There is no information as to the upper reaches, but the catches were pretty fair.
3. Expressed as percentages for each month of the season, so as to show the times of greatest run, the figures are :—

	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.
By Fixed Engine, .	–	–	–	–	–	–	–	–	–
By Sweep Net, . .	–	–	–	–	–	–	–	–	–
By Rod and Line, .	–	1		–	1	8	10	10	70

Particulars as to the times grilse and sea trout appeared, as included in the above return, are as follows :—Grilse appeared in June ; sea trout appeared in May.

4. The weight of the heaviest salmon taken during the season was 36 lbs. by net and 25¼ lbs. by rod and line.

The particulars of time and place of capture are :—The 36-lb. fish was captured in August in the bag net in the sea near to the river mouth ; the 25¼-lb. fish was captured by rod and line about the beginning of August in Doonholm water about three miles from the river mouth.

Protection—

1. The assessable rental for 1905 was £498.
2. The assessment levied was £37 7s.
3. There are only two water bailiffs employed, but during October the Board engaged the services of a special constable to watch the upper reaches of the river. The keepers also of the various proprietors look after the water.
4. Particulars as to prosecutions instituted are briefly as follows:—(1) The lessees of the bag-net fishings in the sea were prosecuted for failure on two separate occasions to remove the leaders of eight of their nets during the weekly close time. The Sheriff assoilzied the defenders, but this decision was reversed on appeal to the High Court of Justiciary. The ground of the decision was that the fishermen must prove, in order to escape the penalties provided by the Act, that during the *whole* period of the weekly close time they were unable to remove the leaders. (2) Two men were convicted and heavily fined for taking sea trout during the close season.

Obstructions to the Passage of Fish—

1. With regard to the observance of bye-laws, they are generally observed.
2. The pass in Alloway dam dyke has been modified and rendered of easier gradient.

Pollutions—

1. The existing pollutions are :—Scouring wash from the Skeldon Mill (blanket manufactory).
1. Remedial measures :—None.

The Salmon Disease—

1. Disease made its appearance this year in the month of July, and reached its height in August.

The river was free of diseased fish in end of August.

2. The number of diseased fish taken from the river and destroyed was as follows :—

	Males.	Females.
Kelts, ...	–	–
Clean, ...	9	8

The Spawning Season—

1. Fish were first noticed spawning in November.
2. The greatest number spawn in December.
3. Spawning ceases in January.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as very good.

Smolts—

1. Smolts are noticed to be migrating seawards in February.
2. As a smolt year 1905 was fair.

REPORT FROM GIRVAN DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been much below the average both in sea and river. Supposed to be the least productive season on record.
2. The actual number of fish caught has been as follows :—
   (*a*) By fixed engine, 202 salmon, 300 grilse, 1200 sea trout.
   (*b*) By rod and line, 1 salmon, about 300 sea trout so far as known.
3. Particulars as to the times salmon, grilse, and sea trout appeared are as follows :—First salmon caught 3rd May 1905 ; first sea trout caught 3rd May 1905. No grilse caught till 21st June.
4. The weight of the heaviest salmon taken during the season was 27 lbs. The particulars of time and place of capture are :—In August at Lendalfoot (Crown Sea Fishery).

Protection—

1. The assessable rental for 1905 was £544.
2. The assessment levied was £27 4s.
3. The water bailiffs employed are 1 in number.
4. Particulars as to prosecutions instituted are briefly as follows :—One prosecution : illegal capture of fish at Bridgemill dam. Two panel, fined £1 or 14 days each.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—No change.
2. With regard to the observance of bye-laws :—On two occasions the weekly close time was not observed in August owing to stormy weather, but proceedings were not considered advisable.
3. Fish passes built or in prospect :—None.
4. Natural obstructions not yet dealt with are :—Fairlaw Linn, near upper part of river.

Pollutions—

1. The existing pollutions are :—None since the pumping of the polluted water from Dalquharran Colliery ceased.
1. Remedial measures :—None.

The Salmon Disease—

No salmon disease observed.

The Spawning Season—

1. Fish were first noticed spawning in December.
2. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as very poor—the number of breeding fish observed being small.

Smolts—

As a smolt year 1905 was, curiously enough, considered quite an average one—at least the average number of smolts and fry were observed in the lower reaches and estuary.

Artificial Propagation of Salmon—

1. The number of ova secured locally during the past season was nil.
2. In securing ova the numbers of male and female fish captured were nil.

General—

Owing to the falling-off in the returns this year, a meeting of proprietors was convened to consider what steps should be taken to improve matters now that the pollution has ceased. Very valuable suggestions and advice, kindly tendered by Mr. Calderwood, have since been before the proprietors, and it is hoped something practical may result.

REPORT FROM STINCHAR DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been smaller.
   More particularly it has been :—
   (*a*) By fixed engines in the sea, considerably less.
   (*b*) By rod and line, less.
2. Grilse and sea trout appeared in August.
3. The weight of the heaviest salmon taken during the season was 20 lbs.

Protection—

1. The assessable rental for 1905 was £400.
2. The assessment levied was £15 13s. 4d.
3. There is one water bailiff employed.
4. Particulars as to prosecutions instituted are briefly as follows :—No prosecutions.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—None.
2. Fish passes built or in prospect :—None.
3. Natural obstructions not yet dealt with :—None.

Pollutions—

No pollution.

The Salmon Disease—

No disease.

The Spawning Season—

1. Fish were first noticed spawning on 28th November.
2. The greatest number spawned 1st December to middle of January.
3. Spawning ceased about end of January.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as bad.

Smolts—

1. Smolts were noticed to be migrating seawards about 1st March.
2. As a smolt year 1905 was below the average.

REPORT FROM RIVER CREE DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been below average.
   More particularly it has been
   (*a*) By fixed engines in the sea, below average of some years, but, being a dry season, a little above last year.
   (*b*) By sweep net in tidal or fresh waters, below average.
   (*c*) By rod and line, up to average.
2. Expressed as percentages for each month of the season, so as to show the times of greatest run, the figures are :—

	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
By Fixed Engine, . . .				Not known.				
By Sweep Net, . . .				Not known.				
By Rod and Line, . . .	–	$8\frac{1}{3}$	50	$16\frac{2}{3}$	$8\frac{1}{3}$	$2\frac{8}{21}$	$9\frac{11}{21}$	$4\frac{16}{21}$

Particulars as to the times grilse and sea trout appeared, as included in the above return, are as follows :—Grilse about 18th May ; trout a little earlier.

Protection—

1. The assessable rental for 1905 was £728.
2. The assessment levied was 8d. per £.
3. The water bailiffs employed are 4 in number—employed from 1st June till 31st October ; remainder of year, 3. Spawning ground well watched.
4. Particulars as to prosecutions instituted :—None.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—None.
2. With regard to the observance of bye-laws :—Seem to be regular.
3. Fish passes built or in prospect :—None.
4. Natural obstructions not yet dealt with are on High Cree, at Bargrennan Lynn.

Pollutions—

None.

The Salmon Disease—

1. Disease made its appearance this year in the month of May, and reached its height in June.
   It is not known if river free yet from disease (end of November).
2. The number of diseased fish taken from the river and destroyed :—No count kept.

The Spawning Season—

1. Fish were first noticed spawning on 21st November.
2. The greatest number spawned in November.

3. Spawning ceased end of November.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as very moderate.

Smolts—

1. Smolts were noticed to be migrating seawards in April and May.
2. As a smolt year 1905 was not remarkable in any way.

REPORT FROM DEE (SOLWAY) DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been average.
2. The weight of the heaviest salmon taken during the season was 30 lbs. The particulars of time and place of capture :—June.

Protection—

1. The assessable rental for 1905 was £1556.
2. The assessment levied was £77 16s.
3. The water bailiffs employed are 16 in number.
4. Particulars as to prosecutions instituted :—None.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—None.
2. With regard to the observance of bye-laws :—These are observed.
3. Fish passes built or in prospect :—None.
4. Natural obstructions not yet dealt with :—None.

Pollutions—

No pollution.

The Salmon Disease—

No disease.

The Spawning Season—

1. Fish were first noticed spawning during the last few days of October.
2. The greatest number spawned during the first ten days of November.
3. Spawning ceased about 1st December.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as fair.

Smolts—

1. Smolts were noticed to be migrating seawards in April and May.
2. As a smolt year 1905 was very light.

REPORT FROM ANNAN DISTRICT.

Take of Fish—

1. As compared with the average results of previous years, the take of fish generally throughout the district has been below the average.

More particularly it has been

(*a*) By fixed engines in the sea, below the average.
(*b*) By sweep net in tidal or fresh waters—No sweep-net fishing in district.
(*c*) By rod and line, below the average.

2. The actual number of fish caught has been as follows :—
   (*a*) By fixed engine—Notes not taken ; take therefore cannot be given.
   (*b*) By sweep net—No sweep nets fished in district.
   (*c*) By rod and line—Notes not taken ; take therefore cannot be given.
3. Particulars as to the times grilse and sea trout appeared are as follows :—Grilse, second week in May—best takes first and second weeks in July ; sea trout, in March—best takes third and fourth weeks in June ; salmon, first caught 27th February—best takes second week in July and first week in September (in Solway Firth).
4. The weight of the heaviest salmon taken in the Solway was 45 lbs., with a haaf net, on Annan burgh fishings on 24th August 1905, and with rod and line 36 lbs., on the Mount Annan portion of the Annan on 8th November 1905.

Protection—

1. The assessable rental for 1905 was £3256.
2. The assessment levied was £447 14s.
3. The water bailiffs employed are 4 in number—3 at Annan and 1 at Lochmaben (one of those at Annan does duty at Moffat during spawning season).
4. Particulars as to prosecutions instituted are briefly as follows :—One person was tried at Sheriff Court, Dumfries, contravention of Salmon Act, 1868, Section 15 (Sub-section 4), and fined 5s. and 34s. 9d. of expenses.

Obstructions to the Passage of Fish—

1. Dam dykes disused, built, or in prospect :—No alteration.
2. With regard to the observance of bye-laws :—*On the Annan*—No heck at the tail of the mill race at Brydekirk Mill, belonging to James Graham, meal miller there. *On the Kirtle*—No heck at intake or tail of mill race at Beltenmont Mill, belonging to Miss Ann Beattie, 13 Charles Street, Annan, and no heck at tail of mill race at Kirtlebridge Mill, belonging to the trustees of the late John Irving, per H. C. Irving of Burnfoot, Ecclefechan, and never was. *On the Mein*—No heck at intake or tail of mill race at Mein Mill, belonging to the Duke of Buccleuch. *On the Dryfe*—No heck at intake or tail of mill race at Sandbed Mill, belonging to Walter Jackson, but there is a heck across the lade above the wheel. *On the Milk*—No heck at intake of the mill race at Scroggs Mill, belonging to the Earl of Mansfield, but there is a heck across the lade at the entrance to the wheel, which is placed close on the Milk water.
3. Fish passes built or in prospect :—No alteration.
4. Natural obstructions not yet dealt with :—None in district.

No pollutions.

The Salmon Disease—

1. Disease made its appearance this year in the month of January, and reached its height in March.
   The river was free of diseased fish at end of April.
2. The number of diseased fish taken from the river and destroyed was as follows :—

	Males.	Females.
Kelts, ...	4	2
Clean, ...	1	2

The Spawning Season—

1. Fish were first noticed spawning on 23rd December at Mount Annan.
2. The greatest number spawned during last week in January and first week in February.
3. Spawning ceased first week in March.
4. As regards numbers of breeding fish, and state of the water, the past spawning season is regarded as about an average. The numbers seen were more than during last season. The river was of a medium size.

Smolts—

1. Smolts were noticed to be migrating seawards during the month of May.
2. As a smolt year 1905 was a fair average.

Artificial Propagation of Salmon—

None in district.

APPENDIX II.

A CONTRIBUTION TO THE LIFE-HISTORY OF THE SALMON, AS OBSERVED BY MEANS OF MARKING ADULT FISH.

[THIRD PAPER.]

BY

W. L. CALDERWOOD,

Inspector of Salmon Fisheries for Scotland.

In continuing the marking of salmon an attempt has been made to extend the area of operations, and, as far as possible, to gain information along lines suggested by previous results. The number of recaptures which I am able to report is not so great as in my second paper [*Twenty-second Annual Report*, Part II., p. 84], but the results are interesting because of additional recaptures on the coast—so that I am able to present a chart of these—and because the proportion of spring fish taken is considerable, especially from the rivers Helmsdale and Brora. The total number of recaptures since my last paper is thirty-seven. The particulars are tabulated as formerly in the consecutive order of the mark-numbers.

TABLE OF RECAPTURES, 1904 AND 1905 MARKING.

Note.—The particulars at time of marking and at time of recapture are bracketed together, the former above the latter.

No.	Weight.	Length.	Condition.	Sex.	Date.	Where caught.	Remarks.
	lbs.	inches.					
7729A	14	36	Kelt.	F.	19 Jan. 1903.	Kinnaird, Tay.	
	Est. 17	43	Kelt.		18 Jan. 1905.	Newbury, Tay.	Found dead (apparently from disease).
	Note.—Was in poor condition, had a large frame, and had been a heavy fish when in condition.						
8347A	12	37	Kelt.	M.	10 Mar. 1903.	Tummel, Tay.	Bad condition.
	25¼	41	Clean.		17 Aug. 1904.	Estuary, Tay.	Poor condition, and reported as "bull trout."
	Note.—On recapture, this fish had both sea lice and gill maggots.						
9043A	7¼	28	Nearly spawned out.	F.	24 Nov. 1902.	Almond mouth, Tay.	A grilse.
	Est. 24	...	Unspawned.		Oct. 1904.	Earn mouth, Tay.	Found dead.
9147A	5½	23½	Unspawned.	F.	10 Nov. 1903.	Lower Tay.	A grilse.
	7½	27	Clean.		19 Aug. 1904.	Lower Tay.	A "bull trout."
	Note.—Had both sea lice and gill maggots.						

TABLE OF RECAPTURES, 1904 AND 1905—*Continued.*

No.	Weight.	Length.	Condition.	Sex.	Date.	Where caught.	Remarks.
	lbs.	inches.					
9410A	6	30	Kelt.	F.	17 Jan. 1905.	Logierait, Tay.	
	19	36½	Clean.		8 Mar. 1906.	Pyerod Station, Tay.	
9523A	15	36½	Kelt.	F.	24 Mar. 1904.	Deveron.	Laithers Water.
	24½	39½	Unspawned.		14 Dec. 1904.	Spey.	Brae Water.
4B	11	34	Kelt.	F.	17 Jan. 1904.	Tummel, Tay.	
	Est. 20	...	Clean.		16 June 1905.	Tay.	Mark recovered from Grove's shop in Bond St. through Mr. Towse.
16B	16	36½	Kelt.	F.	11 Feb. 1904.	Tummel, Tay.	
	34	43	Clean.		17 July 1905.	Tay estuary.	
202B	16	39	Kelt.	M.	14 April 1904.	Deveron.	(Ardmeallie.)
	25	40½	Clean.		19 Aug. 1904.	Nr. Aberdeen.	Mark found in fish shop in Newquay, Cornwall. Fish sent from Aberdeen by rail from Mr. Hector's fishery.
203B	13½	36	Kelt.	...	15 April 1904.	Deveron.	(Ardmeallie.)
	...	...	Kelt.		30 April 1904.	On coast near Banff.	
209B	15½	37	Kelt.	F.	20 Feb. 1905.	Deveron.	(Ardmeallie.)
	Est. 20	...	Clean.		26 Aug. 1905.	On coast near mouth of Ugie.	
316B	4½	25	Kelt.	M.	23 Mar. 1904.	R. Stinchar.	Grilse.
	14	...	Clean.		5 July 1905.	On coast near Girvan (Lendal Foot).	
339B	3	23	Unspawned.	F.	24 Oct. 1904.	Luss.	A sea trout.
	4½?	...	Spawning.		25 Oct. 1905.	Luss Water.	
	Note.—Three other sea trout were recaptured, at Luss, of which particulars cannot, unfortunately, be given.						
472B	1¼	16	Kelt.	F.	25 April 1905.	Deveron (Muiresk).	A sea trout.
	2¼	...	Clean.		7 July 1905.	Deveron.	
627B	3	24	Kelt.	...	Mar. 1905.	R. Helmsdale.	
	15·2	...	Clean.		25 Aug. 1905.	On coast at Hilton of Cadboll.	S. of Tarbat Ness.
629B	5	24	Unspent.	F.	28 Sept. 1904.	Helmsdale.	
	12	32	Clean.		27 Mar. 1906.	Helmsdale.	
637B	7½	33	Kelt.	...	March 1905.	Helmsdale.	
	17·2	...	Clean.		20 April 1905.	Balintore.	Coast S. of Tarbat Ness.

TABLE OF RECAPTURES, 1904 AND 1905—*Continued.*

No.	Weight.	Length.	Condition.	Sex.	Date.	Where caught.	Remarks.
	lbs.	inches.					
736B	8	30	Kelt.	F.	9 Nov. 1904.	Helmsdale.	Stripped at Kildonan.
	18½	36	Clean.		17 April 1906.	Dunbeath.	Coast net.
732B	12	35½	Kelt.	F.	9 Nov. 1904.	Helmsdale.	
	20	38	Clean.		9 Nov. 1906.	Helmsdale.	
767B	7·10	28½	"Ripe for spawning."	M.	24 Oct. 1904.	Dee, Cluny Water.	
	...	...	...		Feb. 1905.	Dee, at Crathes.	Found dead—no other particulars.
780B	5·10	27	Kelt.	M.	25 Oct. 1904.	Dee, Geldie Water.	
	...	...	...		Feb. 1905.	Dee Estuary.	Found dead.
807B	7	30	Kelt.	F.	9 Nov. 1904.	Helmsdale.	Stripped at Kinbrace.
	16	36¾	Clean.		22 Mar. 1906.	Helmsdale.	
*1156B	4	24¼	Kelt.	F.	9 Dec. 1904.	Helmsdale.	
	25	...	Clean.		25 July 1905.	Rockfield Fishery.	S. of Tarbat Ness.
1158B	8	30¼	Kelt.	F.	9 Dec. 1904.	Helmsdale.	
	18	35	Clean.		26 April 1906.	Halladale R.	
1180B	5	26¼	Kelt.	F.	12 Dec. 1904.	Helmsdale.	
	14	36	Clean.		30 April 1906.	Helmsdale.	
1203B	5	27	Kelt.	F.	7 Mar. 1905.	Loch Brora.	
	12½	32½	Clean.		26 April 1906.	Loch Brora.	
1204B	5	27	Kelt.	F.	7 Mar. 1905.	Loch Brora	
	14	34	Clean.		2 April 1906.	Loch Brora	
1223B	5	26½	Kelt.	F.	7 Mar. 1905.	Loch Brora.	
	10	31	Clean.		26 April 1906.	Loch Brora.	
1232B	6	28½	Kelt.	F.	20 Mar. 1905.	Loch Brora	
	14	35	Clean.		6 April 1906.	Loch Brora	
1243B	6	28½	Kelt.	F.	20 Mar. 1905.	Loch Brora.	
	9½	...	Clean.		18 July 1905.	On coast at Berriedale.	
1266B	4½	26½	Kelt.	F.	31 Mar. 1905.	Loch Brora.	
	15	32½	Clean.		26 April 1906.	Loch Brora.	
1833B	7½	31½	Kelt.	M.	15 Jan. 1906.	Sandside.	Stripped after being kept in pond. Afterwards put in Isauld Burn.
	10	...	Kelt.		31 Jan. 1906.	R. Thurso.	14 miles up river.
1903B	6¾	25½	Clean.	F.	18 Dec. 1905.	Culter, Dee.	
	6	26	Clean.		21 Feb. 1906.	Glentana, Dee.	28 miles up.
1908B	8	26¾	†Unspawned.	F.	19 Dec. 1905.	R. Dee.	Donald's Gurth.
	8	...	Clean.		31 Mar. 1906	R. Dee.	Culter.

* The enormous increase in weight given for this fish I regard with some suspicion. I received the particulars about a month after the recapture, and the increase is considerably greater than any shown by previous records.

† In view of the particulars of recapture I am inclined to think that, in marking, a mistake as to condition was made, and that the fish was a very early run clean fish, which had become coloured in the fresh water.

Migratory Movements.

Nine of the recaptures have been made on the coast, and two fish are found to have wandered to other rivers. By combining these recent recaptures with the few similar recaptures which we previously have obtained, while disregarding several recaptures at such short distances as to be unimportant in the present connection, I am able to present the accompanying chart. All migrations down the coast in a southerly or south-easterly direction are indicated in red, while movements up the coast in a northerly or westerly direction are inserted in black. There are 15 red lines and 5 black ones. The total of 20 out of 274 recaptures, or $8\frac{3}{4}$%, may or may not represent the actual proportion of salmon which desert the districts and rivers of their birth; but the result is at all events of some value as indicating for the first time with some probable degree of accuracy the nature of the coastal movements which take place. Three of the red lines represent the somewhat rapid movements of kelts after leaving the fresh water where they were marked. Line A represents a kelt marked in the Grimersta, West Lewis, caught in five months at Castletown, near Thurso, still not recovered from the kelt condition. We are indebted to the private marking of Mr. J. Byres-Leek for this interesting record, and I have the specimen preserved. Line C represents a fish artificially stripped at Sandside by Mr. Pilkington's keeper and released in a small burn on 15th January of this year. It was retaken 14 miles up the river Thurso, still a kelt, on 31st January, *i.e.*, in 16 days. Like other kelts in small streams, this fish had evidently made a prompt descent to the sea, and, it may be, the artificial stripping affected its movements. The reascent of a larger stream is striking and, so far as our records go, unique. In the light of this Sandside-Thurso fish it is possible that the Grimersta-Castletown fish marked by Mr. Byres-Leek had in the interval between marking and recapture been in the fresh waters of some north-coast river, thus accounting for the continuance of the kelt condition. The third case is line K, an unspawned fish marked in Spey on 14th December 1896, recaptured as a kelt in the Dee on 22nd February 1897. If, as seems most probable, this fish spawned in the Dee rather than the Spey, its movements are analagous to those of the fish represented by line L, a large male fish unripe in the Spey in December 1896, recaptured as a partially spent kelt in the Deveron in March 1897. Three Helmsdale fish represented by letters H, I, and S made southerly migration to Portmahomack, just south of Tarbat Ness. Three other Helmsdale fish (E, F, and G) go from that river into the Brora, while a Brora fish (D) goes north to Berriedale, and a Helmsdale fish goes north to Dunbeath (line T). Two rather remarkable migrations are represented by the lines B and V. The particulars of marking and recapture of those two cases are:—

No.	Lbs.	Inches.	Condition.	Sex.	Date.	Where Caught.
7283A	3	24	Kelt.	F.	20th April 1901.	Loch Brora.
	$8\frac{1}{2}$	—	Clean.	F.	17th July 1901.	Coast off Halladale.
1158B	8	$30\frac{1}{4}$	Kelt.	F.	9th Dec. 1904.	River Helmsdale.
	18	35	Clean.	F.	26th April 1906.	River Halladale.

Those two fish leaving neighbouring rivers were both taken 90–100 miles north in or at the Halladale river in the Pentland Firth. The increase in weight in the former was $5\frac{1}{2}$ lbs. in 88 days; the increase in

the latter 10 lbs. in 506 days. No doubt the second fish had spawned in the interval, or the increase would have been more marked; but the interest of the recaptures lies not in the increase of weight, but in the fact that two fish should have followed so similar a course in contradistinction to the condition revealed by the other coastal recaptures as shown in the red lines. There is nothing to show that this is more than a coincidence, but as Helmsdale and Brora marking is likely to be continued on an even greater scale more evidence may be gathered in the future. The five fish which are traced from the Deveron out of the Moray Firth, represented by lines M, N, O, P, and R, offer, however, the most striking feature of the chart. The similarity of the records are remarkable, and can hardly, I think, be considered as accidental. The details are:—

	No.	Lbs.	Inches.	Condition.	Sex.	Date.	Increase in Weight.	Increase in Length.	Interval of Time.
							Lbs.	In.	Days.
M	209B	15½	37	Kelt.	F.	20th Feb. 1905.	4½ (est.)	–	187
		20 (est.)	–	Clean.	F.	26th August 1905.			
N	9639A	4	25	Kelt.	F.	28th April 1903.	4½	–	88
		8½	–	Clean.	F.	25th July 1903.			
O	9607A	3	24	Kelt.	F.	24th March 1903.	3¾	2	109
		6¾	26	Clean.	–	11th July 1903.			
P	6508A	3	23	Kelt.	M.	11th March 1901.	2¾	2½	122
		5¾	25½	Clean.		11th July 1901.			
R	202B	16	39	Kelt.	–	14th April 1904.	9	1½	126
		25	40½	Clean.	M.	19th August 1904.			

The mark in the fish represented by line M was only noticed after the fish had been sent by rail from Aberdeen to New Quay, in Cornwall.

Another Deveron fish, marked 9523A in Laithers Water when a kelt, was recaptured the following winter in the lower waters of the Spey, an unspawned female, thus forming an exception to the Deveron series.

With regard to the migrations not referred to in the chart, we have 18 fish, marked as kelts, recaptured in their own rivers (including a Loch Lomond sea trout and a Deveron sea trout). These recaptures bear out what was in my second report on this subject described as the short and long habits of migration. Similar evidence has also recently been reported in connection with the Irish salmon marking.* In the present instance, however, it is noticeable that the great majority of the fish have spent more than a year in the sea before returning to the river. Omitting the two sea trout and taking the 16 remaining fish, we have only No. 9147 representing a short migration and recapture in nine months. The others show intervals of from 11¾ months to two years, viz.:—

8437A—17 Months.	732B—24 Months.	1204B—13 Months.
9043A—23 ,,	807B—16 ,,	1223B—12¾ ,,
4B—17 ,,	1158B—13½ ,,	1232B—13 ,,
16B—17 ,,	1180B—14½ ,,	1266B—11¾ ,,
672B—18 ,,	1203B—12¾ ,,	9410A—14 ,,

It may be noticed that on 26th April of this year three recaptures were made in Loch Brora, and that of these, two of the fish had been marked on the same day, 7th March 1905. No. 1203 had gained 7½ lbs., and No. 1223 5 lbs.

* A. B. E. Hillas, *Fisheries, Ireland, Sci. Invest.*, 1904, VII. (1906).

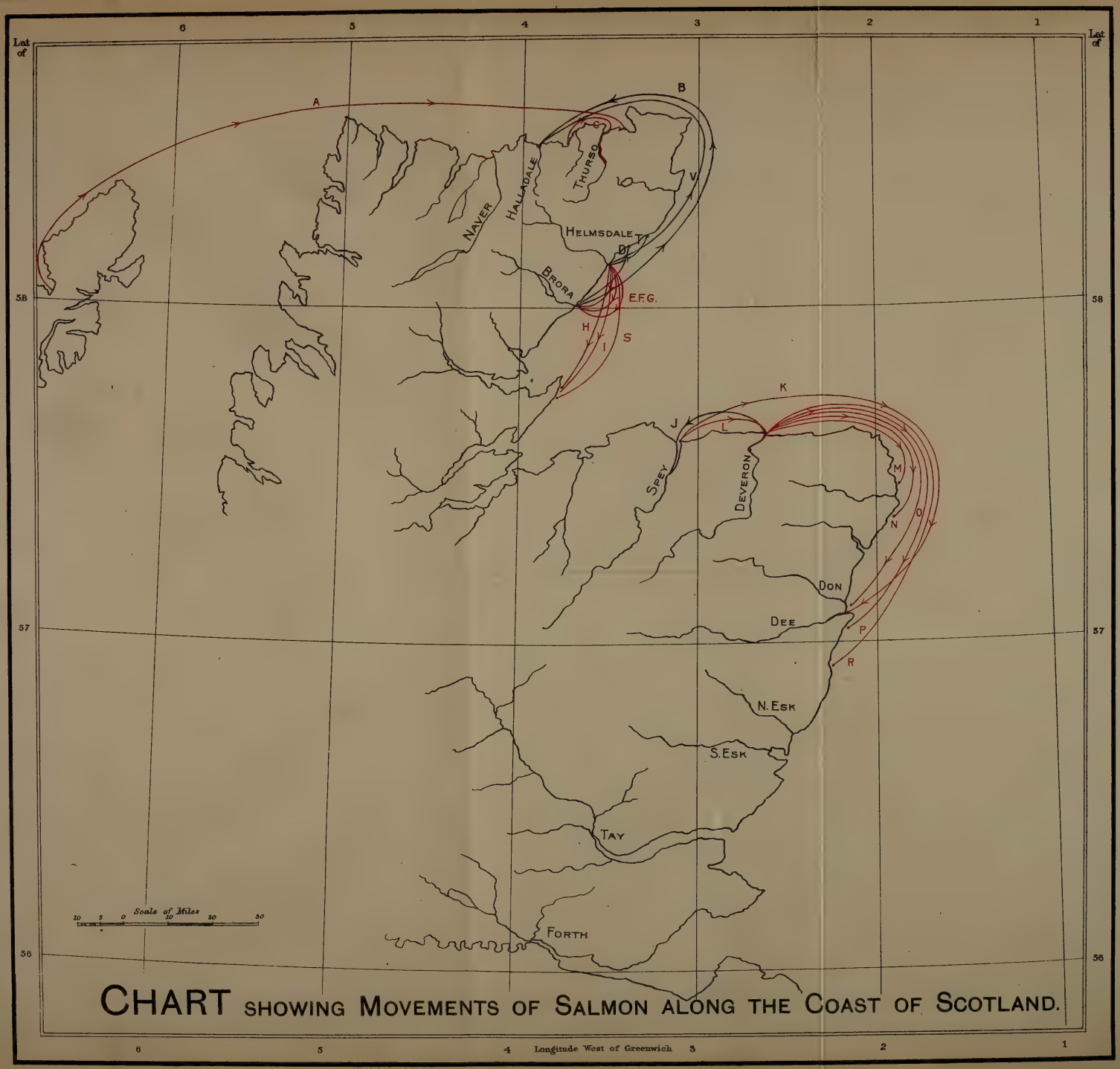


CHART SHOWING MOVEMENTS OF SALMON ALONG THE COAST OF SCOTLAND.

Increase of Weight.

If the fish marked as kelts and recaptured as clean fish be taken in the order of their increase of weight the following result is procured:—

Increase.	Interval.	No.	District.
(?) 21 lbs.	218 days.	1156B	Helmsdale.
18 ,,	521 ,,	16B	Tay.
16¾ ,,	691 ,,	9043A	Tay.
13¼ ,,	525 ,,	8347A	Tay.
12·2 ,,	163 ,,	627B	Helmsdale.
10½ ,,	525 ,,	736B	Helmsdale.
10½ ,,	391 ,,	1266B	Brora.
10 ,,	Ca. 370 ,,	637B	Helmsdale.
10 ,,	506 ,,	1158B	Helmsdale.
9½ ,,	265 ,,	9523A	Deveron, Spey.
9½ ,,	469 ,,	316B	Stinchar.
Est. 9 ,,	514 ,,	4B	Tay.
9 ,,	127 ,,	202B	Deveron.
9 ,,	498 ,,	807B	Helmsdale.
9 ,,	504 ,,	1180B	Helmsdale.
7½ ,,	415 ,,	1203B	Brora.
5 ,,	415 ,,	1223B	Brora.
Est. 4½ ,,	187 ,,	209B	Deveron.
3½ ,,	120 ,,	1243B	Brora.

The same great variation in rate of increase, as has previously been remarked, is again apparent—9 lbs. are gained by one fish in 127 days and by another fish in 498 days. Such extreme contrasts must be explained to some extent by understanding that a fish entering fresh water and spawning on two consecutive seasons cannot grow as rapidly as a fish which remains, it may be, one or two consecutive spawning seasons in the sea. To estimate the condition properly, it seems necessary to classify the records according as fish show short or long periods of sojourn in the sea, and to select records from one river district alone. Variation in weight is thus found to be not great, fish recaptured after intervals of from 6 to 8 months showing a variation of about 3 lbs., and fish recaptured after intervals of from 12 to 18 months a variation of 9 or 10 lbs.

Addendum.

Since the above results were compiled the following recaptures have been made:—

No.	Lbs.	Inches.	Condition.	Sex.	Date.	District.
749	7	31	Kelt.	F.	9th November 1904.	Helmsdale.
	19	44	Clean.	F.	10th May 1906.	Helmsdale.
1186	4½	26¼	...	F.	12th December 1904.	Helmsdale.
	11½	3[illegible]	...	F.	8th May 1906.	Helmsdale.
1167	3	22½	...	F.	9th December 1904.	Helmsdale.
	11	30	...	F.	16th May 1906.	Near mouth of R. Brora.

The last is not included in the chart showing coastal migrations.

APPENDIX III.

AUTUMN MIGRATION OF SALMON SMOLTS IN SCOTLAND.

By W. L. CALDERWOOD.

In my last Annual Report (Appendix III.) I dealt with the seaward migration of smolts in the spring as observed by the aid of certain netting operations, both with a small-mesh sweep net and with a sparling net lowered from a smack moored in the Tay estuary. The great abundance of smolts congregating in the neighbourhood of Kinfauns, where the first trace of marine influence seems to be felt, was referred to, and by the use of the sparling net in the lower estuary the difference of habit between the salmon and sea-trout smolt was apparently ascertained in the rapid descent to the open sea on the part of the salmon as contrasted with the lingering estuarial habit of the sea trout.

Since the time when Shaw at Drumlanrig proved that parr and smolts are the young of the salmon, the significance of the spring migration to the sea of shoals of smolts has been recognised. Numerous observations have since been made to ascertain the age and growth of smolts previous to the seaward migration, and the generally accepted view at the present day undoubtedly is that in our country the great majority of salmon smolts leave the river for the sea when they are 26 months old or thereby, but that some go a year earlier and some a year later. The famous Stormontfield experiments have largely guided opinion on this point, and from these it has been estimated that 8 per cent. migrate the first year, 60 per cent. the second year, and 32 per cent. the third year. It has to be understood, however, that this statement refers to the British Islands, and not apparently to other habitats of *S. salar*, such as Norway and the American Continent. It is accepted on all hands that the greatest annual migration of smolts takes place in spring. Further than this, it has, however, been ascertained by a limited number of observers that smolts also migrate seawards in autumn and winter, and probably to some extent all through the year. On this point information from Scotland has been practically absent. Many writers, it is true, have referred to parr as being found at all seasons, but it is by no means clear that the references were to fish sufficiently advanced to be in the migratory condition, although the name parr has sometimes been employed to describe the little fish with silvery scales usually called smolts. In England, Murie, *Proc. Zoo. Soc.*, 1870, states on the authority of Buckland that "there is good evidence "of a second migration of smolts in the month of September." Willis Bund, *Salmon Problems*, p. 60, maintains that in a well-stocked salmon river the time when smolts of various stages descend depends upon various conditions, and that no hard and fast rule can be laid down; and on p. 9 of the same work he describes finding silvery scaled samlets in eel traps in the Severn in December 1884. Day, *British and Irish Salmonidæ*, p. 90, states as a fact that migrations occur in the autumn "as well as probably throughout the year." From time to time refer-

ences to autumn smolts have appeared in *The Field* and *Land and Water*; and in Major Traherne's *Habits of the Salmon*, a short chapter is devoted to the subject, in which very definite reference is made to the catching of smolts in December in the river Galway. There are two reasons why, if migrations regularly occur in autumn and winter, the movements of the little fish are likely to have been overlooked. The smolts do not seem to have the habit of gently rising and breaking the surface of the water as in spring, or are never in sufficient numbers to make such rising noticeable; and also the occurrence of the close season results in fewer observers being by the river banks, and in the absence of all tests likely to demonstrate that smolts are in the water. In the reports prepared from year to year by Mr. Willis Bund, as chairman of the Severn Board of Conservators, and which have occasionally been sent to me by the kindness of the author, it is noticeable that the occurrence of an autumn run of smolts has come to be regarded as an established fact. In the report upon the season 1904, for instance, I notice that in referring to the effects of the Liverpool Waterworks it is suggested that the cutting off of the spring freshets has prevented to some extent the descent of the spring migration of smolts and has caused an increase in "the autumn migration of smolts." That there is, as a matter of fact, a great increase in the number of smolts descending in the autumn is definitely stated, and in a letter received by me from Mr. Willis Bund the catching of these fish in the eel traps is described. Evidence was given before the Irish Inland Fisheries Commission to show that, at any rate in certain rivers, smolts are found descending at seasons other than spring, and Mr. Holt, in a letter to me on the subject from Dublin, says:—"I have had a good "many sent to me from time to time, and an autumn migration seems "to occur regularly. While there is no doubt that the fish are moving "down and, from the position of some captures, are going into brackish "water, I do not remember to have ever seen one quite so silvery or so "large as some of the spring smolts."

From Scotland, as has been said, evidence on this subject is much more deficient, and it has been a point of some interest therefore to determine whether or not these autumn and winter migrations occur with us. Through the kindness of the Tay Fisheries Co., and the courtesy of the Tay District Board, a small-meshed net has been fished by the employees of the Company on six occasions during the last close time and present spring. Fishing was conducted on 18th September, 3rd November, 7th December, 10th January, 13th February, and 27th March, on each occasion at or in the neighbourhood of Kinfauns, in the upper estuary of the Tay, past experience having shown us that descending smolts congregate here previous to their more rapid passage to the sea. (*Twenty-third Annual Report*, Part II., p. 82.)

The results are as follows:—

18*th September* 1905. Eleven shots with the net were taken as follow:—

3 at "Inchyret"—blank.
2 at "Lower Mary" produced—
- 1 Salmon Parr.
- 1 Yellow Fin or Sea-trout Smolt.
- 1 Brown Trout.
- 3 Whitling (clean).

2 at "Flookie"—
- 3 Salmon Parr.
- 5 Yellow Fins.

4 at "Tappie"—
14 Salmon Parr.
4 Brown Trout.
1 Whitling.

Of the 18 salmon parr obtained, 2 were nearing the silvery-scaled smolt stage.

3rd November 1905. Fourteen shots taken as follow:—

The tide was ebbing. Water temperature at 1 p.m. = 46°.

5 at "Sleepless"—
1 Salmon Parr, 10·8 cm. long.
1 Yellow Fin.
2 Whitling, 18·0 cm. long.

6 at "Tappie"—
9 Salmon Parr and Smolts, 10·7, 11·0, 6·0, 14·5, 12 cm.
3 Yellow Fins.
6 Whitling (clean).
1 Sea Trout.

3 at "Pyerod"—
19 Salmon Parr and Smolts.
9 Yellow Fins.
1 Brown Trout.
3 Whitling.

Ten of the smolts and parr taken at Pyerod were brought by me to Edinburgh and examined carefully. Notes on this examination are as follow:—

(*a*) Length, 14·0 cm.; depth of caudal ped., 1·1 cm.; max. bone vertically below centre of eye; scales, 12; pectorals, ventrals, and anal fin, yellowish; adipose fin, slate colour.

A shapely little fish with silvery scales, black spot on operculum, and a few red spots on sides. A salmon smolt.

(*b*) Length, 12·0 cm.; depth of caudal ped., 1·0 cm.; max. bone vertically below centre of eye; scales, 12. A salmon smolt.

A silvery fish of appearance exactly as (*a*).

(*c*) Length, 10·5 cm.; depth of caudal ped., 0·9 cm.; scales, 12 or possibly 13; max. bone vertically beneath centre of eye; all lower fins yellowish; adipose fin and caudal fin pink edged.

This fish was not silvery, but presented the appearance characteristic of parr.

(*d*) Length, 12·0 cm.; depth of caudal ped., 0·9 cm.; scales, 11; max. beneath centre of eye; dorsal, caudal, and adipose fins tinged with pink; ventral and anal fins whitish; pectoral fins with dark veins in rays; two black spots on operculum.

A silvery fish, but still bearing 8 parr bands on side, and red spots along lat. line; dorsum spotted, dusky. In transition stage—between parr and smolt.

(*e*) Length, 8·5 cm.; depth of caudal ped., 0·7 cm.; max. vertically beneath centre of eye; scales, 12; adipose and caudal fins tipped with red; under fins whitish.

A silvery fish without parr markings. A few red spots still on lat. line. A salmon smolt of small size.

(*f*) Length, 11·7 cm.; depth of caudal ped., 0·9 cm.; max. bone vertically beneath centre of eye; dorsum spotted; adipose fin dusky; ventral and anal fins whitish.

A silvery fish with 8 parr marks. In transition stage between parr and smolt (as specimen (*d*)).

(*g*) and (*h*). Two parr, 5·8 and 6·3 cm. respectively.

Mr. Johnston, who contributed to last Annual Report the paper on *The Scales of Tay Salmon*, examined the scales of specimens (*g*) and (*h*) and formed the opinion that these small examples were less than a year old.

7*th December* 1905. Six shots were taken at Kinfauns with result as follows:—

3 Salmon Parr.
7 Yellow Fins.
14 Whitling (clean).
3 Sea-trout Kelts.

I was not present on this occasion, but Mr. Johnston kindly sent me one of the parr. It was 11·2 cm. in length, and although showing the parr marks and red spots was a fairly silvery fish, and might almost be described as a smolt.

10*th January* 1906. Ten shots were taken at Pyerod fishing station, near Kinfauns:—

2 Salmon Parr, 8·9 and 5·3 cm., without silvery scales.
20 Yellow Fins.
23 Whitling.
12 Sea-trout Kelts.
1 Grilse Kelt.
1 Salmon Kelt.
1 Perch.

In every haul of the net numbers of young flounders were also taken (*P. flesus*).

13*th February* 1906. Netting in neighbourhood of Kinfauns:—

7 Salmon Parr. (3 showing subdued silvery condition, largest 10·5 cm., 3 very small fry.)
15 Yellow Fins.
1 Sea-trout (clean).
34 Sea-trout Kelts.
45 Whitling.

27*th March* 1906. Netting near Kinfauns—15 shots:—

50 Salmon Parr.
68 Yellow Fins.
21 Whiting.
2 Sea Trout (clean).
13 Sea Trout (kelts).
1 Grilse Kelt.
1 Pike.

Water low; temperature 38° F. The salmon parr varied from 4·6 to 14 cm. Many of the larger examples were silvery, though not brightly so.

From these observations it will be seen that while ordinary river parr were found in the tidal waters of the Tay in *September* 1905, they did not occur, apparently, in any great number. Only 18 were caught in eleven shots with the net at four neighbouring fishing stations.

In *November* the numbers had increased, and many of the young fish showed silvery scales, which, although not quite so bright as those upon migrating smolts in the spring, nevertheless gave strong presumptive evidence that these fishes were migrating to the sea. Twenty-nine salmon parr and smolts were caught in fourteen shots with the net at three neighbouring fishing stations.

In *December* these silvery fishes were not found, but a limited number of ordinary parr were caught. Three were taken in six casts of the net.

In *January* 1906 the fishing showed results similar to those obtained in December. Only 2 salmon parr were found in ten casts of the net, and the parr were without silvery scales and were small in size. Such small parr might be found at any season in this locality. Our nettings in the spring produced very many of them which had probably descended, in company with the migrating smolts, but which were not in a condition to migrate, many of them being only about two inches long.

In *February* similar results were obtained. Of 7 parr, 3 were slightly silvery, 1 was a non-silvery parr, and 3 were small fry with scales little more than formed.

In *March* fifteen shots with the net resulted in 50 parr and semi-silvery smolts, many about 5½ inches long, and, as it were, approximating to the condition of the usual spring smolt.

It is more than probable, therefore, I think, that ordinary salmon parr inhabit the upper tidal waters of the Tay at all times. I may add that similarly I have specimens 3 to 3½ inches long taken from the stomach of a cormorant which was shot while diligently feeding in tidal water at the mouth of the river Helmsdale; 16 small salmon parr were in the stomach, and the bird was shot in the month of December. We have, however, no evidence to show that these small parr actually enter the sea, as the fry of Pacific coast salmon are reported to do. In the same way I am inclined strongly to doubt if the 8 per cent. of one-year-old parr which were said, on the authority of the Stormontfield experiments, to migrate to the sea, did more than descend to the upper estuary to remain there, as we find that apparently so many parr do through the summer. I am inclined also to think that the parr caught by Dahl in Norway at the mouths of rivers in July and August and which, if I mistake not, he considers are migratory year old fish, are prototypes of the small class of parr found near Kinfauns at all seasons of the year. If one might venture upon a theory from the result of these experiments in the Tay, I would suggest that in all probability the semi-silvery smolt-like specimens we find in November, and which, as I have said, are probably descending to the sea, represent the juvenile company, this 8 per cent., which descended so far with their associates of an older generation, and which after spending the summer in those upper tidal waters make an early descent in winter. In support of this it is worthy of notice that the sizes of the silvery November fish are rather less than the sizes of the twenty-six months old spring smolts and that the silvery migratory dress is less bright. From artificial rearing of young salmon it is abundantly clear that young fish of similar age may be of very different length; but it is fairly certain that this feature is greatly exaggerated by artificial and abundant feeding in confinement. The view, however, that the November smolts are descending before rather than after the usual time is greatly strengthened by the examination of the scales. Mr. Johnston, who has examined the scales, describes the fish as "rising two years." If my view is correct, the November migratory smolts will be about twenty months old. The netting in December, January, and February, while showing ordinary parr in this upper tidal area, does not result in evidence to indicate that during these months smolts are descending.

APPENDIX IV.

NATURAL HISTORY NOTES.

By W. L. CALDERWOOD.

(a) Smolts Reared in Salt Water.

In September 1901, a sea pond, which had been excavated in the beach at Tugnet, at the mouth of the river Spey, was completed, and a syphon pipe adjusted for the tidal supply of salt water. This pond was constructed in connection with the salmon hatching operations which for some years have been carried on at Fochabers under instruction of His Grace the Duke of Richmond and Gordon, and as an elaboration of the rearing of the fry in the ponds at Cunninghaugh, near the mouth of the Spey. Mr. Muirhead, the Duke's commissioner, and Mr. Rae, the manager of the extensive salmon fisheries of the estate, have from time to time very kindly supplied me with information respecting the rearing operations, and I have repeatedly visited the ponds.

In 1901 many of the smolts which had been reared to their natural period of seaward migration, *i.e.*, about 26 months, were retained in the fresh-water ponds pending the completion of the sea pond above referred to. In May they had been active silvery little fish, but by September, when the pond was ready, they had reverted to the more sombre parr colouration. Twenty-five of these two-year-olds were introduced in the middle of September into pure sea water in the new pond. They ceased feeding at once, and in a few days four were dead. The salinity of the pond was then reduced by about half, through the introduction of fresh water. The fish at once recommenced feeding, and it was at the same time noticed that a clear silvery dress was again assumed. The food supplied was the chopped liver used at the fresh-water ponds.

These few young fish having been successfuly established in sea water, the pond was stocked with 500 salmon smolts.

In May 1902, while some repairs were being made to the superstructure of the pond by a carpenter, it was noticed that the fish had become frightened, and presently that they were turning up, sick, in large numbers. The water in the pond at the time was four feet in depth. Mr. Rae was hastily summoned, but, in spite of efforts to aerate the water, some 400 of the fish died. The remaining hundred were removed from the pond and carried back to the fresh-water ponds of Cunninghaugh. It was subsequently discovered that a considerable quantity of disintegrated seaweed had been carried into the Tugnet pond by the syphon through the beach, and it was believed that the rapid movements of the frightened fish stirred up this sediment to such an extent that the water became poisoned by the gasses from the decomposing seaweed. Twelve of the dead fish were sent to me for examination, and I afterwards received also a sample of the sediment, which was analysed. The fish were distinctly silvery in appearance,

but were not very well nourished or plump in outline. But for the the silvery scales there was nothing to distinguish them from smolts which were reared in fresh water alone. In length the fish varied from 8 to 10 inches, being then three years old.

As a result of this most unfortunate accident, the pond was divided into two compartments, so that each could be cleaned out periodically and the fish transferred from the one to the other.

The experiment was subsequently repeated, and after the second lot of smolts had been one year in the sea pond under the new and apparently healthier conditions, I received a specimen 13 inches in length (33· cm.). This specimen has already been figured together with a specimen of a Galway fish (*Proc. Roy. Soc. Ed.*, xxv., p. 395).

One great difficulty experienced at Tugnet is the procuring of a supply of suitable food from a marine source. The food supplied to the fish has been exclusively, so far as I am aware, the liver used at the fresh-water ponds at Cunninghaugh. Dahl, in Norway, who succeeded in a year and a half in rearing smolts to nearly the same size (21·5 to 31·5 cm.), fed his little fish on marine worms, the fry of *Gobius ruthes parri* and *G. minutus*, two common shore fishes, and in the autumn and winter on fresh herring.

(B) Spawning of Smolts.

At the Cunninghaugh Ponds, where the smolts above referred to were reared, it was found in December 1904 that some smolts taken from the fresh water were ripe. There were three females about two and a half years old, one larger and probably older female, and one male two and half years old. The females were stripped on 22nd December 1904, and the ova impregnated by the milt from the male. As, however, the quantity of milt was rather deficient, a ripe adult male fish was procured and some additional milt from this fish used. The ova were then placed in the Fochabers Hatchery and kept separate from the ordinary salmon ova. They hatched out well on 5th April 1905, the proportion of loss being, I am informed, in no way remarkable. Last December (1905) Mr. Rae kindly sent me two sets of specimens, one of those fry, and the other of the ordinary salmon fry hatched at the same time from the eggs of adult fish. The two sets of specimens are indistinguishable in every respect.

Another search was made for ripe smolts last December in order that, if possible, the impregnation might be effected by male smolt milt alone. On 17th January (1906) two ripe females and one ripe male were secured. Concerning these Mr. Rae writes—"We spawned these and fertilised with the male smolt *only*, and in due time we will be able to let you know how they progress. The ova is as large as grilse ova, of a green colour. . . . The females were about ½ lb. in weight each, and the male about ¼ lb."

I have since been informed that this experiment with smolt ova and smolt milt has totally failed.

(C) Salmon Caught out at Sea.

After considerable inquiry I have obtained the following limited number of records of salmon captured by steam trawlers. It is evident, however, that a few other captures may from time to time have occurred, but salmon captured at sea by those whose business it is to fish for white fish may not always find their way to market or be reported to the owners, especially in the close season.

1888, or earlier.—1 salmon : locality now unknown. *General Steam Fishing Company, Granton.*

—— On several occasions, and on at least one occasion, two fish at a time; 30 miles east of the May Island. *Charles Muirhead, Edinburgh.*

1892, January 28th.—1 salmon : 18 lbs. : 20 miles S.E. by E. of Scurdy Ness, Montrose. *Joseph Johnston & Sons, Montrose.*

1892, February 21st.—1 salmon : 16½ lbs. : 13 miles S.E. by E. of Scurdy Ness. *Joseph Johnston & Sons, Montrose.*

1899, November, .—1 salmon : 12 lbs. : off the tail of the Dogger Bank. A trawler of Messrs. Haggerup & Doughty, through a *Fish Inspector, Billingsgate.*

APPENDIX V.

"THE WHITE SPOT" AFFECTING SALMON IN THE ISLAND OF LEWIS.

Through the kindness of Mr. George Pople, the tenant of the Grimersta fishings on the west side of Lewis, I have received several specimens of fish and heads of fish showing this peculiar ailment. It occurs in fish which, owing to dry weather and the shrunken state of the streams, are unable to leave the salt water but remain for a considerable time in the shallow bays. When the streams become sufficiently swollen after rain to admit of their ascent in fresh water, "the white spot" disappears. The only reference to this disease of which I am aware is in *Scottish Moors and Indian Jungles*, p. 141, by Captain J. T. Newall, who was at one time tenant of Scaliscro shootings, just south of Grimersta. It is as follows:—"The summer in the Lews "in 1880 was remarkable for the unusual heat. Salmon, in consequence, "could not ascend the rivers, which became so attenuated as to afford "no waterway for them. Fresh water being equally necessary as sea "for the health of the fish at the proper season, they suffered in "consequence. Many became quite blind, and developed a white spot "on the head, the result being the death of numbers near the mouths "of rivers." The natural inference is that the lack of fresh water is responsible for this trouble. This I consider very unlikely indeed. The blindness, the bright sunshine of hot weather, the perfect translucency of the sea water around these western islands, and the shallow nature of the estuaries or bays in which the fish congregate, seem to me to suggest a diffierent cause. One is reminded of the pale-skinned, sightless condition to which fish are reduced when confined too long in aquaria exposed to sunlight. When in Stornoway in 1902, I was informed by a former gamekeeper at Stornoway Castle, the present lessee of the Royal Hotel, that in summers when this disease is really bad, the fish become so helpless that boys stone them and drag them ashore in the neighbourhood of the harbour, but it is evidently unusual for fish to become blind or to die of the disease. Mr. Pople, in sending me the specimens referred to, informs me that he had never seen a fish dead from this cause. The summer of 1905 was unusually dry, and one of the specimens sent was described as the worst Mr. Pople had seen during his tenancy. The dull white appearance had developed into a raw red sore. The significant remark is also made in a letter of 14th August, "although we have had it very dry it has been more or "less cloudy and windy, it (the disease) would have been worse in "brilliant sunshine and light east or no wind." The accompanying figure represents the head of one of the specimens received from Grimersta, and shows the early or "white spot" condition of the ailment. The specimen was killed on 14th August, and represents, I believe, an average state of the peculiarity. The skin is unbroken, the white area

is noticeable not only on the crown of the head but to some extent in the occipital region behind the head, it also extends downwards to the operculum, in which region, I am assured, it first appears. It is not noticeable in front of the eye, which organ appears to be normal and functional. The colour was a dead white, slightly clouded here and there with a bluish tint. Pigment remains in the dorsal region only at the end of the snout and in a patchy manner above the eyes. There is a distinct depression in the region of the cranial cavity above the brain. The fish was otherwise healthy and in splendid condition, with pyloric appendages loaded with fat; indeed, it may be stated that the disease does not appear to reduce the plump condition of the fish affected. In another specimen received, killed on 24th July, and showing the disease in a more advanced state, no very marked difference to that seen in the figure is noticeable on the crown of the head, but the white area above the muscular tissue just beyond the head shows the surface broken and ulcerated in three places. The spreading of this condition over the circumscribed area ultimately seems to give rise to the prevailing red colour seen in the worst specimens. On lifting the specimen killed on 24th July from the box in which the fish came, the pupil or lens dropped out from one of the eyes. The specimen was certainly not very fresh, having been sent during the hottest of the summer and having taken three days to reach Edinburgh from Grimersta Lodge. Still this could not, I consider, account for the ease with which the lens of the eye dropped out. In no specimen which I have seen or of which I have heard has the fish been affected except in the region of the brain and medulla.

W. L. Calderwood.

APPENDIX VI.

THE SEALING OF FOREIGN AND HOME SALMON FOR SALE DURING CLOSE SEASON.

The modern possibility of placing salmon in cold store during the fishing season, and of selling such fish during close time, has opened up the further possibility of evil-disposed persons selling poached fish or fish caught out of season under the guise of fish out of cold stores. To anticipate and prevent any such practice, The Fishmongers' Company of London, at the suggestion of their chief inspector, Mr. Morris, have adopted a system of sealing salmon placed in cold stores. This has now been practised since 1896, with the concurrence of the fish trade, and during recent years has become very generally adopted.

Through the kindness of Mr. J. Wrench Towse, clerk to the Fishmongers' Company, I am enabled to give particulars of the number of salmon sealed during the three last winters. W.L.C.

NUMBER OF SALMON SEALED BY THE FISHMONGERS' COMPANY OF LONDON, CLOSE SEASONS 1903-1906 INCLUSIVE.

	1903-1904.	1904-1905.	1905-1906.
Aberdeen, Scottish,	2,875	979	1,966
Danish,	...	45	...
Dundee, Scottish,	...	31	34
Edinburgh, Scottish,	60	30	60
Canadian,	14	13	...
Leith, Scottish,	...	3	6
Glasgow, Scottish,	234	234	272
Canadian,	1,664	57	38
Perth, Scottish,	1,721	...	...
London, Scottish,	442	35	739
Irish,	180	147	...
Canadian,	7,386	587	1,364
British Columbian,	...	2,665	9,547
Liverpool, Scottish,	50	...	100
Irish,	50	50	...
Canadian,	4,715	6,144	4,839
British Columbian,	...	244	...
Hull, Scottish,	35	6	...
Irish,	35	...	...
Norwegian,	25	163	10
English,	...	...	13
Nottingham, Scottish,	157	158	35
Canadian,	...	...	23
Leicester, Scottish,	49	38	84
Eastbourne, Scottish,	...	13	21
Southampton, Scottish,	...	...	119
Birmingham, Scottish,	...	...	1
English,	...	...	1
Chesterfield, Scottish,	40	...	...
Cheltenham, Scottish,	...	10	...
	19,732	11,652	19,272

Grand total, 50,656. Total for Canadian and British Columbian Fish, 39,300.

APPENDIX VII.

RATEABLE VALUE OF SALMON FISHERIES, IN DISTRICTS WHERE BOARDS HAVE BEEN FORMED, FOR THE YEARS 1881 TO 1904 INCLUSIVE.

Year.	Alness.		Annan.		Awe.		Ayr.		Baa & Glencoilleader.		Balgay.		Bervie.		Broom.		Conon.		Cree.		Dee (Aberdeen).		Dee (Solway).	
	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.
	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£
1881	–	–	1,391	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	501	–	9,857	–	1,175	–
1882	–	–	1,719	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	522	–	9,556	–	1,195	–
1883	–	–	1,720	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	532	–	9,931	–	1,200	–
1884	–	–	1,864	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	530	–	10,504	–	1,200	–
1885	–	–	1,933	**1,725**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	645	**546**	10,791	**10,127**	1,235	**1,201**
1886	–	–	1,998	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	530	–	10,805	–	1,565	–
1887	–	–	1,993	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	540	–	11,220	–	1,615	–
1888	–	–	2,007	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	530	–	12,532	–	1,517	–
1889	–	–	2,007	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	530	–	12,036	–	1,517	–
1890	–	–	2,107	**2,022**	701	–	–	–	–	–	40	–	585	–	–	–	2,624	–	530	**532**	12,274	**11,773**	1,627	**1,568**
1891	–	–	2,112	–	701	–	–	–	–	–	40	–	586	–	–	–	2,560	–	530	–	11,968	–	1,463	–
1892	–	–	2,099	–	718	–	–	–	–	–	40	–	586	–	–	–	2,756	–	530	–	12,336	–	1,463	–
1893	–	–	2,165	–	723	–	–	–	–	–	40	–	586	–	–	–	2,975	–	544	–	13,911	–	1,463	–
1894	579	–	2,778	–	723	–	–	–	–	–	40	–	536	–	–	–	2,944	–	554	–	14,489	–	1,463	–
1895	584	–	2,793	**2,389**	896	**752**	–	–	–	–	20	**36**	536	**566**	–	–	2,540	**,755**	554	**542**	14,593	**13,461**	1,633	**1,497**
1896	584	–	3,182	–	896	–	–	–	–	–	20	–	1,071	–	–	–	2,455	–	571	–	15,820	–	1,603	–
1897	614	–	3,182	–	878	–	–	–	–	–	20	–	1,071	–	–	–	2,590	–	571	–	16,176	–	1,632	–
1898	608	–	3,182	–	878	–	100	–	–	–	20	–	871	–	–	–	2,554		696	–	17,468	–	1,603	–
1899	609	–	3,182	–	870	–	110	–	–	–	42	–	871	–	–	–	2,554	–	696	–	17,427	–	1,603	–
1900	610	**605**	3,182	**3,182**	870	**878**	110	–	–	–	20	**24**	871	**951**	–	–	2,504	**2,525**	696	**646**	18,989	**17,176**	1,603	**1,609**
1901	606	–	3,196	–	936	–	110	–	230	–	20	–	910	–	–	–	3,142	–	696	–	19,419	–	1,596	–
1902	601	–	3,197	–	936	–	110	–	230	–	20	–	910	–	–	–	3,141	–	696	–	19,455	–	1,557	–
1903	617	–	3,197	–	1,052	–	110	–	230	–	40	–	910	–	70	–	3,108	–	691	–	18,393	–	1,556	–
*1904	816	–	3,194	–	–	–	110	–	–	–	40	–	910	–	–	–	2,974	–	695	–	19,078	–	1,556	–

* Assessable rentals.

APPENDIX VII.—*continued.*

RATEABLE VALUE OF SALMON FISHERIES, IN DISTRICTS WHERE BOARDS HAVE BEEN FORMED, FOR THE YEARS 1881 TO 1904 INCLUSIVE.

Year.	Deveron.		Don.		Doon.		Esk (North).		Esk (South).		Findhorn.		Forth.		Girvan.		Kyle of Sutherland.		Lochy.		Lussa.		Nairn.	
	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.
	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£
1881	2,354	–	3,303	–	–	–	6,385	–	2,045	–	4,055	–	3,793	–	574	–	2,762	–	1,582	–	–	–	–	–
1882	2,575	–	3,025	–	–	–	5,942	–	2,200	–	3,493	–	3,862	–	571	–	2,828	–	1,484	–	–	–	–	–
1883	2,569	–	3,016	–	–	–	5,624	–	2,475	–	3,493	–	3,896	–	571	–	2,388	–	1,873	–	–	–	–	–
1884	2,549	–	3,499	–	–	–	6,349	–	2,546	–	3,501	–	3,862	–	571	–	2,280	–	1,677	–	–	–	–	–
1885	2,340	**2,477**	3,395	**3,247**	–	–	6,757	**6,211**	2,889	**2,431**	3,546	**3,617**	3,931	**3,868**	571	**571**	2,222	**2,496**	1,667	**1,658**	–	–	–	–
1886	1,790	–	3,588	–	–	–	7,216	–	2,934	–	3,546	–	4,240	–	571	–	2,545	–	1,682	–	–	–	–	–
1887	1,834	–	3,703	–	–	–	6,400	–	3,104	–	3,661	–	4,382	–	542	–	2,558	–	1,749	–	–	–	–	–
1888	1,865	–	3,908	–	–	–	6,419	–	3,124	–	3,551	–	4,241	–	542	–	2,585	–	1,628	–	–	–	–	–
1889	1,748	–	3,929		–	–	6,608	–	3,104	–	3,551	–	4,187	–	542	–	2,610	–	1,866	–	–	–	–	–
1890	1,800	**1,807**	3,905	**3,806**	–	–	6,725	**6,673**	3,012	**3,055**	3,541	**3,570**	4,257	**4,261**	542	**547**	2,693	**2,598**	1,674	**1,719**	–	–	1,542	–
1891	2,047	–	3,646	–	–	–	6,476	–	3,012	–	3,541	–	3,890	–	542	–	2,640	–	1,895	–	–	–	1,543	–
1892	2,071	–	3,623	–	–	–	6,519	–	3,012	–	2,501	–	3,704	–	542	–	2,665	–	1,961	–	–	–	1,343	
1893	2,073	–	3,964	–	–	–	6,609	–	3,012	–	3,491	–	3,765	–	542	–	2,613	–	1,961	–	–	–	1,343	–
1894	2,138	–	3,743	–	–	–	6,812	–	3,002	–	3,501	–	3,806	–	554	–	2,658	–	2,122	–	–	–	1,343	–
1895	2,383	**2,142**	3,583	**3,711**	–	–	6,812	**6,645**	3,149	**3,037**	3,501	**3,507**	3,766	**3,786**	544	**544**	2,611	**2,637**	2,122	**2,012**	–	–	1,136	**1,341**
1896	2,360	–	3,390	–	–	–	6,519	–	3,149	–	3,446	–	3,617	–	500	–	2,634	–	2,094	–	–	–	1,136	–
1897	2,469	–	3,383	–	–	–	6,540	–	3,149	–	3,436	–	3,616	–	524	–	2,731	–	2,115	–	–	–	1,135	–
1898	2,658	–	3,374	–	–	–	6,579	–	3,507	–	3,436	–	3,738	–	524	–	2,771	–	2,115	–	–	–	1,136	–
1899	2,979	–	3,430	–	–	–	6,523	–	3,424	–	3,436	–	3,792	–	524	–	2,838	–	2,020	–	–	–	1,136	–
1900	3,078	**2,708**	3,336	**3,382**	–	–	6,414	**6,515**	3,492	**3,342**	3,511	**3,458**	3,801	**3,712**	544	**523**	2,845	**2,763**	2,338	**2,130**	–	–	1,136	**1,136**
1901	3,186	–	3,691	–	473	–	6,510	–	3,492	–	3,527	–	3,925	–	514	–	2,890	–	2,992	–	397	–	1,136	–
1902	3,048	–	3,700	–	473	–	6,466	–	3,567	–	3,527	–	3,928	–	528	–	3,132	–	2,306	–	397	–	1,139	–
1903	3,105	–	3,646	–	486	–	6,494	–	3,552	–	3,587	–	3,731	–	553	–	2,523	–	2,300	–	397	–	1,139	–
*1904	3,387	–	3,863	–	498	–	6,494	–	3,565	–	3,661	–	3,510	–	–	–	3,516	–	2,231	–	–	–	–	–

* Assessable rentals.

APPENDIX VII.—*continued.*

RATEABLE VALUE OF SALMON FISHERIES, IN DISTRICTS WHERE BOARDS HAVE BEEN FORMED, FOR THE YEARS 1881 TO 1904 INCLUSIVE.

Year.	Ness.		Nith.		Pennygown.		Skye.		Spey.		Stinchar.		Tay.		Torridon.		Tweed.		Ugie.		Ythan.	
	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.	Annual value.	Average value for each period of 5 years.
	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£
1881	3,075	–	568	–	–	–	–	–	10,563	–	–	–	21,698	–	–	–	13,477	–	322	–	746	–
1882	3,198	–	478	–	–	–	–	–	9,724	–	–	–	19,630	–	–	–	13,563	–	343	–	746	–
1883	3,285	–	499	–	–	–	–	–	8,654	–	–	–	19,223	–		–	13,745	–	339	–	790	–
1884	2,924	–	505	–	–	–	–	–	8,454	–	–	–	17,773	–	–	–	13,658	–	339	–	726	–
1885	3,030	**3,093**	553	**520**	–	–	–	–	8,430	**9,165**	–	–	19,656	**19,596**	–	–	13,557	**13,600**	334	**335**	726	**746**
1886	3,225	–	534	–	–	–	–	–	9,483	–	–	–	20,447	–	–	–	13,681	–	301	–	726	–
1887	3,239	–	515	–	–	–	–		9,559	–	–	–	22,542	–	–	–	14,382	–	290	–	816	–
1888	3,291	–	447	–	–	–	–	–	10,663	–	–	–	22,103	–	–	–	14,199	–	284	–	876	–
1889	3,185	–	402	–	–	–	–	–	10,663	–	–	–	19,701	–	–	–	14,254	–	351	–	876	–
1890	3,079	**3,203**	423	**464**	–	–	–	–	10,669	**10,207**	–	–	17,731	**20,504**	–	–	14,278	**14,158**	348	**314**	876	**834**
1891	3,366	–	443	–	–	–	–	–	9,669	–	–	–	17,820	–	40	–	14,414	–	358	–	931	–
1892	3,254	–	423	–	–	–	–	–	9,687	–	–	–	17,227	–	40	–	14,746	–	358	–	1,004	–
1893	3,253	–	756	–	–	–	–	–	9,687	–	–	–	19,008	–	40	–	14,573	–	358	–	1,004	–
1894	3,468	–	775	–	–	–	–	–	9,316	–	–	–	21,763	–	40	–	15,583	–	356	–	1,004	–
1895	3,209	**3,310**	771	**633**	–	–	–	–	9,588	**9,589**	–	–	19,587	**19,079**	20	**36**	15,803	**15,023**	402	**366**	1,024	**993**
1896	3,085	–	815	–	–	–	–	–	8,671	–	–	–	17,091	–	20	–	15,084	–	503	–	1,024	–
1897	3,503	–	780	–	–	–	–	–	9,638	–	–	–	17,211	–	20	–	15,444	–	504	–	1,294	–
1898	3,667	–	781	–	–	–	–	–	10,634	–	–	–	17,905	–	20	–	15,239	–	508	–	1,299	–
1899	3,510	–	775	–	–	–	–	–	11,633	–	–	–	21,048	–	20	–	15,000	–	768	–	1,299	–
1900	3,647	**3,482**	676	**765**	–	–	424	–	10,122	**10,119**	200	–	22,482	**19,147**	20	**20**	15,032	**15,159**	845	**625**	1,317	**1,246**
1901	3,582	–	654	–	65	–	540	–	8,608	–	400	–	22,549	–	20	–	15,005	–	839	–	1,398	–
1902	3,636	–	545	–	65	–	540	–	8,052	–	400	–	22,608	–	20	–	15,005	–	839	–	1,398	–
1903	3,516	–	554	–	65	–	540	–	8,147	–	400	–	22,648	–	40	–	15,338	–	812	–	1,389	–
*1904	2,546	–	584	–	–	–	–	–	7,396	–	–	–	23,099	–	–	–	–	–	779	–	1,359	–

* Assessable rentals.

APPENDIX VIII.

ANNUAL CLOSE TIME APPLICABLE TO THE SALMON RIVERS IN SCOTLAND.

N.B.—Observe that, in the following List, the days fixing the commencement and termination of the Annual Close Time for Net-fishing and for Rod-fishing, respectively, are in all cases inclusive, as in the case of the Add, the first river in the List.

Name of River.	Annual Close Time for Net-fishing.	Annual Close Time for Rod-fishing.
Add,	From Sept. 1 to Feb. 15, both days inclusive.	From Nov. 1 to Feb. 15, both days inclusive.
Aline,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Alness,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Annan,	From Sept. 10 to Feb. 24.	From Nov. 16 to Feb. 24.
Applecross,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Arnisdale (*Loch Hourn*),	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Awe,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Aylort (*Kinloch*),	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Ayr,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Baa and Goladoir,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Badachro and Kerry (*Gairloch*),	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Balgay and Shieldag,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Beauly,	From Aug. 27 to Feb. 10.	From Oct. 16 to Feb. 10.
Berriedale,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Bervie,	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Bladenoch,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Broom,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Brora,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Carradale (*in Cantyre*),	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Carron,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Clayburn, Finnisbay, Avennangeren, Strathgravat, North Lacastile, Scalladdale and Mawrig (*East Harris*),	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Clyde and Leven,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Conon,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Cree,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Creed or Stornoway, and Laxay (*Island of Lewis*),	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Creran (*Loch Creran*),	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Croe and Shiel (*Loch Duich*),	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Dee (*Aberdeenshire*),	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Dee (*Kirkcudbright*),	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Deveron,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Don,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Doon,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Drummachloy or Glenmore (*Isle of Bute*),	From Sept. 1 to Feb. 15.	From Oct. 16 to Feb. 15.
Dunbeath,	From Aug. 27 to Feb. 10.	From Oct. 16 to Feb. 10.
Earn,	From Aug. 21 to Feb. 4.	From Nov. 1 to Jan. 31.
Eckaig,	From Sept. 1 to Feb. 15.	From Nov. 1 to Feb. 15.
Esk, North,	From Sept. 1 to Feb. 15.	From Nov. 1 to Feb. 15.
Esk, South,	From Sept. 1 to Feb. 15.	From Nov. 1 to Feb. 15.
Ewe,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.

Name of River.	Annual Close Time for Net-fishing.	Annual Close Time for Rod-fishing.
Fincastle, Meaveg, Ballanachist, South Lacastile, Borve, and Obb (*West Harris*), . . .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Findhorn, ...	From Aug. 27 to Feb. 10.	From Oct. 11 to Feb. 10.
Fleet (*Sutherlandshire*), .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Fleet (*Kirkcudbrightshire*),	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Forss, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Forth, ...	From Aug. 27 to Feb. 10.	From Oct. 16 to Jan. 14.
Fyne, Shira, and Aray (*Loch Fyne*), . . .	From Sept. 1 to Feb. 15.	From Nov. 1 to Feb. 15.
Girvan, ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Glenelg, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Gour, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Greiss, Laxdale, or Thunga,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Grudie or Dionard, . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Gruinard and Little Gruinard, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Halladale, Strathy, Naver, and Borgie, . . .	From Aug. 27 to Feb. 10.	From Oct. 1 to Jan. 11.
Helmsdale, ...	From Aug. 27 to Feb. 10.	From Oct. 1 to Jan. 10.
Hope and Polla or Strathbeg,	From Aug. 27 to Feb. 10.	From Sept. 11 to Jan. 11.
Howmore, ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Inchard, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Inner (*in Jura*), . .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Inver, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Iorsa (*in Arran*), . .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Irvine and Garnock, . .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Kannaird, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Kilchoan or Inverie (*Loch Nevis*), ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Kinloch (*Kyle of Tongue*), .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Kirkaig, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Kishorn, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Kyle of Sutherland, . .	From Aug. 27 to Feb. 10.	From Oct. 16 to Feb. 10.
Laggan and Sorn (*Island of Islay*), ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Laxford, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Leven, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Little Loch Broom, . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Lochy, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Loch Duich, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Loch Luing, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Loch Roag, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Lossie, ...	From Aug. 27 to Feb. 10.	From Oct. 16 to Feb. 10.
Luce, ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Lussa (*Island of Mull*), .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Moidart, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Morar, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Mullanageren, Horasary, and Lochnaciste *North Uist*), .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Nairn, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Naver and Borgie, *see* Halladale.		
Nell, Feochan, and Euchar,	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Ness, ...	From Aug. 27 to Feb. 10.	From Oct. 16 to Feb. 10.
Nith, ...	From Sept. 10 to Feb. 24.	From Nov. 15 to Feb. 24.
Orkney Islands (*River from Loch of Stenness, &c.*), .	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Ormsary (*Loch Killisport*), Loch Head, and Stornoway (*Mull of Cantire*),	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Pennygowan or Glenforsa, and Aros. . . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.

Name of River.	Annual Close Time for Net-fishing.	Annual Close Time for Rod-fishing.
Resort, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Ruel, ...	From Sept. 1 to Feb. 15.	From Nov. 1 to Feb. 15.
Sanda, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Scaddle, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Shetland Islands (*River of Sandwater, &c.*), . .	From Sept. 10 to Feb. 24.	From Nov. 16 to Jan. 31.
Shiel (*Loch Shiel*), . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Sligachan, Broadford, and Portree (*Isle of Skye*), .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Snizort, Orley, Oze, and Drynoch (*Isle of Skye*), .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Spey, ...	From Aug. 27 to Feb. 10.	From Oct. 16 to Feb. 10.
Stinchar, ...	From Sept. 10 to Feb. 24.	From Nov. 15 to Feb. 24.
Tay (except Earn), . .	From Aug. 21 to Feb. 4.	From Oct. 16 to Jan. 14.
Thurso, ...	From Aug. 27 to Feb. 10.	From Oct. 6 to Jan. 10.
Torridon, Balgay, and Shieldag, . . .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Ugie, ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.
Ullapool (*Loch Broom*), .	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Urr, ...	From Sept. 10 to Feb. 24.	From Nov. 30 to Feb. 24.
Wick, ...	From Aug. 27 to Feb. 10.	From Nov. 1 to Feb. 10.
Ythan, ...	From Sept. 10 to Feb. 24.	From Nov. 1 to Feb. 24.

APPENDIX IX.

LIST OF CHAIRMEN AND CLERKS OF SALMON FISHERY DISTRICT BOARDS IN SCOTLAND.

District.	Name and Address of Chairman.	Name and Address of Clerk.
Alness, - -	Col. Alex. J. C. Warrand, Ryefield House, Conon Bridge, Dingwall.	William J. Duncan, Solicitor, Dingwall.
Annan, - -	A. Johnstone Douglas, Esq., Comlongan Castle, Ruthwell.	John F. Cormack, Solicitor, Lockerbie.
Awe, - -	The Duke of Argyll, Inveraray Castle, Inveraray.	Alex. MacArthur, Solicitor, Oban.
Ayr, - -	Richard A. Oswald, Esq., of Auchincruive, Ayr.	Wilfrid C. Macrorie, Commercial Bank, Ayr.
Baa & Glencoilleader (Mull)	The Duke of Argyll, Inveraray Castle, Inveraray.	Alex. MacArthur, Solicitor, Oban.
Balgay, - -	C. R. Manners, Esq., C.E., 12 Lombard Street, Inverness.	Duncan Shaw, W.S., 15 High Street, Inverness.
Bervie, - -	David Scott Porteous, Esq., of Lauriston, as mandatory of the Commissioners of Woods and Forests.	W. C. Walls, Solicitor, Montrose.
Broom, - -	W. Ewing-Gilmour, Esq., of Inverlael, per A. W. G. Aitken, Esq., S.S.C., Edinburgh.	W. R. T. Middleton, Solicitor, Dingwall.
Conon, - -	John Little Mounsey, Esq., W.S., 5 Thistle Street, Edinburgh, Commissioner for Col. J. A. F. H. Stewart Mackenzie of Seaforth.	W. R. T. Middleton, Solicitor, Dingwall.
Cree, - -	The Earl of Galloway, Cumloden, Newton-Stewart.	A. B. Matthews, Solicitor, Newton-Stewart.
Dee (Aberdeen),	The Lord Provost of Aberdeen.	Alex. Duffus, Advocate, Aberdeen.
Dee (Solway), -	Col. W. J. M. Baillie of Cally, Gatehouse.	W. Nicholson, Sheriff-Clerk, Kirkcudbright.
Deveron, - -	Wm. MacIntosh, Esq., Factor for the Duke of Fife, St. Leonards, Banff.	Francis George, Solicitor, Banff.
Don, - -	Vacant.	Alex. Duffus, Advocate, Aberdeen.
Doon, - -	Marquis of Ailsa, Culzean Castle, Maybole.	Wilfred C. Macrorie, Solicitor, Ayr.
Esk (North), -	The Rev. J. S. More Gordon of Charleton and Kinnaber, per George More Gordon, Esq., Charleton, Montrose.	J. R. Findlay, Solicitor, Montrose.
Esk (South) -	William Douglas Johnston, Esq., Montrose.	James Don and David G. Shiell, Solicitors, Brechin.
Findhorn, -	R. C. Munro Ferguson, Esq., of Novar, M.P., per J. J. Meiklejohn, Esq., factor.	William Grant, National Bank Buildings, Forres.
Forth, - -	Mandatory of Commissioners of Woods and Forests.	Patrick Welsh, County Buildings, Stirling.
Girvan, - -	John Campbell Kennedy, Esq., of Dunure.	T. Gerald Tait, Solicitor, Girvan.
Gruinard and Little Gruinard,	Alfred N. G. Aitken, Esq., S.S.C., Edinburgh, Factor and Commissioner for Hugh Mackenzie, Esq., of Dundonnell.	W. R. T. Middleton, Solicitor, Dingwall.
Kyle of Sutherland,	Sir Charles Lockhart Ross, Bart., of Balnagowan.	John M'Crone, Solicitor, Dornoch.
Little Broom, -	Alfred N. G. Aitken, Esq., S.S.C., Edinburgh, Factor and Commissioner for Hugh Mackenzie, Esq., of Dundonnell.	W. R. T. Middleton, Solicitor, Dingwall.

APPENDIX VIII. (*continued*)—LIST OF CHAIRMEN AND CLERKS OF SALMON FISHERY DISTRICT BOARDS IN SCOTLAND.

DISTRICT.	Name and Address of Chairman.	Name and Address of Clerk.
Lochy, - -	Lord Abinger, Inverlochy Castle, Fort-William.	N. B. Mackenzie, Solicitor, Fort-William.
Lossie, - -	The Duke of Richmond and Gordon, Gordon Castle, Fochabers, per George Muirhead, Esq., Commissioner.	John Wink, Solicitor, Elgin.
Lussa (Mull) & River from Loch Uisk to Loch Buie,	Maclaine of Lochbuie, Isle of Mull.	Alex. MacArthur, Solicitor, Oban.
Nairn, - -	Brodie of Brodie, Brodie Castle, Forres.	H. T Donaldson, Solicitor, Nairn.
Ness, - -	George Malcolm, Esq., Factor for Mrs. Ellice of Invergarry, Fort-Augustus.	Anderson & Shaw, Solicitors, Inverness.
Nith, - -	John Henderson, Esq., Solicitor, Dumfries.	C. Steuart Phyn, Procurator-Fiscal, Dumfries.
Pennygowan or Glenforsa, & Aros (Mull),	Vacant.	Alex. MacArthur, Solicitor, Oban.
Sligachan, Broadford, & Portree (Skye)	Lachlan Macdonald, Esq., of Skeabost.	Kenneth Macrae, Sheriff-Clerk, Portree.
Snizort, Orley, Oze, and Drynock (Skye),	Lachlan Macdonald, Esq., of Skeabost.	Kenneth Macrae, Sheriff-Clerk, Portree.
Spey, - -	The Duke of Richmond and Gordon, Gordon Castle, Fochabers, per George Muirhead, Esq., Commissioner.	John Wink, Solicitor, Elgin.
Stinchar, - -	The Earl of Stair, Lochinch, Wigtownshire.	Stair M'Harrie, Rephad, Stranraer.
Tay, - -	Hon. Morton Stuart Gray, Kinfauns Castle, Perth.	Condie, Mackenzie, & Co., Solicitors, Perth.
Thurso, - -	Peter Keith, Esq., mandatory for Sir J. G. Tollemache Sinclair, Bart., of Ulbster.	David Keith-Murray, Solicitor, Thurso.
Torridon, -	C. R. Manners, Esq., C.E., 12 Lombard Street, Inverness.	Duncan Shaw, W.S., 15 High Street, Inverness.
Ugie, - -	Lieut.-Col. Ferguson, of Pitfour, Mintlaw.	Robert Gray, Solicitor, Peterhead.
Ythan, - -	Earl of Errol, Slains Castle, Aberdeenshire.	D. M. A. Chalmers, Advocate, Aberdeen.
Tweed (Police Committee of the Commissioners),	Sir Richard John Waldie-Griffith, Bart., of Hendersyde Park, Kelso.	David W. B. Tait, W.S., Kelso.

Note.—In addition to the districts specified above, the Duke of Sutherland is sole proprietor of the districts of the following rivers, viz.:—Helmsdale, Brora, Fleet, Kirkaig, Inver, Laxford, and Inchard (under the charge of his factor, Mr Donald M'Lean, Dunrobin Office, Golspie); and the Halladale, Naver, Borgie, Kinloch, and Hope (under the charge of his factor, Mr John Morrison, Tongue); W. E. Gilmour, Esq., of Rosehall, etc., is proprietor of the rivers Dionard, Polla, Strathy, and Armadale, also in the north of Sutherland; Lord Lovat has sole right of fishing in the river Beauly (Mr J. T. Garrioch, Beauly, factor); and the Countess of Cromartie is sole proprietrix of the district of the river Kannaird (under the charge of her factor Mr George Wetherspoon, Cromartie Estate Office, Kildary).

Fishery Board for Scotland,
Edinburgh, 19th May 1905.

GLASGOW: PRINTED BY JAS. HEDDERWICK & SONS LIMITED
FOR HIS MAJESTY'S STATIONERY OFFICE.

Trade (Imports and Exports) of the United Kingdom with the Colonies and Foreign Countries; Rates of Wages and Hours of Labour at Home and Abroad; Customs Tariff; Food Supply, &c., viz.:—

[Cd. 2622.] STATISTICAL ABSTRACT OF THE UNITED KINGDOM. 1890-1904. Price 1*s.* 3*d.*
[Cd. 2679.] Do. do. COLONIES. 1890-1904. Price 1*s.* 9*d.*
[Cd. 2566.] Do. do. FOREIGN COUNTRIES. Years 1893-1902-03. Price 1*s.* 6*d.*
[Cd. 2754.] Do. do. BRITISH INDIA. 1894-1895 to 1903-1904. Price 1*s.* 3*d.*
[Cd. 2928.] TRADE OF THE UNITED KINGDOM, 1905. Vol. I. Price 7*s.* 8*d.*
[Cd. 3022.] Do. do. do. Vol. II. Price 4*s.* 2*d.*
[Cd. 2797.] FOREIGN IMPORT DUTIES, 1905. Price 2*s.*
[Cd. 2556.] NAVIGATION AND SHIPPING STATEMENT. 1904. Price 3*s.* 1*d.*
[Cd. 1761, 2337, 2669.] BRITISH AND FOREIGN TRADE AND INDUSTRIAL CONDITIONS. Memoranda, Tables, and Charts. Prepared by the Board of Trade. First and Second Series, and Index. Price 7*s.*
[Cd. 2473.] EAST INDIA. Trade of. Years 1899-1900 to 1903-1904. Price 1*s.* 3*d.*
[Cd. 2629.] STATISTICAL TABLES RELATING TO BRITISH COLONIES, POSSESSIONS, AND PROTECTORATES. Part XXVIII. 1903. Price 7*s.*
[Cd. 2856.] STATISTICAL ABSTRACT OF THE BRITISH EMPIRE, YEARS 1900-1904. Price 10*d.*
[Cd. 2414.] NEW GERMAN TARIFF, AS MODIFIED BY TREATIES; comes into force 1st March 1906. Price 1*s.* 10*d.*
[Cd. 2594.] AGRICULTURAL RETURNS—GREAT BRITAIN. 1904. Price 1*s.* 5*d.*
[Cd. 2627.] COLONIAL IMPORT DUTIES, 1905. Price 2*s.* 3*d.*
[Cd. 2674.] WAGES AND HOURS OF LABOUR—Report on the Changes in; 1904. Price 7*d.*
[Cd. 2768.] SWITZERLAND. New Customs Tariff as modified by Treaties with Germany and Italy. Price 7*d.*
[Cd. 2828.] ROUMANIA. New Customs Tariff. Price 7*d.*
[Cd. 2857.] RUSSIA. New Customs Tariff. Price 9*d.*
[Cd. 2862.] BULGARIA. New Customs Tariff. Price 6*d.*
[Cd. 2977.] SOUTH AFRICA. Customs Union Convention, 1906. Price 2½*d.*

Military:—

COMMISSION IN H.M. REGULAR FORCES. Short Guide to obtaining a. Price 4*d.*
SCHOOLS, ARMY. Lists of Technical Terms, with Definitions, &c., for use in. Price 2*d.*
STORES USED IN H.M. SERVICE. Priced Vocabulary of. Part I, Price 1*s.* 9*d.*; Part II, 3*s.* 6*d.*
SUDAN. THE ANGLO-EGYPTIAN. Vol. II. Chap. VII. Supplement (A) Bahr el Ghazal. Additional Routes. Price 1*s.*
PAY, APPOINTMENT, PROMOTION, AND NON-EFFECTIVE PAY OF THE ARMY. ROYAL WARRANT, 1906. Price 1*s.*
TERRITORIAL REGIMENTS OF THE BRITISH ARMY, Nos. 1 to 67. Short Histories of. Price 1*d.* each. And in one volume. Price 5*s.*
VETERINARY CORPS. ARMY. Standing Orders, 1906. Price 4*d.*

Hydrographical:—

AUSTRALIAN DIRECTORY. Vol. III. N., N.W., and W. Coasts. 4th Edition. Price 3*s.*
EASTERN ARCHIPELAGO. Part I. Supplement, 1906. Price 6*d.*
CHARTS, PLANS, AND SAILING DIRECTIONS. Catalogue. 1906. Corrected to 31st Dec. 1905. Price 1*s.* Do. do. do. Consecutive List. 31st Dec. 1905. Price 8*d.*
ST. LAWRENCE PILOT. Price 6*s.*

Local Government Board. Reports to:—

PAUPERISM IN POPLAR. Memo. as to. Price 6*d.*
SULPHUR DIOXIDE, as applied in the Destruction of Rats and in Disinfection on Shipboard. Further Experiments on. No. 232. Price 2*s.* 6*d.*
SANITARY CIRCUMSTANCES AND ADMINISTRATION OF THE NARBETH RURAL DISTRICT. No. 233. Price 4*d.*
GENERAL SANITARY CIRCUMSTANCES AND ADMINISTRATION OF THE URBAN DISTRICT OF ROYSTON (YORKSHIRE), AND PREVALENCE OF CERTAIN INFECTIOUS DISEASES THEREIN. No. 234. Price 4*d.*

Emigrants' Information Office, 31 Broadway, Westminster, viz.:—

COLONIES, HANDBOOKS FOR. 8vo. Wrapper.
No. 1. Canada. 2. New South Wales. 3. Victoria. 4. South Australia. 5. Queensland. 6. Western Australia. 7. Tasmania. 8. New Zealand. 9. Cape Colony. 10. Natal. 11. Transvaal. 12. Orange River Colony. Price 1*d.* each.
No. 13. Professional Handbook. 14. Emigration Statutes and General Handbook. Price 3*d.* each.
No. 15 (viz., Nos. 1 to 14, in cloth). Price 2*s.*
INTENDING EMIGRANTS, INFORMATION FOR:—Argentine Republic, price 2*d.* British East Africa Protectorate, 1904, price 6*d.* Ceylon, June 1904, price 1*d.* Federated Malay States, &c., 1905, price 6*d.* Newfoundland, March 1905, price 1*d.* British Central Africa Protectorate, July 1905, price 6*d.* Uganda Protectorate, 1904, price 6*d.* West African Colonies, Dec. 1904, price 6*d.* West Indies, 1904, price 6*d.*
SUMMARY OF CONSULAR REPORTS, NORTH AND SOUTH AMERICA, 1904-5. Price 2*d.*

Foreign Office:—

AFRICA BY TREATY. The Map of. By Sir E. Hertslet, K.C.B. 3 Vols. Price 31*s.* 6*d.*
COMMERCIAL TREATIES. (Hertslet's.) A complete collection of Treaties, &c., between Great Britain and Foreign Powers so far as they relate to Commerce and Navigation, &c. By Sir E. Hertslet, K.C.B., &c. Vols. I. to XXIII. Price 15*s.* each.
STATE PAPERS. British and Foreign. Vol. 93 (Index vol.) and Vol. 94. 1900-1901. Price 10*s.* each.

Board of Trade Journal, of Tariff and Trade Notices and Miscellaneous Commercial Information. Published weekly. Price 1*d.*

Board of Trade Labour Gazette. Monthly. Price 1*d.*

TWENTY-FOURTH

ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND,

Being for the Year 1905.

IN THREE PARTS.

PART I.—GENERAL REPORT.
PART II.—REPORT ON SALMON FISHERIES.
PART III.—SCIENTIFIC INVESTIGATIONS.

PART II.—REPORT ON SALMON FISHERIES.

Presented to both Houses of Parliament by Command of His Majesty.

GLASGOW:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE
BY JAMES HEDDERWICK & SONS LIMITED,
AT "THE CITIZEN PRESS," ST. VINCENT PLACE.

And to be purchased, either directly or through any Bookseller, from
OLIVER & BOYD, EDINBURGH; or
WYMAN & SONS, LTD., FETTER LANE, E.C., and
32 ABINGDON STREET, WESTMINSTER, S.W.; or
E. PONSONBY, 116 GRAFTON STREET, DUBLIN.

1906.

[Cd. 3042.] *Price* 1*s.* 1½*d.*

TWENTY-FOURTH ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND,

Being for the Year 1905.

IN THREE PARTS.

PART I.—GENERAL REPORT.
PART II.—REPORT ON SALMON FISHERIES.
PART III.—SCIENTIFIC INVESTIGATIONS.

PART III.—SCIENTIFIC INVESTIGATIONS.

Presented to both Houses of Parliament by Command of His Majesty.

GLASGOW:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE
BY JAMES HEDDERWICK & SONS LIMITED,
AT "THE CITIZEN" PRESS, ST. VINCENT PLACE.

And to be purchased, either directly or through any bookseller, from
OLIVER & BOYD, EDINBURGH; or
WYMAN & SONS, LTD., FETTER LANE, E.C., and
32 ABINGDON STREET, WESTMINSTER, S.W.; or
E. PONSONBY, 116 GRAFTON STREET, DUBLIN.

1906.

[Cd. 3199.] Price 4s. 7½d.

SALE OF GOVERNMENT PUBLICATIONS.

The under-mentioned Firms have been appointed sole Agents for the sale of Government Publications, including Parliamentary Reports and Papers, Acts of Parliament, Record Office Publications, &c., &c. (*excepting* Ordnance Maps and Geological Maps and Memoirs, the Hydrographical Works of the Admiralty, the Journal of the Board of Agriculture, and Patent Office Publications), and all such works can be purchased from them either directly or through retail Booksellers, who are entitled to a discount of 25 per cent. from the selling prices :—

IN ENGLAND :—Messrs. WYMAN & SONS, LTD., Fetter Lane, E.C.
IN SCOTLAND :—Messrs. OLIVER & BOYD, Edinburgh.
IN IRELAND :—Mr. E. PONSONBY, 116 Grafton Street, Dublin.

Hydrographical Works of the Admiralty are sold by Mr. J. D. POTTER, 145 Minories, E.

The Journal of the Board of Agriculture is sold by Messrs. LAUGHTON & CO., LTD., No. 3 Wellington Street, Strand, W.C.

Patent Office Publications are sold at the Patent Office.

The Publications of the ORDNANCE SURVEY and of the GEOLOGICAL SURVEY can be purchased from Agents in most of the chief towns in the United Kingdom, through any Bookseller, or from the Director-General of the Ordnance Survey, Southampton, or, in the case of Ireland, from the Superintendent, Ordnance Survey, Dublin. In addition, Ordnance Survey Publications can be obtained through Head Post Offices in towns where there are no accredited Agents, and Small Scale Maps are, as a rule, procurable at Railway Bookstalls in England and Wales.

The following is a list of some of the more important Parliamentary and Official Publications recently issued :—

Parliamentary :

Statutes—

Public General Acts, 1906. In course of issue.

Local and Personal Acts, 1906, in course of issue ; 3*d*. per 4 pp.

Army Act—Consolidation—including amendments to 1906. Price 1*s*. 2*d*.

Public General, Session 1905. With Index, Tables, &c. Cloth. Price 3*s*.

Index to Local and Personal Acts, 1801-1899. Price 10*s*.

Index to Local and Personal Acts, 1900-1905. Each year may be purchased separately.

Second Revised Edition. 1235-1886. XVI. Vols. Price 7*s*. 6*d*. each.

Revised Editions. Tables showing subsequent Repeals, effected by Acts of Session 2 Edward VII. 1902. Price 6*d*.

Statutes in Force. Chronological Table and Index of. 21st Edition. To the end of the Session 5 Edward VII. (1905.) 2 Vols. Price 10*s*. 6*d*.

The Statutory Rules and Orders Revised. Statutory Rules and Orders, other than those of a Local, Personal, or Temporary Character, in force on December 31, 1903. Vols. I. to XIII. Price 10*s*. each.

Statutory Rules and Orders, other than those of a Local, Personal, or Temporary Character. With a List of the more important Statutory Orders of a Local Character arranged in classes; and an Index. Roy. 8vo. Boards. Issued in 1890 to 1904. Price 10*s*. each.

Statutory Rules and Orders in force on 31st December 1903. Index to. Price 10*s*.

HISTORICAL MANUSCRIPTS. Reports of the Royal Commissioners. In course of issue.

ROYAL COMMISSIONS. Evidence, in separate parts :—Canals ; Mines ; Irish Railways.

[Cd. 3040, 3069, 3070, 3071, 3072.] ECCLESIASTICAL DISCIPLINE. Royal Commission. Report ; with Evidence and Appendices. Price 15*s*. 7*d*.

[Cd. 3080, 3081.] MOTOR CARS. Royal Commission. Report ; with Evidence and Appendices. Price 6*s*. 10*d*.

[Cd. 3127 to 3131.] WAR STORES IN SOUTH AFRICA. Royal Commission. Report ; with Evidence and Appendices. Price 12*s*. 3½*d*.

[Cd. 3167.] LOCOMOTIVES AND WAGGONS ON LINES AND SIDINGS. Report on Draft Regulations. Price 3½*d*.

[3174, 3176.] TRINITY COLLEGE, DUBLIN. Royal Commission. First Report, with Appendix. Price 1*s*. 5*d*.

[Cd. 3182.] PUBLIC ELEMENTARY SCHOOLS. List of. January, 1906. Price 3*s*. 8*d*.

H.C. No. 245. BUTTER TRADE. Select Committee. Report ; with Evidence and Appendices. Price 4*s*.

ENDOWED CHARITIES, ENGLAND AND WALES. SEPARATE PARISHES. Reports thereon ; in course of issue.

MINES. Reports of H.M. Inspectors for 1905, with Summaries of the Statistical portion under the provisions of the Coal Mines Regulation Act, 1887 ; Metalliferous Mines Regulation Acts, 1872-1875 ; Slate Mines (Gunpowder) Act, 1882, Districts Nos. 1 to 12. Price 9*s*. 9½*d*.

MINES in the United Kingdom and the Isle of Man. List of, for 1905. Price 3*s*. 7*d*.

QUARRIES Ditto. ditto. ditto. 1905. Price 4*s*. 10*d*.

MINES ABANDONED. Plans of, List of the. Corrected to 31st December 1905. Price 1*s*.

800—[Cd. 3199]—11/1906—H. & Sons Ltd.

TWENTY-FOURTH
ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND,

Being for the Year 1905.

IN THREE PARTS.

PART I.—GENERAL REPORT.
PART II.—REPORT ON SALMON FISHERIES.
PART III.—SCIENTIFIC INVESTIGATIONS.

PART III.—SCIENTIFIC INVESTIGATIONS.

Presented to both Houses of Parliament by Command of His Majesty.

GLASGOW:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE
BY JAMES HEDDERWICK & SONS LIMITED,
AT "THE CITIZEN" PRESS, ST. VINCENT PLACE.

And to be purchased, either directly or through any bookseller, from
OLIVER & BOYD, EDINBURGH; or
WYMAN & SONS, LTD., FETTER LANE, E.C., and
32 ABINGDON STREET, WESTMINSTER, S.W.; or
E. PONSONBY, 116 GRAFTON STREET, DUBLIN.

1906.

[Cd. 3199.] *Price* 4*s.* 7½*d.*

CONTENTS.

PAGE

General Statement, ... 5

Trawling Investigations, ... 6
The Hatching and Rearing of Food Fishes, . . . 7
Scientific and Technical Instruction to Fishermen, . . 8
Investigations on the Herring Fisheries of the Firth of Clyde, . 10
The Chemical Composition of the Herring, . . . 12
The Rate of Growth and the Age of Herrings, . . . 12
The Rate of Growth and the Age of Food Fishes, . . 13
The Tay Sprat Fishery, ... 14
The Specific Characters of certain Species of the Codfish Genus, 14
The Otoliths or Earstones of Fishes, ... 15
The Spawning and Fecundity of the Plaice, . . . 15
The Spawning of the Lumpsucker and the Paternal Guardianship of the Eggs, ... 16

SCIENTIFIC REPORTS.

I. Trawling Investigations. By Dr. T. Wemyss Fulton, F.R.S.E., Superintendent of Scientific Investigations, . . 17

II. Observations on the Otoliths of some Teleostean Fishes. By Thomas Scott, LL.D., F.L.S. (Plates I.-V.), . . 48

Preliminary Remarks, ... 48
List of Fishes whose Otoliths are described, . . 52
Systematic Description of the Otoliths, . . 53
Literature bearing on the Otoliths of Fishes, . . 80

III. The Food Value of the Herring. By T. H. Milroy, M.D., B.Sc., F.R.S.E., Professor of Physiology, Queen's College, Belfast, ... 83

Previous Analyses of Herrings, . . . 83
Methods of Analysis, ... 85
Analysis of May Lochfyne Herrings, . . . 86
,, July Lochfyne Herrings, . . . 88
,, September Lochfyne Herrings, . . 89
,, October Lochfyne Herrings, . . 89
,, November Lochfyne Herrings, . . 92
,, December Helmsdale Herrings, . . 93
,, ,, Lochfyne Herrings, . . 94
,, ,, Lochboisdale Herrings, . . 95
,, February Lochboisdale Herrings, . . 96
Tables of Ratios, ... 97
Summary of Results, ... 101
Remarks on Nutritive Value of Spent Herrings, with some additional Tables illustrating Differences in Composition of these Fish, . . . 103

PAGE

IV. Report on the Operations at the Marine Fish Hatchery, Bay of Nigg, Aberdeen. By T. Wemyss Fulton, M.D., F.R.S.E., Scientific Superintendent. (Plates VI.-VII.), . . 108

V. On the Specific Characters of *Gadus luscus*, *Gadus minutus*, and *Gadus esmarkii*. By H. Chas. Williamson, M.A., D.Sc. (Plates VIII.-X.), ... 116

Introduction, ... 116
List of Body Dimensions, ... 119
List of Enumeration Characters, . . . 121
Discussion of the Averages, ... 121
The Numbers of Fin-Rays, ... 126
The Numbers of Vertebræ, ... 129
The Reproduction of the Three Species, . . 130
The Skulls of the Three Species, . . . 131
General Comparison between the Three Species, . 133
A Specific Description, ... 135

VI. On the Tay Sprat Fishery, 1905-1906. By John Fletcher, . 159

VII. On the Spawning of the Lumpsucker (*Cyclopterus lumpus*) and the Paternal Guardianship of the Eggs. By T. Wemyss Fulton, M.D., F.R.S.E. (Plate XI.) . . . 169

VIII. On the Rate of Growth of Fishes. By T. Wemyss Fulton, M.D., F.R.S.E. (Plates XII., XIII.), . . . 179
Introduction, ... 179

Species dealt with, ... 179
Methods, ... 180
Comparison between Different Species, . . 180
Influence of External Conditions, . . 181
A Law of Growth, ... 182

Plaice (*Pleuronectes platessa*), ... 184
Common Dab (*P. limanda*), ... 189
Flounder (*P. flesus*), ... 191
Lemon Dab (*P. microcephalus*), . . . 192
Long Rough Dab (*Drepanopsetta platessoides*), . . 196
Turbot (*Rhombus* (*Bothus*) *maximus*), . . . 199
Brill (*Rhombus lævis*), ... 203
Cod (*Gadus callarias*), ... 209
Haddock (*G. æglefinus*), ... 226
Whiting (*G. merlangus*), ... 229
Grey Gurnard (*Trigla gurnardus*), . . . 232
Tables of Measurements, I.-XXV., . . . 243

IX. Notes on New and Rare Copepoda from the Scottish Seas. By Thomas Scott, LL.D., F.L.S. (Plate XIV.), . . 275

X. On the Spawning and Fecundity of the Plaice (*Pleuronectes platessa*). By T. Wemyss Fulton, M.D., F.R.S.E., Superintendent of Scientific Investigations, . 281

XI. On Two Cases of Hermaphroditism in the Cod (*Gadus callarias*). By H. Charles Williamson, M.A., D.Sc., Marine Laboratory, Aberdeen. (Plates XV., XVI.). 290

PAGE

XII. On the Growth and Age of the Herring (*Clupea harengus*). By T. Wemyss Fulton, M.D., F.R.S.E. (Plates XVII.-XIX.),

1. Previous Opinions and Observations, . . 293
   (*a*) English Authors, ... 293
   (*b*) Scandinavian and Dutch, . . . 294
   (*c*) Meyer and Jenkins, ... 295
   (*d*) Masterman and Cunningham, . . . 298
2. The Size of the Herring when it first attains Maturity, 299
3. The Maximum Size attained by the Herring, . 301
4. The Spawning-Periods of the Herring, . . 302
5. The Duration of Embryonic Development: Relation to Temperature, ... 303
6. A Criticism of Meyer's Conclusions and Observations, 304
7. The Scottish Collections, ... 307
   (*a*) Larval and Post-larval Stages, . . 308
   (*b*) The Annual Groups, ... 323
8. Conclusions, ... 334
9. Literature, ... 338
10. Description of Plates, ... 338

TWENTY-FOURTH ANNUAL REPORT.

TO THE RIGHT HONOURABLE

JOHN SINCLAIR, M.P.,

His Majesty's Secretary for Scotland.

OFFICE OF THE FISHERY BOARD
FOR SCOTLAND,
EDINBURGH, 30*th August* 1906.

SIR,

In continuation of our Twenty-fourth Annual Report, we have the honour to submit—

PART III.—SCIENTIFIC INVESTIGATIONS.

GENERAL STATEMENT.

This, the third part of the Twenty-fourth Annual Report, deals with the scientific investigations conducted by the Board in 1905, so far as they have been completed, by means of the Parliamentary Vote granted for the purpose.

The scientific work has, as usual, been carried out under the supervision of Dr. T. Wemyss Fulton, the Scientific Superintendent under the Board, the researches having been for the most part undertaken at the Marine Laboratory at Aberdeen, in the Moray Firth, and the Firth of Clyde. The sea-fish hatchery, which is also situated at Aberdeen, was reconstructed during the year in connection with the formation of a new road at the Bay of Nigg by the Town Council of Aberdeen and at their expense, as described below, where a statement of the hatching operations will also be found.

In the Firth of Clyde, and more particularly in Lochfyne, an investigation into the natural history and migrations of the herring was continued, with the view of ascertaining if possible the cause of the decline in the yield of the herring fishery there in recent years, and whether any regulations affecting the time or methods of fishing would be likely to be beneficial to the fishery as a whole. As stated in the first part of this Report, the catch last year was

one of the poorest on record, the shortage on the previous year's catch, which was much below the average, amounting to 3160 crans in quantity and £6243 in value. The work has been done as far as was possible by the use of fishing boats and the hire of a small yacht for monthly observations within the loch itself, and this had to be interrupted during the winter.

The investigations into the condition of the fishing-grounds in the Moray Firth were made as far as possible by the use of commercial trawlers, without expense, as referred to more fully below, and the observations on the growth, reproduction, and distribution of the edible fishes continued as in the last few years, as well as those on the destruction and capture of immature and undersized fishes. Owing to the unfortunate stranding of one of these vessels in Aberdeen Bay last December, while engaged in procuring plaice for the hatchery-ponds, and the loss of life occasioned thereby, the Board have thought it right to refrain from making use of such vessels for inshore work in future.

As mentioned later, the Board has been pleased with the favourable response of seaboard County Councils to their invitation to send fishermen to the Marine Laboratory and Hatchery at Aberdeen for a week's instruction, each spring, in the life-history of fishes, and they hope that the facilities offered may be still further taken advantage of.

Trawling Investigations.

During the last few years, since the *Garland* was disposed of, the fishing grounds in certain parts of the territorial waters, especially in the Moray Firth and Aberdeen Bay, have been examined from time to time by means of commercial steam-trawlers, whose services were obtained without expense, partly with the view of ascertaining their condition and partly for the purpose of scientific research on the reproduction, growth, and distribution of fishes, and the capture of immature or undersized fish. A number of papers embodying the results of this work have already been published in previous Annual Reports. In the present Report there are two containing further observations by Dr. Fulton, one on the growth of fishes, referred to later, and the other furnishing an account of the trawling experiments last year, with detailed tables of the fish captured and the proportions which were unmarketable.

The more important areas in the Moray Firth were visited in February, September, October, and November, and the grounds in Aberdeen Bay were also examined in March. The aggregate quantity of fish brought to the market in the various trips was 388½ cwts., and the total number of fishes caught in the recorded hauls was 71,982, of which 41,444, or over 59 per cent., were unmarketable.

On most of the occasions marketable fish were by no means plentiful, and the voyages were not very profitable financially. This was particularly noteworthy in the Moray Firth in the autumn months, at which time the vessels working on the offshore grounds in the North Sea were much more successful. Haddocks

of marketable size were exceedingly scarce, the total catch of these being under twenty boxes for all the trips together, and more than half of them were obtained in February; in September they totalled five boxes, and in November a box and a half.

On the other hand, immense shoals of young haddocks, under two years of age, were present in the bays in autumn, from which they were absent in the spring, and by far the greater part of those taken were thrown overboard as unmarketable.

Some of the hauls may be referred to as showing the enormous destructive power possessed by the modern otter-trawl when employed in shallow bays at certain seasons. In six hauls in the Dornoch Firth at the end of September, the duration of the actual fishing being 23¾ hours, 25,563 fishes were caught, and of these, 18,809, or 73½ per cent., were thrown overboard as unmarketable. The number of haddocks taken in these six hauls was large, viz., 10,361, but only 394 of them were large enough to be marketable, 96 per cent. of the catch being returned to the sea. The prevalence of the small haddocks on the ground in autumn, and their scarcity in spring, may be shown in another way. While in February it took ten hours' trawling to catch one unmarketable haddock and two marketable, the number of the former taken in the same time in September was 4196 and of the latter 166. The capture of small unmarketable plaice was also very considerable on this ground in autumn, 54 per cent. of the 13,610 plaice caught in the six hauls being rejected on account of their small size.

All the young haddocks and a large proportion of the young plaice caught in this way perish, although under favourable conditions many of the latter may be preserved.

It was shown formerly by similar investigations on board commercial trawlers fishing on the deeper grounds in the North Sea that the percentage of small fish taken there was less than in the waters near shore. In the Moray Firth in February the proportion of the unmarketable was 19 per cent., and in autumn it was 67 per cent.

Observations were also made on the maturity and growth of the fishes caught, and a number of experiments were carried on with small-meshed nets.

The Hatching and Rearing of Plaice.

Owing to the formation of a new road at the Bay of Nigg last year, the Town Council of Aberdeen, from whom the site of the hatchery is leased, desired that that building and some others might be transferred to an adjoining part of the ground and re-erected at their expense. To this proposal the Board agreed, and the hatchery, the boiler and pump-house, and the storehouse were accordingly taken down and rebuilt on the new site.

The change involved considerable re-arrangement of the pipes, &c., and the opportunity was made use of to effect some improvements which experience had shown to be desirable. The Town Council gave all reasonable facilities for the alterations and improvements being carried out, so that the hatchery is now better adapted for the work than it was before. The building itself is

now somewhat enlarged; a concrete floor replaces the old wooden one; a strong wall has been built along the seaward face of the site, and granite retaining walls around the gravitation tank. In the present Report a brief description is given of the hatchery as rearranged, with illustrations showing the interior and exterior, the pumping plant, and the large spawning-pond in which the breeding fishes are kept and where the eggs are shed at the spawning season.

During last year the eggs of the plaice were first discovered in the pond on 20th January, about the usual date when they make their appearance. Collections of eggs were thereafter obtained almost daily. The numbers gradually increased until the middle of March, after which they declined until 16th May, when the last collection was made. The duration of the spawning in the pond was thus about 117 days, which may be regarded as approximately the period in the sea. The aggregate number of eggs collected in the season was estimated at 40,110,000, of which 48 per cent. were spawned in March, 23 per cent. in February, and the same proportion in April.

The duration of the period of embryonic development, until the eggs hatch, varies with the temperature of the water. The average at the beginning of the season, when the temperature is low, is about three weeks; towards the end of the season, with the temperature some degrees higher, hatching takes place in about a fortnight. The larval fishes, on issuing from the eggs, are retained in the apparatus for several days until the yolk-sac is partly absorbed, and it is calculated that the eggs and larvæ are protected in this way for about half of the time from the spawning of the eggs until the young plaice undergo their metamorphosis and assume the form and habit of the adult.

The estimated number of fry which hatched out and were placed in the sea was 24,500,000. Most of them were distributed off Aberdeen, but one lot of about three and a half millions was taken to St. Combs, further up the coast, at the request of the fishermen, and there distributed.

Since the establishment of the hatchery the total number of the fry of plaice which have been set free in the sea amounts to 387,750,000, the number of fry of other fishes, as turbot, lemon dabs, and cod, being close upon 17,000,000.

Owing to the circumstance that the hatchery is worked in conjunction with the Marine Laboratory, the expense of the hatching operations is comparatively small, the annual expenditure being estimated at rather under than over £100, which meets the cost of extra coal and an additional assistant at the height of the season.

Scientific and Technical Instruction to Fishermen.

For some years past, as mentioned in previous Reports, by an arrangement with the Technical Education Committee of the County Council of Aberdeenshire, representative fishermen from various parts of the coast of that county have visited the laboratory and hatchery in spring, to attend demonstrations on the life-

history and habits of fishes, such as might be of interest and use to them, and to see the processes of fish-hatching.

The fishermen were so much interested in the instruction they received that, in some instances, on returning home, they held public meetings to discuss and communicate what they had learned; and as it appeared to the Board desirable to encourage this inclination among the fishing population for knowledge of the kind, they invited other seaboard County Councils to send fishermen to the demonstrations, if they felt so disposed, no expense being incurred except for the travelling and maintenance of the men. The response has been gratifying, fishermen from the counties of Argyll, Bute, Caithness, and Elgin having attended the last course of instruction.

The subjects taught include the life-history of such fishes as the herring, cod, haddock, and plaice, as well as of the mussel and edible crustacea, the instruction being given in as simple a manner as possible. The food, reproduction, growth, &c., of fishes are explained and illustrated by specimens and experiment, and the men are shown the process of fertilisation and the development of a fish within the egg. Demonstrations are also given on various methods of "barking" nets and lines, a subject which, touching as it does on their daily occupation, is always interesting, and the opportunity is taken to show them some of the fish-curing and ice-making establishments in Aberdeen, as well as the fish-market.

With reference to the "barking" of nets, it may be stated that experiments are being tried as to the relative value of certain methods for the preservation of herring-nets, and that the Congested Districts Board have courteously agreed to defray the cost, and to have the trial of the nets made on board the experimental motor-fishing boat *Pioneer*.

It may be worth stating that on the whole question of the technical education of fishermen and those engaged in the fishing industry most other countries in Europe are in advance of ourselves. In France and Germany there are a number of schools devoted to this work, directly or indirectly under the patronage of the State; there are several in Denmark, The Netherlands, Belgium, and Sweden. Most of them are concerned chiefly with that part of a fisherman's knowledge which relates to navigation, fishing-grounds, and actual fishing, but many offer elaborate facilities for instruction of a more purely scientific kind, and are provided with laboratories, museums, libraries, and a teaching staff; some have ships as floating schools for practical work. By far the most important and the best-equipped institution of the kind is the Imperial Fisheries Institute at Tokio, Japan, which was recently rebuilt by the Japanese Government at a cost of £17,000. The buildings and grounds occupy 8½ acres, including a dock for the experimental vessels; there are sixteen lecture rooms, as well as laboratories, museum, and libraries; the staff includes ten professors and many assistants; and the course, which is divided into three sections—fishing, fisheries technology, and pisciculture—extends over three years. The aim is to educate the young Japanese connected with the fishing industry in the most thorough and scientific manner; but much work is also done in training teachers

for the local fisheries and technical schools, and men who wish to devote themselves to such industries as canning and curing fish, the manufacture of fish-oils, iodine, &c.

In this country there is perhaps room for a more thorough scientific and technical training in connection with the treatment and curing of fish than now obtains.

Investigations on the Herring Fisheries in the Firth of Clyde.

The investigations on the herring fisheries in the Clyde refer chiefly to Ballantrae Bank and Lochfyne. With regard to the former, where a Bye-law (No. 18) is in operation interdicting seine-net fishing within a certain area, the fishery last season, as for some years past, was a failure, the weather having been almost continuously stormy up to the middle of March. The Fishery Officer reports that, although the "appearances" of herrings on the bank were as good as ever they were before—that is, the presence of whales, solan geese, and the oily look of the surface, by which fishermen judge of the location of herring-shoals—and though it was conclusively proved that herrings visited the ground to spawn by the fact that the gill-nets set for cod were coated with herring-eggs, the total quantity of herrings taken was 383 crans—15 by drift-nets, 83 by seine-net, and 285 by "trammels" or set-nets. No observations were thus possible as to the herring at Ballantrae; and, owing to the want of a steamer, equipped for such work, dredging operations on the bank could not be undertaken.

The fact that shoals of herrings have continued to frequent these grounds every spring in recent years, and have been scarcely at all disturbed by the action of the nets of fishermen, while the Lochfyne fishing has been extremely unsuccessful, does not lend support to the theory, strenuously held a few years ago, that the seine-net fishing at Ballantrae was injurious to the fishing in the loch; though sufficient time has not yet elapsed to make this certain.

The investigations in Lochfyne concern the decline in the yield of the fishery in recent years, especially in 1904 and 1905, the latter being amongst the worst years on record, and are designed to throw light on the movements of the herring-shoals into and out of the loch, the places where the herrings spawn and the periods, the relation of the abundance of food-material in the loch to the abundance of the herrings, the growth of the herring, and the great fluctuations that occur. An investigation of this kind is difficult under the most favourable circumstances and must necessarily cover several successive seasons. As much as possible has been done by the hire of boats; monthly observations on the temperature and food-material for the herring have been made for over a year, but they had to be suspended during last winter, owing to the lack of funds to meet the expenses.

In addition to the information afforded by the course of the fishing and the places of capture of the fish, two methods have been adopted with the object of tracing the migrations of the herring. One consists in marking the herrings with a printed silk

tag, suitably treated, and then liberating them, and over 500 herrings have been thus dealt with. The tag contains directions to the finder and enables the particular herring to be identified. So far, five of the marked herrings have been caught again, but as they were caught within the loch, and not far from the place of liberation, they do not afford evidence as to the route of the herrings from the loch or their destination. The herring is much more delicate than ordinary round fishes and flat fishes, as plaice and cod, which are made the subject of similar experiments, and it was found necessary to attach the tag to them while they were still in the water within the bag of the seine-net. This method will be persevered in, since the recovery of a single marked herring at a distance from the place of liberation, particularly if it is caught at a spawning-ground and about the spawning-time, affords direct and conclusive evidence as to the migration of that particular herring, and presumptive evidence as to the movement of the shoal to which it belongs, since the individuals composing it are governed by a common object, namely, reproduction.

The second method consists in the attempt to identify a particular shoal by a study of the characters of the herrings belonging to it. It was applied in particular to the large and fine fish which loiter till near the end of the year in the deep water of the upper loch, which they quit by easy stages, and are believed, and probably rightly, to make their way down Kilbrennan Sound to spawn in the early months of the year somewhere off the southern part of Kintyre. Many hundreds of these herrings were examined at different periods, weighed, various measurements tabulated, and the condition and weight of the reproductive organs determined; the latter observations affording incidentally valuable information as to the ripening process and its duration. These herrings were traced down the loch at the end of the year, and they appear to have gone down Kilbrennan Sound, but, owing to the absence of the Fishery Officer at Campbeltown on other duties, sufficient samples of the herrings being caught in the early part of the year could not be procured. It is accepted as a working hypothesis that these large herrings pass down Kilbrennan Sound, but there is not conclusive evidence to show that they do so.

In the meantime, it may be pointed out that in the past the fluctuations in the yield of herrings in Lochfyne in different years have been noteworthy, as the following Table, which covers the long period of half a century, shows:—

Ten Year Period.	Average Number of Boats.	Average Number of Barrels Taken.	Average Number of Barrels per Boat.	Minimum Catch in Decade.	Maximum Catch in Decade.
				Barrels.	Barrels.
1827–36, . . .	300	3,469	11·5	1,453 (1830)	4,898 (1832)
1837–46, . . .	350	7,388	25·1	3,225 (1839)	9,400 (1846)
1847–56, . . .	396	19,949	50·4	10,630 (1852)	32,726 (1851)
1857–66, . . .	558	33,096	59·3	16,151 (1864)	79,893 (1862)
1867–76, . . .	479	25,561	53·4	6,934 (1874)	34,471 (1876)

The Food-Value of the Herring.

As part of the series of researches now being carried out by the scientific department of the Board on the herring and herring fisheries, it was decided to obtain analyses of herrings in order to determine their composition and food-value at different periods of their development, especially when ripe or nearly mature and when spent. This investigation was undertaken by Dr. T. H. Milroy, Professor of Physiology, Queen's College, Belfast, who furnishes an important paper on the subject which is contained in the present Report, the detailed analyses being set forth in numerous Tables. Herrings have been analysed before, but the results have shown much discrepancy from the fact that the season of the year or the sexual development of the fish has been ignored. Professor Milroy shows that great differences in the muscle of the herring exist at different periods, even when the herrings are taken from the same waters. The herrings used for the research were obtained principally from Lochfyne, but also from Lochboisdale and Helmsdale.

The composition of the herrings is stated in terms of water, proteid, fat, and phosphoric acid, and as the muscle or flesh constitutes the main source of the nutritive value of the herring, it is important to recognise the variations in its composition. These are most striking, especially as concerns the percentage of fat, and as this food principle possesses such a high caloric value, any marked decrease in its amount lowers the nutritive value of the fish to a serious extent. The lowest fat-percentage was found in the large spent herrings from Lochboisdale in February, and the total amount of fat present in the collective muscles of the average fish was exceedingly small. In these muscles the percentage of water was higher than normal, but the proteid and phosphorus percentages were but little affected. In Lochfyne, the fat-percentage of the flesh of the herring continues to rise during August, September, and October. It begins to fall slowly in November, markedly in December, most markedly during spawning, and continues at a low level until the fish begin to feed again.

With regard to the nutritive value of spent herrings, Professor Milroy says the statements often vaguely made as to their unwholesome character usually rest upon the general appearance of the flesh, which is undoubtedly poorer in fat. But the nutritive value depends not only upon the fat, but upon the proteids, and the analyses show that in this respect spent herrings compare by no means unfavourably with the maturing or mature fish. Fully mature fish, about to spawn, are in the same condition as freshly spent fish.

A similar research on the composition of the herrings of the east coast of Scotland is now in progress.

The Rate of Growth and Age of the Herring.

To the present Report a paper is contributed by Dr. Wemyss Fulton on the growth and age of the herring, based upon the measurements and examination during the last six years of nearly

20,000 specimens, which were obtained mostly in small-meshed nets around the cod-end of otter-trawls during the trawling investigations. It is shown that the opinions hitherto generally held as to the growth of this fish, and which are for the most part based on the investigations of a German naturalist, Dr. H. A. Meyer, which were made at Kiel, on the Baltic, over twenty-five years ago, are not well-founded, and that the herring grows more slowly than he supposed.

Dr. Meyer's observations and experiments are submitted to critical examination, the results showing that he over-estimated the growth of the herring in winter, when the growth of all fishes is retarded, and missed at least a year in the computation of its age. The gradual growth of the young post-larval herring from the spring and from the autumn spawning respectively is traced, the latter towards the end of the year being between one and two inches in length, while the growth of the spring herring under more favourable temperature conditions is quicker.

The herring when one year of age measures barely two and a quarter inches in length, and it does not reach maturity and spawn until five years old and of an average length of about $9\frac{1}{4}$–$9\frac{1}{2}$ inches. The size of the herring at different ages is approximately as follows :—

Approximate Age.	Length.		Increase in Length from Previous Year.	
	Mm.	Inches.	Mm.	Inches.
1 Year, ...	60·5	$2\frac{3}{8}$	–	–
2 Years, ...	113	$4\frac{7}{16}$	52	$2\frac{1}{16}$
3 ,, ...	159	$6\frac{1}{4}$	47	$1\frac{7}{8}$
4 ,, ...	200	$7\frac{7}{8}$	41	$1\frac{5}{8}$
5 ,, ...	238	$9\frac{3}{8}$	38	$1\frac{1}{2}$
6 ,, ...	257	$10\frac{1}{8}$	19	$\frac{3}{4}$

Herrings over twelve inches long, like the large Lochfyne fish, may be ten years old and more, and the very large herrings that are occasionally caught, measuring 14–15 inches, are probably over 15 years of age, and may be 20. Compared with most fishes caught by lines or trawls, the herring caught by drift-nets has a great advantage, since no less than four generations of undersized or immature herrings escape capture by passing through the meshes of the net, and only fish which have reached adult size are taken.

The paper is illustrated with three plates of diagrams.

The Rate of Growth and the Age of the Food Fishes.

Another paper dealing with the growth of numerous species is contributed by Dr. Fulton, the results being founded upon the measurements of nearly 209,000 fishes belonging to 21 species, which was done almost entirely by means of the commercial

trawlers employed in the trawling investigations, as previously described, and is the same method as that which has since been used so extensively in the course of the international investigations in the North Sea. During the course of the investigation, which has extended over six years, the numbers of the chief species dealt with have been as follows :—

Plaice,	17,950	Whiting,	58,164
Common Dab,	26,230	Gurnard,	5,495
Long Rough Dab,	20,261	Norway Pout,	7,192
Cod,	7,176	Herring,	19,806
Haddock,	28,760	Sprat,	6,473

From a study of the growth of the different fishes and the size at which they attain maturity, a law of growth is stated, namely, that fishes approximately double their size and increase their weight about eight times after they have reached sexual maturity.

The species whose growth and age are specially dealt with in the paper are the plaice, dab, flounder, lemon dab, long rough dab, turbot, brill, cod, haddock, whiting, and grey gurnard. A general conclusion is that fishes do not grow so quickly as is generally supposed. Thus, while the plaice reaches a length of about three inches in the first year of its life, the female is five years old and the male four years when they attain maturity. It is estimated that the turbot does not spawn until it is at least seven years old, while the cod spawns at four or five years, the haddock at three, and the whiting when two years of age. The paper is accompanied by a number of tables of measurements and two plates.

In connection with the question of the growth of fishes, a research on the rate of digestion by Dr. Noël Paton, whose investigations on the salmon are so well known, is in progress. Two sets of observations have been made, but the final results are reserved for next year's Report.

The Tay Sprat Fishery.

Mr. John Fletcher contributes a paper on the sprat fishery in the Tay, similar to the one published last year, but dealing with the winter of 1905–1906. The fishery was again a comparative failure, only 1371 crans of sprats, including young herrings, being taken. The estimated number of young herrings caught in the sprat fishing is stated to have been nearly 12,000,000, while the sprats are estimated at a little over 16,000,000, the estimated percentage of young herrings amounting to 42·4.

The Specific Characters of the Gadidæ.

Dr. Williamson contributes a paper, illustrated with three plates, on the classification of certain members of the cod-family, viz., the bib, or whiting-pout, the poor-cod, and the Norway pout, the paper being a continuation of a previous one, in which the cod, the saithe, and the lythe were dealt with. Two of the species, the whiting-pout and the poor-cod, have often been confused, certain

authors at different times maintaining that they are specifically the same, a circumstance attributed to only a few specimens having been examined, and the specific characters as published ambiguous. By a study of the distinguishing characters and numerous measurements, Dr. Williamson shows that these two species are distinct, and a key is given incorporating the results of the previous and the present researches, by which the six species may be separated. The same naturalist supplies a paper, with two plates of drawings, on hermaphroditism in the cod, a condition which is normal in certain fishes, as the Gilthead (*Chrysophrys auratus*), and occurs occasionally in others.

The Otoliths or Earstones of Fishes.

In this Report will be found a long and elaborate paper by Dr. Thomas Scott on the otoliths or earstones of teleostean or bony fishes, which is illustrated by five plates containing figures of the otoliths described, belonging to about seventy species. The otoliths of different fishes vary remarkably in shape and size, and Dr. Scott shows how these differences may be used as a means for the identification of the various species should other data not be available. It is thus sometimes possible, as the author has shown in previous papers, to tell upon what fishes a particular fish or cetacean may have been feeding, by the presence of the earstones alone. The otoliths consist almost entirely of calcareous matter, only a trace of organic tissue being present. The structure shows that the limy matter is deposited in concentric layers, the density of each layer being slightly greater or less than the one immediately preceding it. In flat fishes, the earstones form round or oval discs, so thin that the alternating concentric layers are easily made out. The number of such layers, or growth-lines, appears to correspond more or less closely with the age of the fish, but Dr. Scott is of opinion from his researches that it is doubtful if the evidence of age obtained in this way can be safely relied on.

The same naturalist also contributes a brief paper on new and rare copepoda from the Scottish seas, illustrated by a plate of drawings. Most of the species were obtained in the Firth of Forth and the Moray Firth.

The Spawning and Fecundity of the Plaice.

An experiment was made on this subject by Dr. Fulton, by keeping adult plaice about to spawn in tanks and collecting all the eggs that appeared in the overflow daily, or twice daily. By this means the number of eggs spawned by each of the two females experimented with was determined, as well as the duration of the spawning and the quantity of eggs that appeared from day to day. One of the females spawned steadily, and almost daily for a period of 36 days, the quantity shed at any time being small; the spawning of the other extended over 41 days, but eggs were spawned on only 16 days during the period, large quantities of eggs being shed on each occasion, as many as 49,000. The first

female produced a total of about 163,500 eggs, and the second one a total of 252,700. The eggs of one of the fishes were found to be smaller than those of the other, and towards the end of the spawning the size of the egg became reduced in each case.

The Spawning of the Lumpsucker and the Paternal Guardianship of the Eggs.

A paper by Dr. Fulton describes the spawning of the Lumpsucker and the remarkable assiduity with which the male guards the eggs during the period of incubation, which lasts for about two months.

During all this time the male stands sentinel over the eggs, repelling the attacks of intruders, pursuing other males that approach them, constantly aërating them by a movement of his fins, and by spouting currents of water on them from his mouth, and refusing all food until almost the end of his long vigil.

We have the honour to be,

Your most obedient Servants,

ANGUS SUTHERLAND, *Chairman.*
D. CRAWFORD, *Deputy-Chairman.*
D'ARCY W. THOMPSON.
W. R. DUGUID.
L. MILLOY.
D. MEARNS.
H. WATSON.

WM. C. ROBERTSON, *Secretary.*

SCIENTIFIC REPORTS.

I.—TRAWLING INVESTIGATIONS. By Dr. T. Wemyss Fulton, F.R.S.E., Superintendent of Scientific Investigations.

Introductory.

Last year the investigations into the conditions of the fishing grounds in the Moray Firth and Aberdeen Bay, by means of steam trawlers, whose services were obtained for the purpose without expense, were continued as in previous years as far as circumstances permitted. In the Moray Firth the more important areas were visited in February, September, October, and November, and the grounds in Aberdeen Bay were also examined in March. The grounds at Burghead Bay and in the neighbourhood on the south coast were most fully examined, but a number of hauls were also taken in the Dornoch Firth, off the Suters of Cromarty, and a few off the Caithness coast.

On most occasions fish were found to be scarce, and the results of the voyages were not regarded as financially profitable by the owners, especially in the Moray Firth in September, October, and November, when the vessels working on the usual grounds in the North Sea were much more successful. Haddocks, in particular, were unusually scarce, only 19¼ cwts. being taken in the whole of the voyages together, and of these 12¾ cwts. were got in the February trip. In September the total quantity of haddocks amounted to only 5 cwts., and in November to 1½ cwts., while none at all were caught in Aberdeen Bay in March. The haddocks that were taken were mostly small, and in autumn large numbers of these small unmarketable haddocks were brought up in the trawl in the Moray Firth and thrown overboard. On one occasion close upon 4000 were taken in a single haul. Particulars in regard to these are given below, and in the Tables appended. The total quantity of fish of all kinds brought to market in the course of the various trips amounted to 388½ cwts., mostly consisting of plaice.

With regard to the number of fishes taken, the aggregate for the completely recorded hauls was 71,982, of which 30,538 were marketable and 41,444 unmarketable, either because of their small size, or because they were not of edible kinds. The total number of plaice taken in these hauls was 29,958; the number of haddocks was 26,348, the greater proportion being too small to be marketable, and the number of cod was 302. As showing the quantity of unmarketable fish in autumn as compared with spring (February) it may be said that while at the latter period 12,882 marketable fish were taken as against 3088 unmarketable, in autumn the number of unmarketable was 26,133, while the number of marketable was almost the same as in spring, viz., 12,756.

One of the objects of these trawling investigations is to ascertain as far as possible the changes which occur in the abundance of the food and other fishes on the grounds in different seasons and years; but observations are also made on the reproduction of the fishes, their spawning,

food, &c., while at the same time collections of floating organisms, or plankton, are obtained. The employment of commercial trawlers for this purpose is associated with certain disadvantages, particularly from the point of view of comfort; but as the trawling work is carried on precisely as it is when fishing for market purposes, opportunities are afforded for various observations bearing on this method of fishing, as, for example, the proportion of marketable and unmarketable fishes which are taken, the influence of the size of the mesh on the size of the fish caught, &c. The expense, moreover, is comparatively slight, as no charge is made for the use of the vessels, which are also available for procuring supplies of adult living plaice for the hatchery, without cost.

On some of the occasions the records of the catches on board the trawlers were made by Dr. Williamson.

I.

The first of the trawlings was made in the Moray Firth and Aberdeen Bay from the 6th to the 11th February, the steam-trawler "Loch Lyddoch" being employed; rather heavy weather was encountered during the latter part of the trip. The places visited in the Moray Firth were Burghead Bay and the grounds off it, the grounds in deeper water to the east of the Suters of Cromarty, and the Dornoch Firth. A gale which sprang up, with a heavy sea, prevented the vessel from visiting Smith Bank and the grounds off the Caithness coast, as was intended.

The first hauls were made in Burghead Bay in the afternoon of 6th February, the wind when the work commenced being from the westwards and light. A drag in from about 5 to 12 fathoms for four hours, and therefore somewhat close in, yielded a total of 596 fish, of which 511 were marketable and 85 unmarketable. The greater part of the marketable catch consisted of plaice, and witches were fairly numerous. The plaice numbered 292, all of them marketable, and most of them medium and small, only 1 large plaice being taken. There were 100 witches, all marketable, and among the other flat-fishes, 3 turbot, 13 brill, 1 halibut, 26 common dabs, and 7 flounders. Round-fishes, especially haddocks, were scarce; they included 2 cod, 7 codlings, 39 haddocks, all but 1 being small, 18 whitings, and 2 cat fish. The unmarketable fishes consisted mostly of common dabs, whiting, and codling. The second haul, in the same locality and about the same depths, was for four hours and five minutes. The number of fishes secured was 792, of which 712 were marketable and 80 unmarketable. Plaice were better represented, the total being 492, all of them marketable, and consisting chiefly of medium and small specimens. This catch also included a halibut, 3 turbot, and 14 brill, as well as 49 witches, all marketable, and 100 common dabs. There were also 7 cod and 11 codlings; haddocks were equally scarce, only 26 being taken. A third haul in the same place gave somewhat the same results. It was for four hours, and the aggregate catch amounted to 863 fishes, 768 being marketable and 95 unmarketable. Plaice formed the bulk of the catch; they numbered 375, mostly small and medium, and there were also 178 witches, all marketable, as well as 37 brill, 79 common dabs, and 5 flounders. The marketable round-fishes included 4 cod, 28 codling, and 43 haddocks, all of the latter, except one, being small.

In the three hauls in this place within the range of depth mentioned, occupying altogether twelve hours and five minutes, 2251 fishes were caught, of which 1991 were marketable and 260 unmarketable. The

particulars are given in the following Table, the marketable fishes being represented on the first line (I.) and the unmarketable on the second line (II.).

	Cod.	Codling.	Haddock.	Whiting.	Cat-fish.	Halibut.
I.	13	46	108	41	2	2
II.	-	9	5	8	-	-
Total	13	55	113	49	2	2

	Turbot.	Brill.	Plaice.	Witch.	Lemon Dab.	Common Dab.	Flounder.
I.	6	64	1,159	327	6	205	12
II.	-	-	-	-	-	183	-
Total	6	64	1,159	327	6	388	12

In addition to those in the Table, there were 3 herrings, 34 anglers, and 18 thornbacks.

In the same locality, but in rather shallower water, another haul was taken on the 8th, which may be here referred to. The depth was from 7 to 10 fathoms, but mostly 7, 8, and 9, and it lasted four hours and twelve minutes. The catch was smaller than in the others, totalling 367 fishes, 334 being marketable and 33 unmarketable. Plaice were not so numerous, consisting of 263 (3 baskets of mediums and 1½ of small). There were also 2 turbot and 21 brill. Haddocks were represented by 2 small, unmarketable specimens, but, on the other hand, there were 17 cod.

After the three first hauls above referred to, the vessel shifted a little further out into deeper water. The light on Burghead pier bore about S.S.E., and the depths ranged to about 25 fathoms, the distance from the light being about four miles. In the first haul, in from 17 to 20 fathoms, which lasted for four hours and ten minutes, 1295 fishes were caught, of which 1011 were marketable and 284 unmarketable. The bulk of the catch was made up of plaice, haddocks, and witches. There were 273 plaice, mostly medium and small (*see* page 35), and all marketable, 371 witches, all marketable and all except four large, while the number of haddocks was 277, of which 213 were marketable, though nearly all were small. The catch included 12 cod, 22 codling, 2 coal-fish, 2 cat-fish, 3 turbot, and 4 brill.

The second haul, made in the same locality in from about 17 to 21 fathoms, and which lasted for four hours and five minutes, yielded 1460 fishes, of which 1081 were marketable and 379 unmarketable. Haddocks were much scarcer than in the preceding drag, the bulk of the fishes being plaice and witches. The number of plaice was 384, and they were all marketable; most of them were mediums and thirds. The witches numbered 528, there being 466 large, marketable, and 62 unmarketable. There were also 11 brill, 1 turbot, 6 lemon dabs, 10 cod, and 2 cat-fish. The number of haddocks was 148, and 63 of them were too small to be marketable. It is of interest to note that in this catch there were 9 berried edible crabs.

The next haul in the same place, for four hours and fifteen minutes, yielded 1013 fishes, 822 being marketable and 191 unmarketable. Plaice were the most numerous in the catch, the total being 563, and all but 11 marketable. Witches were much less abundant, the total being 74, 4 of them unmarketable. Among the other flat-fishes were 1 halibut, 4 turbot, and 18 brill, as well as a black or common sole—a fish which is exceedingly scarce in the Moray Firth. Haddocks were scarce, only 64 being taken, nearly all small, and 18 unmarketable. The number of cod was 5, and there were 2 cat-fish, 1 starry ray, and 4 cuckoo rays. In the next haul, which lasted for four hours and fifteen minutes, the range of depth was rather greater, from 12 to 25 fathoms. The aggregate number of fishes was 707, of which 599 were marketable and 108 unmarketable. Plaice formed the bulk of the catch, numbering 385, and all but 4 were marketable. There were 60 witches, 3 of which were unmarketable, 3 turbot, 14 brill, and 1 megrim. Haddocks were poorly represented, the number being 67, and 7 were unmarketable and nearly all the others small. Three cod and 27 codling were taken, 7 of these being unmarketable, as well as 2 coal-fish and a cat-fish. A fifth haul, lasting for four hours and ten minutes, in somewhat shallower water, from 13 to 17 fathoms, yielded a total of 816 fishes, 673 being marketable and 143 unmarketable. The result was much the same as in the previous four drags, the bulk of the catch consisting of plaice, which numbered 456, all but 6 being marketable. There were 65 witches, all marketable, 1 turbot, 14 brill, 5 cod, and a cat-fish.

Altogether, in the five hauls off Burghead, the aggregate time of actual fishing being twenty hours and fifty-five minutes, the total number of fishes taken was 5291, of which 4186 were marketable and 1105 unmarketable. The particulars for each kind of fish are given in the following Table, the marketable being shown on the first line (I.) and the unmarketable on the second line (II.).

	Cod.	Codling.	Haddock.	Whiting.	Coal-fish.	Cat-fish.	Halibut.	Turbot.
I.	35	52	425	105	4	8	1	12
II.	-	15	158	37	-	-	-	-
Total	35	67	583	142	4	8	1	12

	Brill.	Plaice.	Witch.	Lemon Dab.	Common Dab.	Megrim.	Flounder.
I.	61	2,040	1,029	15	258	1	10
II.	-	21	69	-	678	-	1
Total	61	2,061	1,098	15	936	1	11

	Long Rough Dab.	Sole.	Herring.	Thorn-back.	Starry Ray.	Cuckoo Ray.	Angler.
I.	-	1	14	77	1	1	36
II.	72	-	-	14	-	3	37
Total	72	1	14	91	1	4	73

The vessel then steamed in the direction of the Cromarty Firth and made a number of hauls off the Suters of Cromarty. The distance from the Suters was about five miles to the east, and the depth varied from about 18 to 35 fathoms. The first drag, on the 9th February, lasted for 3½ hours, the depths taken being 25, 18, and 35 fathoms. The number of fishes caught was 1357, of which 1113 were marketable and 244 unmarketable. In this haul plaice were barely represented, the total being 13, and it is noteworthy that 4 were small (thirds), 7 were mediums, and 2 large; there were none belonging to the fourth class. The bulk of the catch consisted of witches, of which there were 9 basket-fuls, the number being 850, and of these 792 were marketable and 58 too small to be taken to market. Among the other flat-fishes were 1 turbot, 4 lemon dabs, 224 common dabs, and 23 long rough dabs; but, in contrast to the hauls off Burghead, no brill were taken. Among the round-fishes, haddocks were much better represented, and the medium-sized fish, practically absent off Burghead Bay, were fairly represented. The total number of haddocks was 132, all but 13 being marketable; 8 were large, 58 medium, and 53 small (thirds). The number of cod caught was 16, and there were 6 marketable codlings and 1 coal-fish.

The depths got in the next haul in the same locality, which lasted for three hours and thirty-five minutes, were 23 and 29 fathoms. The number of fishes taken was 1774, of which 1411 were marketable and 363 unmarketable. The catch differed from the previous one in that plaice and haddocks were much more abundant and witches less abundant. The number of plaice taken was 278, three of them being too small to be marketable; of the marketable, 4 were large, 129 medium, 99 were thirds, and 43 fourths. The witches numbered 493, of which 477 were marketable, and the great majority were large. Among other flat-fishes were 3 brill, 2 lemon dabs, 242 common dabs, and 119 long rough dabs The number of haddocks taken was 536, of which 483 were of marketable size, and 53 too small to be taken to market. The catch also included 27 cod, 11 codling, all but 1 marketable, as well as 26 whiting, 1 coal-fish, 1 pollack, and 2 hake. Two other hauls were taken on the 10th, the depths ascertained in the first being 12, 25, and 28 fathoms; this haul lasted for three hours and fifteen minutes. The catch consisted of 1080 fishes, 963 being marketable and 117 unmarketable. Plaice and haddocks were best represented. The former numbered 326, all marketable, there being 4 large, 150 medium, 115 thirds, and 57 fourths. There were 438 haddocks, 419 of which were marketable, and they almost entirely consisted of mediums. Witches numbered 197, all but 7 being marketable; and the catch included 5 cod, 1 hake, 2 brill, and 38 long rough dabs. The fourth drag, also on the 10th, lasted for four hours and fifteen minutes, the depths being 15, 18, and 25 fathoms. The catch amounted to 947 fishes, 831 being marketable and 116 unmarketable. There were 461 witches, all marketable and mostly large; 17 plaice, all marketable and consisting of large and mediums; 1 megrim was also taken, as well as a number of dabs. Among the round-fishes were 312 haddocks, of which 281 were marketable, 279 of them being mediums, and 2 large. There were 14 cod, 10 codlings, a hake, and a gurnard.

Altogether, in the four drags taken in the deepish water to the east of the Suters of Cromarty, the actual duration of trawling being fourteen hours and thirty-five minutes, the aggregate number of fishes caught was 5158, of which 4318 were marketable and 840 were unmarketable. The particulars as to the different fishes are shown in the following Table, the marketable being distinguished from the unmarketable.

	Cod.	Codling.	Haddock.	Whiting.	Coalfish.	Pollack.	Hake.	Gurnard.	Turbot.	Brill.	Plaice.
I.	62	22	1,302	55	2	1	4	-	1	5	631
II.	-	5	116	11	-	-	-	6	-	-	3
Total	62	27	1,418	66	2	1	4	6	1	5	634

	Lemon Dab.	Com. Dab.	Witch.	Megrim.	Long Rough Dab.	Flounder.	Herring.	Angler.	Thornback.	Grey Skate.
I.	6	177	1,920	1	-	2	2	29	76	20
II.	-	384	81	-	197	-	-	22	15	-
Total	6	561	2,001	1	197	2	2	51	91	20

The vessel then proceeded to the Dornoch Firth, where some hauls were taken, but the catches were not as a rule very large. The first was made on the 9th February, mostly in 10 and 12 fathoms, and it lasted for four hours and a half. The number of fishes caught was 1195, of which 942 were marketable and 253 unmarketable. Plaice were most numerously represented, the number being 805, of which 740 were marketable and 65 unmarketable; the former consisted of 2 large, 106 mediums, 260 thirds, and 372 fourths The other flat-fishes included 1 brill, 4 lemon dabs, 199 common dabs, and 166 flounders. Round-fishes were practically absent, being represented only by 2 small haddocks. The next haul was for an hour, with the small-meshed net around the cod-end of the otter-trawl. In the latter the number of fishes amounted to 277, of which 138 were marketable. The plaice numbered 240, of which 115 were marketable and 125 too small to be marketable. There were also 18 flounders and 9 small common dabs. Round-fishes again were represented by only 2 small, unmarketable haddocks. The third drag in the Dornoch Firth, in from about 4½ to 12 fathoms, lasted for four hours and ten minutes, and the number of fishes taken was 950, the number marketable being 624 and the unmarketable 326. The catch included 788 plaice, most of them being small; 312 were too small to be marketable, and of the 476 marketable, 254 belonged to the fourth class, 143 to the third, and 79 to the second (mediums). Among the flat-fishes were also no less than 140 flounders, while the common dabs numbered 8. Haddocks were represented by a single unmarketable specimen, and there were no other round-fishes.

Omitting the haul with the small-meshed net around the cod-end of the otter-trawl, the total number of fishes taken in the two ordinary hauls, representing eight hours and forty minutes' trawling, was 2145, of which 1566 were marketable and 579 unmarketable. The particulars in regard to the different species of fish, marketable and unmarketable, are as follows:—

	Haddock.	Brill.	Plaice.	Lemon Dab.	Common Dab.	Flounder.	Angler.	Thornback.
I.	2	1	1,216	4	17	306	-	20
II.	1	–	377	–	190	-	3	8
Total	3	1	1,593	4	207	306	3	28

The numbers of the different kinds taken in the small-meshed net may be contrasted with the numbers taken in the trawl net.

	In Otter-trawl.	In Small-meshed Net outside Trawl Net.
Haddock,	2	1
Whiting,	—	628
Codling,	—	7
Gurnard,	—	8
Plaice,	240	355
Common Dab,	9	524
Long Rough Dab,	—	6
Small or Yellow Sole,	—	6
Herring,	—	8
Sprat,	—	15
Armed Bullhead,	—	6
Goby, sp.,	—	3
Sand-eel,	—	3
Pipe-fish,	—	6
Flounder,	18	—
Angler,	3	—
Thornback,	5	—
	277	1576

In the hour's drag a total of at least 1853 fishes had entered the trawl, of which it retained 277, while the remaining 1576 escaped through the meshes of the trawl and were retained by the small-meshed net. The result shows that haddocks, both big and little, were practically absent from the grounds in the Dornoch Firth which were fished over at the time; that small whitings, too small to be taken in the otter-trawl, were present in large numbers, while large whitings were absent, and that small codling were there in inconsiderable numbers. No codling or whiting were caught in any of the hauls with the ordinary net. The large number of small plaice which escaped from the trawl net is also noteworthy, and still more, the common dabs. On the other hand, while 18 flounders were taken in the otter-trawl, none were got in the small-meshed net, the smaller flounders not making their way into water of 6½ fathoms depth, but remaining close in on the beach and the brackish water. The abundance of large flounders in the deepish water at this time of year is in agreement with what has been found on other occasions,* and is referred to more fully below. The presence of young gurnards may be noted.

After leaving the Dornoch Firth, the grounds east of the Suters of Cromarty were again visited, as above stated, and an attempt was then made to go to Smith Bank, but owing to the strong wind and high sea the vessel was forced to turn, and it then proceeded to Aberdeen Bay. Here a haul was made off the Quarries, on February 11th, in from eight to twelve fathoms of water; it lasted for an hour, the small-meshed net being attached as described above. There was a strong north-west breeze and a rough sea, and the number of fishes taken in the otter-trawl was only 60, 47 being marketable and 13 unmarketable. The catch consisted of 7 cod, 20 codlings, all marketable, 14 marketable haddocks, and 3 whitings among the round-fishes, while the flat-fishes were represented by only 7 common dabs, no plaice being taken, and there were also 9 starry rays.

* *Twenty-first Annual Report, Part III.*, p. 44.

A second haul, for three hours and forty minutes, in from 10 to 12 fathoms, was made in the same locality, the number of fishes secured being 252, an extremely poor catch. The marketable numbered 162 and the unmarketable 90. Round-fishes were again most numerous; there were 5 cod, 35 codling, all but 3 marketable, 146 haddocks, of which 121 were marketable, 12 unmarketable whitings, and 6 gurnards. Flat-fishes were scarce, and consisted of 3 medium-sized plaice, a single flounder, and 12 common dabs.

The fish contained in the small-meshed net numbered 490, and belonged to eleven species. The particulars for each of the nets are as follows:—

	Otter-trawl.	Small-meshed Net.
Cod,	7	—
Codling,	20	16
Haddock,	14	—
Whiting,	3	150
Gurnard,	—	2
Lesser Weaver,	—	1
Goby, sp.,	—	4
Armed Bullhead,	—	2
Plaice,	—	2
Common Dab,	7	18
Herring,	—	3
Sprat,	-	291
Pipe-fish,	—	1
Starry Ray,	9	—
	60	490

The quantity of fish landed at the market by the vessel as a result of this trip was as follows, the particulars having been supplied by the Fishery Officer; the total weight being 151¾ cwts.:—

Cod.	Codling.	Coal-fish.	Haddock.	Whiting.	Cat-fish.	Angler.	Hake.	Turbot.
24½	3¾	1⅗	12¾	1¼	3	5	3/16	¾

Halibut.	Lemon Dab.	Plaice.	Brill.	Common Dab.	Witch.	Flounder.	Skate.
¼	½	52¼	2¼	3¼	28¼	4	8

Remarks on the Maturity of the Fishes.

During the investigations carried on in February a number of observations were made by Dr. Williamson, who had been requested to determine in as many cases as possible the condition of sexual maturity of the fishes, especially by using pressure in the ordinary way to see whether ripe eggs or spermatic fluid could be squeezed out, or to note whether the fish were spawning. In the hauls made at Burghead Bay between the 7th and 9th February, 2 of the male cod taken were found to be quite ripe, but none of the females appeared to be ripe; the number of cod caught was over 60. The ripe males were obtained about four miles off, in from 18 to 30 fathoms of water. Of 4 coal-fishes captured in these hauls, 3 were males and 1 was a female; the 3 males were ripe and "running" and the female was ripe and had transparent eggs.

Some of the plaice which were taken were also found to be ripe, though the great majority were immature. The number measured and examined by Dr. Williamson at Burghead Bay was 1534, and of these, so far as could be observed, 3 males and 5 females were ripe, 4 of the females being

in reality spent, but a few mature eggs could still be squeezed from them. The sizes of these were as follows :—Males, 392, 420, 440 mm. ; females, 520, 530, 595, 625, 685 mm. These fishes were got in from 12 to 25 fathoms. Besides these, 3 males and 43 females were nearly ripe, the sizes of which were as follows, in millimetres :—

Males—395, 415, 436 mm.

Females—386, 388, 391, 392, 393, 400, 400, 403, 409, 412, 412, 415, 419, 420, 420, 420, 420, 420, 431, 435, 440, 443, 445, 456, 457, 460, 460, 461, 470, 476, 481, 488, 501, 505, 508, 510, 530, 550, 564, 595, 634, 655, 674.

The smallest of the females indicated as immature measured 21·8 cm., and the largest 46 cm. ; the smallest of the males was 20·5 cm., and the largest 43 cm.

Four nearly ripe female plaice were also obtained in one of the hauls in from 23 to 29 fathoms, five miles off the Suters of Cromarty. Their sizes were as follows :—498, 511, 561, 704 mm.

In the previous year, at the very end of March (30th and 31st), a few spawning and spent plaice were taken at the outer part of Dornoch Firth, but they were not numerous.*

In a previous year at the latter part of January and in the middle of February, spawning plaice were got in large numbers on Smith Bank and a little to the south of it.†

Only one ripe haddock was found ; it was a male, one of 62 large specimens caught in 23-29 fathoms, five miles east of the Suters of Cromarty, on 7th February. Haddocks, however, and especially large haddocks, were very scarce during the trip.

Flounders, which were taken in large numbers, were not as a rule quite ripe. Ripe males were obtained a few miles off Burghead in from 17 to 25 fathoms, and ripe males and females were taken in the Dornoch Firth. Most of the females were full and nearly ripe, but not spawning. As previously stated, flounders migrate to the deeper waters offshore in spring, for the purpose of spawning, and are then caught in the trawl in considerable numbers. A large one was caught in from 23 to 29 fathoms, about 5 miles off the Suters of Cromarty. In the Dornoch Firth as many as 140 and 166 were taken in single hauls.

None of the turbot or brill taken were ripe. The number of these fishes got at Burghead Bay was large, viz., in the nine hauls 146 brill and 21 turbot. Five brill and a turbot were also secured in the deeper water off the Suters of Cromarty. In one of the hauls off Burghead, 37 brill were captured, in another 21, and in a third 18. All the specimens of both species were large enough to be marketable, which is the usual experience ; and their abundance was no doubt associated with the presence of herrings on the ground.

II.

At the end of March a series of trawlings was made in Aberdeen Bay by the steam-trawler "Fifeness," from the morning of the 27th to the morning of the 29th. Fish were remarkably scarce, with the exception of cod and codling, of which a considerable number were taken. Haddocks were practically absent from the grounds, only a few being got. The wind during the continuance of the work was from the south-east at first, and later from the south-west, and it was a moderate breeze. The first ordinary haul was taken in from 6 to 10 fathoms, between Donmouth

* *Twenty-third Annual Report, Part III.*, p. 21.
† *Seventh Annual Report, Part III.*, p. 171.

and "Black Dog," and it lasted for three hours and five minutes. The total number of fishes caught was 232, consisting of 208 marketable and 24 unmarketable. Among the former were 50 cod, of a rather small size, known as "half-cod," as well as 46 codling, 100 plaice, all but 2 marketable and of medium size, 5 flounders, a common dab, and 30 starry rays. The second haul, for four hours and ten minutes, off Newburgh, in 6 to 12 fathoms, yielded only 158 fishes, the marketable numbering 135. They consisted of 29 cod, 38 codling, 23 plaice, and a few others, including 62 starry rays. The third haul, a little further to the north, in about the same depths, for three hours and fifty minutes, yielded 297 fishes, of which 292 were marketable. Cod were less numerous, numbering 4; there were also 9 codling, a few dabs and starry rays, and a lumpsucker, while on this occasion the catch of plaice was relatively large, viz., 258, most of them being medium, and 9 large. The numbers in other hauls were even less.

Altogether, in six recorded hauls, representing twenty hours and thirty-five minutes of actual trawling, the total number of fishes taken was only 1018, consisting of 937 marketable and 81 unmarketable. The particulars are as follows, the marketable being indicated on the first line:—

	Cod.	Codling.	Haddock.	Whiting.	Plaice.	Flounder.	Com. Dab.	Starry Ray.
I.	90	119	3	10	567	9	55	84
II.	-	1	-	7	2	1	21	49
Total	90	120	3	17	569	10	76	133

Two hauls were made with the small-meshed net around the cod-end, the first in from 6 to 10 fathoms between Donmouth and "Black Dog," and it lasted for one hour and five minutes. The number of fishes in the otter trawl was only 30, consisting of 21 codling, 2 plaice, 2 whiting, and 5 starry rays. In the small-meshed net outside the cod-end were 154 small dabs measuring from 29 mm. ($1\frac{1}{8}$ inches) to 177 mm. (3 inches), as shown on page 252.

The second haul was taken in deeper water, about 3 miles off Girdleness, the depth being from 18 to 25 fathoms, and it lasted for seventy minutes. In the otter trawl, which was torn, there were 76 fishes, and in the small-meshed net 718, as follows:—

	In Trawl.	In Small-meshed Net.
Codling,	9	6
Ling,	3	—
Haddock,	19	314
Whiting,	3	364
Norway Pout,	—	9
Turbot,	1	—
Plaice,	14	—
Lemon Dab,	6	—
Common Dab,	21	5
Long Rough Dab,	—	16
Herring,	—	4
	76	718

The quantity of fish, as returned by the officer, which was landed at the market, as the result of twelve hauls and forty-one hours and fifty-five minutes actual trawling, was 47 cwts., as follows :—

Cod.	Codling.	Ling.	Turbot.	Halibut.	Lemon Dab.	Plaice.	Dabs.	Skate.
$17\frac{1}{4}$	8	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{8}$	$16\frac{7}{8}$	2	2

III.

The next series of trawlings was made by the steam trawler "Star of the Ocean" in the Moray Firth at the end of September and the beginning of October, and the trip was not a very productive one. Fairly good catches of plaice were obtained in the Dornoch Firth and at Burghead Bay, but they were mostly small, and marketable haddocks were scarce. On the other hand, small haddocks, too small to be marketable, were very abundant, and the same was the case with small unmarketable plaice.

The first place visited was Burghead Bay, where a haul was taken on 28th September for two hours and five minutes, in from 5 to 12 fathoms of water. The number of fishes caught was 2470, of which 803 were marketable and 1667 unmarketable. Haddocks and plaice were most abundant. The number of haddocks taken was 1423, but only 73, which were of medium size, were marketable, the other 1350 being too small for market. Of a total of 738 plaice, all but 16 were marketable, but by far the greater proportion were small, viz., 711. Among the other flat-fishes were 2 brill, a lemon dab, and 208 common dabs.

The vessel then steamed to the Dornoch Firth, where a number of hauls were made off Dunrobin Castle. The first, in from 5 to 15 fathoms, lasted for four hours and five minutes, the total number of fishes taken being 2909. Most of them were unmarketable, viz., 1994, while the other 915 were marketable. The catch consisted mostly of plaice and small haddocks. The plaice numbered 2095, of which 828 were marketable and 1267 unmarketable. The former consisted of 23 large, 30 medium, and 775 small. Among the flat-fishes were fourteen lemon dabs and 1 witch. All the haddocks taken, 549 in number, were too small to be marketable; all the 52 whitings caught were also unmarketable. The catch included 19 cod, 57 codling, 11 of which were unmarketable, 51 gurnards, and a number of dabs. The next drag, which was for four hours in much the same depth of water, yielded 814 marketable and 630 unmarketable fishes, a total of 1444. The haddocks numbered 424, all but 24 being unmarketable. There were 967 plaice, of which 215 were unmarketable, and 12 lemon dabs. Rather an unusual feature was the presence of 19 mackerel among the other fishes. It is not very uncommon for an odd mackerel to be taken in the course of these trawlings, but rarely so many are captured. The next haul, in from about $6\frac{1}{2}$ to 15 fathoms, and which lasted two hours and fifty-five minutes, yielded the large total of 4833 fishes, 1172 being marketable and 3661 unmarketable. Haddocks were very numerous, the total being 2291, but only 36 of these were marketable; all the rest were thrown overboard. The only other round-fishes present were 3 codling, 1 whiting, and 63 gurnards. Plaice were even more numerous than the haddocks, the total number being 2465, and 1123 of them were marketable and 1342 unmarketable; of the former 7 were large, 86 medium, and 1030 small. A mackerel was taken in this catch and also five lemon dabs.

In the next drag, in from 6 to 15 fathoms, which lasted four hours and five minutes, the large total of 6447 fishes were caught, 1559 being marketable and no less than 4888 unmarketable. Plaice were most

numerous, the total number being 3908, of which 1430 were marketable and 2478 unmarketable; the former included 2 large, 100 medium, and 1328 small. The number of haddocks taken was 1888, of which 122 were marketable and 1766 unmarketable. Five codling, 2 lemon dabs, and a number of common dabs and gurnards were comprised in the catch.

The succeeding two drags were also exceedingly productive as far as the number of fishes was concerned. In one, made in from 8 to 15 fathoms, and lasting for four hours and twenty-five minutes, the total catch amounted to 5991, of which 916 were marketable and 5075 unmarketable. The latter filled nearly twenty baskets. The number of plaice caught was 1623, 754 being marketable and 869 unmarketable—the great proportion of the former being small, as in the previous drags. Of 4091 haddocks, only 141 were of marketable size, 100 of them being large and 41 medium. The other 3950 were thrown away. Eleven codling were taken in this haul, as well as a turbot, 6 lemon dabs, and a number of unmarketable common dabs. The next haul, in the same locality for four hours and fifteen minutes, yielded 3939 fishes, of which 1378 were marketable and 2561 unmarketable. The plaice numbered 2552, the marketable aggregating 1273 and the unmarketable 1279. The other flat-fishes were 11 lemon dabs and 67 common dabs. The haddocks numbered 1118, of which 71 were marketable and 1047 unmarketable. Three mackerel were taken in this drag.

Altogether, in the six recorded hauls in the Dornoch Firth, the duration of actual trawling being 23 hours and 45 minutes, the aggregate number of fishes taken was 25,563, of which 6754 were marketable and 18,809 unmarketable, the percentage of the former being 26·5 and of the latter 73·5. The proportion of the unmarketable fishes was thus very large and far above what is usual. In the February hauls the proportion was almost exactly reversed, there being then 73 per cent. of the total catch marketable and 27 per cent. unmarketable. The particulars of the marketable and unmarketable of each kind of fish are as follows:—

	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Plaice.	Turbot.
I.	19	77	394	1	-	6,160	1
II.	-	12	9,967	52	458	7,450	-
Total	19	89	10,361	53	458	13,610	1

	Common Dab.	Lemon Dab.	Witch.	Long Rough Dab.	Mackerel.	Angler.	Thornback.
I.	7	50	1	-	23	-	21
II	828	-	-	23	-	16	3
Total	835	50	1	23	23	16	24

From this it will be seen that the total number of haddocks caught in the six hauls was 10,361, and of these 9967, or 96 per cent., were unmarketable, while the total number of plaice taken was 13,610, of which 7450, or 54 per cent., were unmarketable. The difference between

the February and September hauls in regard to the numbers of small unmarketable fishes may be contrasted by comparing the numbers taken per hour's fishing, as follows :—

	Marketable.	Unmarketable.	Total.
February	181	67	248
September	284·4	791·9	1076·3

The proportion of small plaice and especially small haddocks, differed very much, as the following figures of the numbers taken on each occasion per hour's fishing show.

	Haddock.			Plaice.		
	Marketable.	Unmarketable.	Total.	Marketable.	Unmarketable.	Total.
February, -	0·23	0·11	0·34	140·4	43·5	184
September, -	16·6	419·6	436·2	259·3	313·7	573

The circumstances show to what an extent the capture of immature specimens of these fishes may take place at some seasons in bays by the use of the trawl-net. All the young haddocks taken in this way probably perish, and there is no doubt that the great majority of the young plaice perish likewise, although, apart from previous experiments recorded on the point, there are reasons for supposing that under favourable conditions a considerable number may survive. Thus, in February, Dr. Williamson observed that some of the small plaice which had been lying all night in a basket along with a number of other small fish taken in the small-meshed net were alive at 10.30 next morning. When placed in a bucket of sea water they swam about freely.

After leaving the Dornoch Firth, a haul, which lasted two hours and twenty minutes, was made outside the entrance to Cromarty Firth, the depth being about twelve fathoms. The catch was a small one, consisting of 479 fishes, of which 182 were marketable and 297 unmarketable. Haddocks were present in greatest abundance, 395 being taken, of which 141 were marketable and 254 unmarketable. The other round-fishes comprised 2 cod, 7 codling, 2 small whiting, and 4 gurnards. The number of plaice was 61, of which 35 were marketable and 26 unmarketable; the only other flat-fish represented was the common dab, of which there were 6.

Burghead Bay was then visited and a number of hauls taken in depths ranging from about 5 to 15 fathoms. In the first, in from 5 to 12 fathoms, which lasted for four hours and thirty-five minutes, 3901 fishes were secured, 1479 being marketable and 2422 unmarketable. Plaice and haddocks formed the bulk of the catch. Of the former the number obtained was 1460, of which 1194 were marketable and 266 unmarketable —a proportion contrasting with the condition in the Dornoch Firth. Small haddocks were, however, very numerous, for of a total of 1334 haddocks caught only 29 were marketable, the remaining 1305 being too small to be taken to market. The catch included among round-fishes 1

cod, 7 codling, 13 whiting, and 159 gurnards, and the other flat-fishes were 9 brill, 10 lemon dabs, 7 witches, and 866 common dabs. The next haul, for four hours and five minutes, in from 8 to 12 fathoms, was less productive, the total number of fishes taken being 791, of which 591 were marketable and 200 unmarketable. No marketable haddocks were obtained, and only 56 unmarketable. There were 7 brill, 4 lemon dabs, 120 common dabs, and 559 plaice, of which 535 were marketable and 24 unmarketable.

Several other drags were made in the same locality, in some of which the net was badly torn and the catches were small. The particulars in regard to three of them, in which this did not occur, are as follows. In the first, in from 8 to 14 fathoms, and which lasted for four hours and twenty minutes, the number of fishes secured was 2218, those marketable numbering 1162, and the unmarketable 1056. The most abundant of the fishes was plaice, which totalled 1220, of which 1012 were marketable and 208 unmarketable. Common dabs were also numerous, the total being 622, but 492 of them were unmarketable. Other flat-fishes included 1 turbot, 12 brill, and a lemon dab. The total of haddocks was 101, only 5 being marketable; there were also 9 codling and 216 gurnards. The next haul, which lasted for four hours and fifteen minutes, and was made in water of from 8 to 13 fathoms depth, yielded 1569 fishes, 854 being marketable and 715 unmarketable. Plaice, common dabs, and haddocks formed the bulk of the catch. The plaice numbered 792, of which 690 were marketable and 102 unmarketable. Three brill and a black or common sole were also taken, as well as 268 common dabs, 14 witches, and 5 lemon dabs. In the third of the hauls, lasting for four hours and a half, and in the same depths, 1898 fishes were obtained, 931 being marketable and 967 unmarketable. The plaice numbered 919, of which 826 were marketable and 93 unmarketable. There were 416 small haddocks, all being unmarketable. Other round-fishes included 6 codling, 103 whiting, and 38 gurnard. There were also 398 common dabs and 3 lemon dabs.

In the five drags collectively, the time of trawling occupying 21 hours and 45 minutes, the total number of fishes taken was 10,377, the marketable numbering 5017, or rather over half the aggregate number. The particulars of the marketable and unmarketable of the various kinds are given in the following table:—

	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Turbot.	Brill.	Plaice.
I.	1	4	62	13	-	1	31	4,257
II.	-	36	2,198	164	468	-	-	693
Total	1	40	2,260	177	468	1	31	4,950

	Lemon Dab.	Witch.	Common Dab.	Sole.	Long Rough Dab.	Angler.	Thorn-back.
I.	23	17	585	1	-	5	17
II.	-	4	1,689	-	50	50	8
Total	23	21	2,274	1	50	55	25

The average numbers per hour's trawling of the total fishes, the marketable and unmarketable, and of the plaice and haddocks are as follows:—

	Marketable.	Unmarketable.	Total.
All kinds, . .	230·7	246·4	477·0
Plaice, . . .	195·7	31·8	227·6
Haddock, . .	2·9	101·0	103·9

They furnish a strong contrast to the corresponding figures for the Dornoch Firth.

The quantity of fishes, in cwts., landed at the market as the result of this trip is given in the following Table, the total amounting to $123\frac{1}{4}$ cwts :—

Cod.	Codling.	Haddock.	Turbot.	Halibut.	Lemon Dab.	Plaice.
$3\frac{1}{4}$	2	5	$\frac{1}{4}$	$\frac{1}{8}$	1	99

Brill.	Common Dab.	Witch.	Skates.
$1\frac{1}{8}$	$5\frac{1}{4}$	$\frac{1}{4}$	6

Of the plaice, there were $5\frac{3}{4}$ cwts. of large, $25\frac{1}{4}$ cwts. of medium, and 68 cwts. of small.

IV.

At the beginning of November another series of hauls was made in the Moray Firth, mostly at Burghead Bay and in the Dornoch Firth, but also on the Caithness coast. The weather was rather stormy, and the vessel, the "Cairntoul," had to be run for shelter to the Cromarty Firth. The fishing turned out to be poor from the market point of view, haddocks especially, which usually form an important item in the catch, being extremely scarce.

The first haul at Burghead Bay, in from 8 to 10 fathoms of water, was for three hours and five minutes, and the total number of fishes taken was large, viz., 4331. They consisted, however, mostly of unmarketable fish, the marketable numbering 780 and the unmarketable 3551. Plaice was by far the most important, the total being 1005, of which 679 were marketable and 326 too small for market. One turbot and 7 brill were among the flat-fishes, as well as a few common dabs. A feature of the catch was the large numbers of small unmarketable haddocks that were taken. They totalled 2852, whereas not a single haddock of marketable size was taken. There were also 23 unmarketable codling, 90 whitings, and 117 gurnards. In the next haul, in the same locality, the depth being from 8 to 13 fathoms and the duration of the haul three hours and fifteen minutes, 3859 fishes were secured, of which 324 were marketable and 3535 unmarketable. The former were made up entirely of plaice, with a few dabs and two thornbacks; the plaice numbered altogether 445, of which 301 were marketable. All the round-fishes were unmarketable, and they comprised 2748 haddocks, 198 whiting, 47 codling, and 204 gurnards.

The total number of fishes taken in the two drags, the time of actual trawling being six hours and twenty minutes, was 8190, of which 1104 were marketable and 7086 unmarketable. The particulars are as follows:—

	Codling.	Haddock.	Whiting.	Gurnard.	Turbot.
I.	-	-	-	-	1
II.	70	5,600	288	321	-
Total	70	5,600	288	321	1

[*Continued.*

	Brill.	Plaice.	Common Dab.	Long Rough Dab.	Thornback.
I.	7	980	107	-	9
II.	-	470	330	7	-
Total	7	1,450	437	7	9

The steamer then went to the Dornoch Firth, where some hauls were taken on the usual ground. The catches here contrasted with those at Burghead Bay in that round-fishes of marketable sizes were present, though not in great numbers, but the small haddocks were still abundant. The first drag, in 8 to 13 fathoms, which lasted for three hours and ten minutes, yielded 2557 fishes, of which 188 were marketable and 2369 were unmarketable. There were 7 cod and 12 codling, all marketable, and the haddocks numbered 2358, consisting of 88 which were marketable and 2270 which were unmarketable. There were also 14 marketable whiting, 1 coalfish, and 27 gurnards. The plaice numbered only 69, 51 of which were marketable, and the other flat-fishes comprised 14 lemon dabs and 55 common dabs.

The next haul, in from 6 to 10 fathoms, which lasted for three hours and twenty minutes, yielded 1013 fishes, consisting of 227 marketable and 786 unmarketable. The catch included 2 cod, 29 codling, 11 of them marketable, 118 whiting, mostly small, and 14 gurnards. The haddocks numbered 641, of which 59 were marketable and 582 unmarketable. The plaice comprised 143 marketable specimens and 39 unmarketable, and there were a few common dabs.

In the two drags made in the Dornoch Firth and completely recorded, the actual time of trawling being six hours and a half, the aggregate catch was 3570 fishes, of which 415 were marketable and 3155 unmarketable. The particulars as to the marketable and unmarketable of the different species are as follows :—

	Cod.	Codling.	Haddock.	Whiting.	Coal-fish.
I.	9	23	147	26	1
II.	-	18	2,852	106	-
Total	9	41	2,999	132	1

	Gurnard.	Plaice.	Lemon Dab.	Common Dab.	Angler.
I.	-	194	6	9	-
II.	41	57	8	72	1
Total	41	251	14	81	1

On leaving the Dornoch Firth the vessel steamed up the coast and took some hauls off Lybster and Noss Head; the weather was bad and the catches poor, though a number of cod were obtained. In a haul for three hours and twenty minutes off Lybster, in from about 18 to 30 fathoms, the total number of fishes caught was 356, of which 110 were marketable. There were 40 cod and 63 codling, all, except one, of marketable size, but haddocks were scarce, only 28 being taken, and all of

them unmarketable; there were also 13 unmarketable whitings, 10 plaice, and 202 gurnards. The catch off Noss Head was not completely recorded, but it included a number of cod and codling, and three baskets of gurnards.

The weather at this time was very bad, a strong wind blowing from the south-east, and the sea was high. The vessel left the Caithness coast and steamed to Burghead Bay, where some more hauls were taken. Fairly good catches of plaice were got, but marketable round-fishes were practically absent, while the small unmarketable haddocks were much less abundant than on the previous visit a few days before. The first drag, in from about 6 to 10 fathoms, lasted for four hours and five minutes, the catch numbering 1026 fishes, of which 541 were marketable and 485 unmarketable. The marketable fishes were confined to flat-fishes, viz., 2 brill, 535 plaice, and 4 common dabs; there were also 21 unmarketable plaice and 71 unmarketable dabs. There were 332 small haddocks, 22 small whitings, and 36 gurnards, all unmarketable.

The number of fishes taken in the second haul, in from about 5 to 9 fathoms, and which lasted for four hours and five minutes, was 1858, the marketable amounting to 1037 and the unmarketable to 821. Among the round-fishes were 1 cod, 5 small codling, 606 haddocks, all small and unmarketable, 52 unmarketable whiting, and 19 gurnards. The flat fishes comprised 3 turbot, 2 brill, 1046 plaice, of which 1015 were marketable, 1 witch, and 116 common dabs. In the third haul, in the same locality and depth, the number of fishes taken amounted to 1029, the haul lasting for four hours. The number marketable was 723, and there were 306 unmarketable. With the exception of one codling, all the marketable fishes consisted of flat-fishes. They comprise d4 turbot, 7 brill, 695 plaice, and 16 common dabs; there were also 38 unmarketable plaice and 115 unmarketable dabs. The round-fishes included 9 codling, 57 unmarketable haddocks, 15 whiting, and 71 gurnards.

Altogether in these three recorded hauls in Burghead Bay, the actual duration of the trawling operations being 12 hours and 10 minutes, the aggregate number of fishes captured was 3913, of which 2301 were marketable and 1612 unmarketable. The particulars as to the marketable and unmarketable of the various species are given in the following Table:—

Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Turbot.	Brill.	Plaice.
1	1	-	-	-	7	11	2,245
-	13	995	89	126	-	-	90
1	14	995	89	126	7	11	2,335

Common Dab.	Witch.	Long Rough Dab.	Angler.	Thornback.
32	1	-	-	3
290	-	5	4	-
322	1	5	4	3

As a result of the week's working in the Moray Firth, during which 19 hauls were made, the total quantity of fish landed at the market by the vessel was 66½ cwts. As already stated, the weather was severe during most of the time and the steamer had to run for shelter on two occasions. The quantities of the different kinds of fish landed were as follows:—

Cod.	Codling.	Saithe.	Haddock.	Catfish.	Turbot.	Lemon Dab.
10¾	3	3/10	1½	⅛	⅝	½

Plaice.	Brill.	Common Dab.	Witch.	Thornback.
44½	1	1½	1½	2

TRAWLING INVESTIGATIONS—TABLE I.

Place	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
1. Burghhead Bay.	1905. Feb. 6.	..	..	..	5–12	3.0 p.m.	7.0 p.m.	Cod, ...	2	..	2	Wind W.; light.
								Codling, ...	7	9	16	
								Haddock (1), ..	1	..	..	
								,, (2), ..	..	..	..	
								,, (3), ..	38	..	..	
									— 39	5	44	
								Whiting, ...	18	8	26	
								Cat-fish, ...	2	..	2	
								Halibut, ...	1	..	1	
								Turbot, ...	3	..	3	
								Brill, ...	13	..	13	
								Plaice (1), ..	1	..	..	
								,, (2), ..	162	..	..	
								,, (3), ..	129	..	..	
									—292	..	292	
								Witch (1), ..	100	..	100	
								Lemon Dab, ..	1	..	1	
								Com. Dab, ..	26	48	74	
								Flounder, ...	7	..	7	
								Herring, ...	..	3	3	
								Angler, ...	..	12	12	
									511	85	596	
2. ,,	,,	..	..	..	,,	7.35 p.m.	11.40 p.m.	Cod, ...	7	..	7	Wind W. by S.; fresh breeze.
								Codling, ...	11	..	11	
								Haddock (1), ..	4	..	..	
								,, (2), ..	.	..	..	
								,, (3), ..	22	..	..	
									— 26	..	26	
								Whiting, ...	9	..	9	
								Halibut, ...	1	..	1	
								Turbot, ...	3	..	3	
								Brill.	14	..	14	
								Plaice (1), ...	1	..	..	
								,, (2), ...	245	..	..	
								,, (3), ...	178	..	..	
								,, (4), ...	68	..	..	
									—492	..	492	
								Witch (1), ...	49	..	49	
								Com. Dab, ..	100	60	160	
								Thornbacks, ..	..	12	12	
								Angler, ...	..	8	8	
									712	80	792	
3. ,,	Feb. 7.	45·7	41·7	44·0	,,	5.0 a.m.	9.0 a.m.	Cod, ...	4	..	4	
								Codling, ...	28	..	28	
								Haddock (1), ..	1	..	..	
								,, (3), ..	42	..	..	
									— 43	..	43	
								Whiting, ...	14	..	14	
								Brill, ...	37	..	37	
								Plaice (1), ..	6	..	..	
								,, (2), ..	154	..	..	
								,, (3), ..	145	..	..	
								,, (4), ..	70	..	..	
									—375	..	375	
								Lemon Dab, ..	5	..	5	
								Witch (1), ...	178	..	178	
								Com. Dab, ...	79	75	154	
								Flounder, ...	5	..	5	
								Thornback, ..	..	6	6	
								Angler, ...	..	14	14	
									768	95	863	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
4. Off Burghead Bay.	1905. Feb. 7.	45·0	42·5	43·0	17–20	1.50 p.m.	6.0 p.m.	Cod, ...	12	..	12	Burghead bearing S.S.E.
								Codling, ...	22	..	22	
								Haddock (1), ..	10	..	..	
								,, (2), ..	2	..	..	
								,, (4), ..	201	..	..	
									—213	64	277	
								Whiting (2), ..	43	2	45	
								Coal-fish, ...	2	..	2	
								Cat-fish, ...	2	..	2	
								Turbot, ...	3	..	3	
								Brill, ...	4	..	4	
								Plaice, ...	273	..	273	
								Lemon Dab (1), ..	2	..	..	
								,, (2), ..	1	.	..	
									— 3	..	3	
								Witch (1), ...	367	..	..	
								,, (2), ...	4	.	..	
									—371	..	371	
								Com. Dab, ...	40	201	241	
								Flounder, ...	3	..	3	
								Herring, ...	7	.	7	
								Thornback, ..	13	..	13	
								Angler, . ..	..	17	17	
									1,011	284	1,295	
5. ,,	,,	..	..	..	17–21	6.40 p.m.	10.45 p.m.	Cod, ...	10	..	10	Nine berried edible crabs were taken.
								Codling, ...	..	4	4	
								Haddock (1), ..	2	..	..	
								,, (3), ..	83	..	..	
									— 85	63	148	
								Whiting, ...	39	17	56	
								Cat-fish, ...	2	..	2	
								Turbot, ...	1	..	1	
								Brill, ...	11	..	11	
								Plaice (1), ...	1	..	..	
								,, (2), ...	177	..	..	
								,, (3), ...	166	..	..	
								,, (4), ...	40	..	..	
									—384	..	384	
								Lemon Dab, ..	6	..	6	
								Witch (1), ...	466	62	528	
								Com. Dab, .. .	32	193	225	
								Long Rough Dab,	..	31	31	
								Thornback, ..	23	5	28	
								Angler, ...	22	4	26	
									1,081	379	1,460	
6. Burghead Bay.	Feb. 8.	..	..	..	17–20	4.30 a.m.	8.45 a.m.	Cod, ...	5	..	5	Of the plaice there were 4 large and 4 baskets medium, 2 baskets thirds, and ½ basket fourths.
								Codling, ...	5	4	9	
								Haddock (1), ..	1	..	..	
								,, (4), ..	45	..	..	
									— 46	18	64	
								Whiting (2), ..	5	7	12	
								Cat-fish, ...	2	..	2	
								Halibut, ...	1	..	1	
								Turbot, ...	4	..	4	
								Brill, ...	18	..	18	
								Plaice, ..	552	11	563	
								Lemon Dab, ..	4	..	4	
								Witch, ...	70	4	74	
								Com. Dab, ...	73	131	204	
								Long Rough Dab,	..	11	11	
								Flounder, ...	2	..	2	
								Black Sole, ..	1	..	1	
								Herring, ...	3	..	3	
								Angler, ...	10	..	10	
								Thornback, ..	19	2	21	
								Starry Ray, ..	1	..	1	
								Cuckoo Ray, ..	1	3	4	
									822	191	1,013	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
7. Burghead Bay.	1905. Feb. 8.	42·0	41·7	42·5	12–25	9.15 a.m.	1.30 p.m.	Cod, ...	3	..	3	The plaice consisted of 2 large, and of 3 baskets of medium, 2 of thirds, and ¼ basket of fourths.
								Codling, ...	20	7	27	
								Haddock (1), ..	5	..	..	
								,, (4), ..	55	..	..	
									— 60	7	67	
								Whiting, ...	9	6	15	
								Coal-fish, ...	2	..	2	
								Cat-fish, ...	1	..	1	
								Turbot, ...	3	..	3	
								Brill, ...	14	..	14	
								Megrim (1), ..	1	..	1	
								Plaice, ...	381	4	385	
								Lemon Dab, ..	2	..	2	
								Witch, ...	57	3	60	
								Com. Dab, ...	40	60	100	
								Flounder, ...	5	1	6	
								Long Rough Dab,	..	18	18	
								Angler, ...	..	1	1	
								Thornback, ..	1	1	2	
									599	108	707	
8. ,,	,,	..	..	..	7–10	1.48 p.m.	6.0 p.m.	Cod, ...	17	..	17	The plaice consisted of 3 baskets of mediums and 1½ of thirds.
								Codling, ...	3	3	6	
								Haddock, ...	..	2	2	
								Whiting, ...	1	1	2	
								Turbot, ...	2	..	2	
								Brill, ...	21	..	21	
								Plaice, ...	263	5	268	
								Lemon Dab, ..	2	..	2	
								Com. Dab, ...	16	20	36	
								Flounder, ...	7	..	7	
								Long Rough Dab,	..	1	1	
								Angler, ...	..	1	1	
								Thornback, ..	2	..	2	
									334	33	367	
9. ,,	,,	..	..	..	13–17	6.30 p.m.	10.40 p.m.	Cod, ...	5	..	5	
								Codling, ...	5	..	5	
								Haddock (3), ..	21	6	27	
								Whiting, ...	9	5	14	
								Cat-fish, ...	1	..	1	
								Turbot, ...	1	..	1	
								Brill, ...	14	..	14	
								Plaice (2), ...	219	..	..	
								,, (3), ...	177	..	..	
								,, (4), . ..	54	..	..	
									—450	6	456	
								Witch, ...	65	..	65	
								Com. Dab, ..	73	93	166	
								Long Rough Dab,	..	12	12	
								Herring, ...	4	..	4	
								Angler, ...	4	15	19	
								Thornback, ..	21	6	27	
									673	143	816	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
10. Five miles east of Suters of Cromarty.	1905. Feb. 9.	.	..	..	18 to 35	6.30 a.m.	10.0 a.m.	Cod, ...	16	..	16	There were 9 baskets of witches.
								Codling, ...	6	..	6	
								Haddock (1), ..	8	..	..	
								,, (2), ..	58	..	..	
								,, (3), ..	53	..	..	
									—119	13	132	
								Whiting, ...	21	..	21	
								Coal-fish, ...	1	..	1	
								Turbot, ...	1	..	1	
								Plaice (1), ...	2	..	..	
								,, (2), ...	7	..	..	
								,, (3), ...	4	..	..	
									— 13	..	13	
								Lemon Dab, ..	4	..	4	
								Witch (1), ...	610	..	..	
								,, (2), ...	182	..	..	
									—792	58	850	
								Com. Dab,.. ..	81	143	224	
								Long Rough Dab,	..	23	23	
								Angler, ...	7	7	14	
								Thornback, ..	33	..	33	
								Gray Skate, ..	19	..	19	
									1113	244	1357	
11. ,,	,,	..	..	..	23 to 29	10.25 a.m.	2.0 p.m.	Cod, ...	27	..	27	
								Codling, ...	10	1	11	
								Haddock (1), ..	52	..	..	
								,, (3), ..	431	..	..	
									—483	53	536	
								Whiting, ...	26	..	26	
								Coalfish, ...	1	..	1	
								Pollack, ...	1	..	1	
								Hake, .. .	2	..	2	
								Gurnard, ...	..	3	3	
								Brill, ...	3	..	3	
								Plaice (1), ...	4	..	..	
								,, (2), ...	129	..	..	
								,, (3), ...	99	..	..	
								,, (4), ...	43	..	..	
									—275	3	278	
								Lemon Dab, ..	2	..	2	
								Witch (1), ...	441	..	..	
								,, (2), ...	36	..	..	
									—477	16	493	
								Com. Dab,.. ..	78	164	242	
								Flounder, ...	1	..	1	
								Long Rough Dab,	..	119	119	
								Herring, ...	2	..	2	
								Angler, ...	4	4	8	
								Thornback, ..	18	..	18	
								Grey Skate, ..	1	..	1	
									1411	363	1774	
12. Dornoch Firth.	,,	45·1	42·5	43·0	10 to 12	4.50 p.m.	9.20 p.m.	Haddock, (3) :	2	..	2	
								Brill, ...	1	..	1	
								Plaice (1), ...	2	..	..	
								,, (2), ...	106	..	..	
								,, (3), ...	260	..	..	
								,, (4), ...	372	..	..	
									—740	65	805	
								Lemon Dab, ..	4	..	4	
								Com. Dab,.. ..	14	185	199	
								Flounder, ...	166	..	166	
								Thornback, ..	15	3	18	
									942	253	1195	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
13. Dornoch Firth.	1905. Feb. 9	..	..	..	6½ to 12	10.15 p.m.	11.15 p.m.	Haddock, ...	..	2	2	Small-meshed shot.
								Plaice (2), ...	46	..	..	
								,, (3), ...	53	..	..	
								,, (4), ...	22	..	..	
									—115	125	240	
								Flounder, ...	18	..	18	
								Com. Dab, ...	..	9	9	
								Angler	..	3	3	
								Thornback, ..	5	..	5	
									138	139	277	
14. ,,	Feb. 10.	..	..	..	4½ to 12	5.0 a.m.	9.10 a.m.	Haddock, ...	..	1	1	
								Plaice (2), ...	79	..	..	
								,, (3), ...	143	..	..	
								,, (4), ...	254	..	..	
									—476	312	788	
								Com. Dab, ...	3	5	8	
								Flounder, ...	140	..	140	
								Angler, ...	..	3	3	
								Thornback, ..	5	5	10	
									624	326	950	
15. Five miles east of the Suters of Cromarty.	,,	42·8	42·0	42·7	12 to 28	11.45 a.m.	3.0 p.m.	Cod, ...	5	..	5	
								Haddock (1), ..	7	..	..	
								,, (2), ..	412	..	..	
									—419	19	438	
								Whiting, ...	2	2	4	
								Hake, ...	1	..	1	
								Gurnard, ...	..	2	2	
								Brill, ...	2	..	2	
								Plaice (1), ...	4	..	..	
								,, (2), ...	150	..	..	
								,, (3), ...	115	..	..	
								,, (4), ...	57	..	..	
									—326	..	326	
								Witch, (1)	190	7	197	
								Com. Dab, ...	11	47	58	
								Flounder, ...	1	..	1	
								Long Rough Dab,	..	38	38	
								Thornback, ..	6	2	8	
									963	117	1080	
16 ,,	Feb. 11.	..	..	..	15 t 25	12.30 a m.	4.45 a.m.	Cod, ...	14	..	14	
								Codling, ...	6	4	10	
								Haddock (1), ..	2	..	..	
								,, (2), ..	279	..	..	
									—281	31	312	
								Whiting, ...	6	9	15	
								Hake, ...	1	..	1	
								Com. Gurnard, ..	..	1	1	
								Plaice (1), ...	3	..	..	
								,, (2), ...	14	..	..	
									— 17	..	17	
								Witch (1), ...	436	..	..	
								,, (2), ...	25	..	..	
									—461	..	461	
								Megrim, ...	1	..	1	
								Com. Dab, ..	7	30	37	
								Long Rough Dab,	..	17	17	
								Angler, ...	18	11	29	
								Thornback, ..	19	13	32	
									831	116	947	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface	Bottom		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
17. Five miles east of the Suters of Cromarty.	1905. Feb. 11.	..	..	..	..	5.20 a.m.		Cod, ...	1	..	1	Net badly split and catch small; Strong N.N.W. wind, increasing to a gale, with snow showers; sea very rough.
								Codling, .. .	3	1	4	
								Haddock, ..	1	4	5	
								Whiting, ...	..	1	1	
								Plaice (2), ...	4	..	..	
								,, (3), ...	8	..	..	
									— 12	..	12	
								Witch (1), ...	109	..	..	
								,, (2), ...	9	..	..	
									—118	..	118	
								Com. Dab, ...	..	12	12	
								Long Rough Dab,	..	8	8	
								Angler, ...	5	3	8	
									140	29	169	
18. Aberdeen Bay off the Quarries.	,,	..	..	..	8 to 12	6.40 p.m.	7·40 p.m.	Cod, ...	7	..	7	Small-meshed. Strong N.W. breeze; sea rough.
								Codling, ...	20	..	20	
								Haddock (2), ..	14	..	14	
								Whiting, ...	3	..	3	
								Com. Dab, ...	3	4	7	
								Starry Ray, ..	..	9	9	
									47	13	60	
19.	,,	..	..	..	10 to 12	8.20 p.m.	12.0 p.m.	Cod, ...	5	..	5	
								Codling, ...	22	3	35	
								Haddock (2), ..	121	25	146	
								Whiting, ...	..	12	12	
								Com. Gurnard, ..	..	6	6	
								Plaice (2), ...	3	..	3	
								Flounder, ...	1	..	1	
								Com. Dab, ...	..	12	12	
								Starry Ray, ..	..	32	32	
									162	90	252	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
1. Aberdeen Bay between Donmouth and Black Dog.	1905. Mar. 27.	..	5·3	..	6–10	6.20 a.m.	7.25 a.m.	Codling, ...	21	..	21	Small-meshed experiment. Wind S.E.; light breeze; sea moderate.
								Whiting, ...	..	2	2	
								Plaice (2), ...	2	..	2	
								Starry Ray, ..	5	..	5	
									28	2	30	
2.	,,	..	..	..	..	8.0 a.m.	11.5 a.m.	Cod, ...	50	..	50	
								Codling, ...	46	..	46	
								Plaice (2), ...	98	2	100	
								Flounder, ...	4	1	5	
								Com. Dab, ...	..	1	1	
								Starry Ray, ..	10	20	30	
									208	24	232	
3. Off Newburgh.	,,	..	..	..	6–12	11.55 a.m.	4.5 p.m.	Cod, ...	29	..	29	
								Codling, ...	38	..	38	
								Whiting, ...	1	1	2	
								Plaice (2), ...	23	..	23	
								Flounder, ...	3	..	3	
								Com. Dab, ...	1	..	1	
								Starry Ray, ..	40	22	62	
									135	23	158	
4. Off Newburgh and Old Castle.	,,	..	..	..	5½–11	4.30 p.m.	8.20 p.m.	Cod, ...	4	..	4	
								Codling, ...	9	1	10	
								Whiting, ...	..	3	3	
								Plaice (1), ...	9	..	..	
								,, (2), ...	249	..	..	
									—258	..	258	
								Com. Dab, ...	14	..	14	
								Starry Ray, ..	7	..	7	
								Lumpsucker, ..	..	1	1	
									292	5	297	
5. Cruden Bay.	Mar. 27 and 28.	..	..	..	6–11	8.30 p.m.	12.45 a.m.	Cod, ...	2	..	2	
								Codling, ...	4	..	4	
								Whiting, ...	2	..	2	
								Plaice (1), ..	7	..	..	
								,, (2), ...	163	..	..	
									—170	..	170	
								Flounder, ..	2	..	2	
								Starry Ray, ..	18	5	23	
									198	5	203	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
6. Off Newburgh.	1905. Mar. 28.	..	..	..	6 to 10	5.20 a.m.	9.30 a.m.	Cod, ...	5	..	5	
								Codling, ...	1	..	1	
								Haddock, ..	3	..	3	
								Whiting, ...	7	1	8	
								Plaice (2), ...	16	..	16	
								Com. Dab, ...	40	19	59	
								Starry Ray, ..	4	2	6	
									76	22	98	
7. Off Donmouth and Bathing Station.	,,	..	..	.	6 to 10	7.40 p.m.	Midnight.	Cod, ...	3	..	..	Nearly half a basket unmarketable fish, mostly dabs.
								Codling, ...	13	..	..	
								Plaice, ...	5 bskts.	..	..	
								Turbot, ...	1	..	..	
								Black Sole, ..	1	..	..	
									..	..	..	
8. 3½ miles. off Girdleness.	Mar. 29.	..	..	..	18 to 25	6.20 a.m.	7.30 a.m.	Codling, ...	9	..	9	Wind S.W., moderate breeze. Trawl-net torn.
								Ling, ...	3	..	3	
								Haddock, ...	..	19	19	
								Whiting, ...	..	3	3	
								Turbot, ...	1	..	1	
								Plaice, (2)	14	..	14	
								Lemon Dab, ..	6	..	6	
								Com. Dab, ...	..	21	21	
									33	43	76	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
1. Burghead Bay.	1905. Sept. 28.	..	..	..	5 to 12	6.15 a.m.	8.20 a.m.	Codling, ...	1	4	5	Wind N.E., moderate; sea choppy.
								Haddock (2), ..	73	1350	1423	
								Whiting, ...	4	43	47	
								Gurnard, ...	..	34	34	
								Brill, ...	2	..	2	
								Plaice (1), ...	4	..	..	Eleven squids.
								,, (2), ...	7	..	..	
								,, (3), ...	711	..	..	
									—722	16	738	
								Lemon Dab, ..	1	..	1	
								Com. Dab, ..	..	208	208	
								Angler, ...	..	12	12	
									803	1667	2470	
2. Dornoch Firth, off Dunrobin Castle.	,,	..	52·2	54·0	5 to 15	1.55 p.m.	6.0 p.m.	Cod, ...	19	..	19	Wind N.E.; moderate breeze; sea choppy.
								Codling, ...	46	11	57	
								Haddock, ...	..	549	549	
								Whiting, ...	..	52	52	
								Gurnard, ...	..	51	51	
								Plaice (1), ...	23	..	..	
								,, (2), ...	30	..	..	
								,, (3), ...	775	..	..	
									—828	1267	2095	
								Lemon Dab, ..	14	..	14	Fourteen squids.
								Witch, ...	1	..	1	
								Com. Dab, ...	..	37	37	
								Long Rough Dab,	..	23	23	
								Thornback, ..	7	..	7	
								Angler, ...	..	4	4	
									915	1994	2909	
3. ,,	,, 29.	..	53·0	54·0	6 to 15	4.30 a.m.	8.30 a.m	Haddock (2), ..	24	400	424	
								Grey Gurnard, ..	..	15	15	
								Plaice (1), ...	10	..	..	
								,, (2), ...	15	..	..	
								,, (3), ...	727	..	..	
									—752	215	967	
								Lemon Dab, ..	12	..	12	
								Mackerel, ...	19	..	19	
								Thornback, ..	7	..	7	
									814	630	1444	
4. ,,	,,	..	..	..	6½ to 15	10·5 a.m.	1.0 p.m.	Codling, ...	3	..	3	
								Haddock (1), ..	21	..	..	
								,, (2), ..	15	..	..	
									— 36	2255	2291	Five small squids.
								Whiting, ...	1	..	1	
								Grey Gurnard, ..	..	63	63	
								Plaice (1), ...	7	..	..	
								,, (2), ...	86	..	..	
								,, (3), ...	1030	..	..	
									—1123	1342	2465	
								Lemon Dab, ..	5	..	5	
								Mackerel, ...	1	..	1	
								Angler, ...	..	1	1	
								Thornback, ..	3	..	3	
									1172	3661	4833	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
5. Dornoch Firth, off Dunrobin Castle.	1905. Sept. 29.	..	..	..	6 to 15	1.10 p.m.	5.15 p.m.	Codling, ...	5	..	5	Four squids.
								Haddock (1), ..	59	..	..	
								,, (2), ..	63	..	..	
									—122	1766	1888	
								Grey Gurnard, ..	..	82	82	
								Plaice (1), ...	2	..	..	
								,, (2), ...	100	..	..	
								,, (3), ...	1328	..	..	
									—1430	2478	3908	
								Lemon Dab, ..	2	..	2	
								Com. Dab, ..	..	554	554	
								Angler, ...	..	5	5	
								Thornback, ..	..	3	3	
									1559	4888	6447	
6. Dornoch Firth.	,, 29.	..	..	..	8 to 15	5.55 p.m.	10.20 p.m.	Codling, ...	11	..	11	There were 19¾ basketfuls of unmarketable fish.
								Haddock (1), ..	100	..	..	
								,, (2), ..	41	..	..	
									—141	3950	4091	
								Grey Gurnard, ..	..	79	79	
								Turbot, ...	1	..	1	
								Plaice (1), ...	8	..	..	
								,, (2), ...	38	..	..	
								,, (3), ...	708	..	..	
									—754	869	1623	
								Lemon Dab (2), ..	6	..	6	
								Com. Dab, ...	..	177	177	
								Thornback, ..	3	..	3	
									916	5075	5991	
7. ,,	,,	..	52·0	54·0	8 to 15	3.45 a.m	8.0 a.m	Codling, ...	12	1	13	
								Haddock (1), ..	20	..	..	
								,, (2), ..	51	..	..	
									— 71	1047	1118	
								Grey Gurnard, ..	..	168	168	
								Plaice (1), ...	4	..	..	
								,, (2), ...	74	..	..	
								,, (3), ...	1195	..	..	
									—1273	1279	2552	
								Lemon Dab, ..	11	..	11	
								Com. Dab, ...	7	60	67	
								Mackerel, ...	3	..	3	
								Angler, ...	..	6	6	
								Thornback, ..	1	..	1	
									1378	2561	3939	
8. Outside Cromarty Firth.	,,	..	52·0	53·0	12	12 noon.	2.20 p.m.	Cod, ...	2	..	2	
								Codling, ...	4	3	7	
								Haddock (1), ..	100	..	..	
								,, (2), ..	41	..	..	
									—141	254	395	
								Whiting, ...	..	2	2	
								Grey Gurnard, ..	..	4	4	
								Plaice (1), ...	1	..	..	
								,, (3), ...	34	..	..	
									— 35	26	61	
								Com. Dab, ..	..	6	6	
								Grey Skate, ..	..	2	2	
									182	297	479	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
9. Burghead Bay.	1905. Oct. 2.	..	..	..	5 to 12	2.45 a.m.	7.20 a.m.	Cod, ...	1	..	1	Five squids.
								Codling, ...	3	4	7	
								Haddock (2), ..	29	1305	1334	
								Whiting (2), ..	13	..	13	
								Grey Gurnard, ..	..	159	159	
								Brill, ...	9	..	9	
								Plaice (1), ...	5	..	..	
								,, (2), ...	167	..	..	
								,, (3), ...	1022	..	..	
									—1194	266	1460	
								Lemon Dab (1), ..	10	..	10	
								Witch (1), ...	7	..	7	
								Com. Dab, ...	206	660	866	
								Angler, ...	..	28	28	
								Thornback, ..	7	..	7	
									1479	2422	3901	
10. ,,	,,	..	..	..	8 to 12	11.55 a.m.	4.0 p m.	Codling, ...	..	9	9	Wind N.W., moderate breeze; sea moderate.
								Haddock, ...	..	56	56	
								Whiting, ...	..	14	14	
								Gurnard, ...	..	12	12	
								Brill, ...	7	..	7	
								Plaice (1), ...	8	..	..	
								,, (2), ...	149	..	..	
								,, (3), ...	378	..	..	
									—535	24	559	
								Lemon Dab, ..	4	..	4	
								Com. Dab, ...	39	81	120	
								Angler, ...	..	4	4	
								Thornback, ..	6	..	6	
									591	200	791	
11. ,,	Oct. 2, 3.	..	..	..	,,	8.15 p.m.	12.30 a.m.	Cod, ...	3	..	..	Unmarketable fishes filled two baskets.
								Turbot, ...	2	..	..	
								Brill, ...	5	..	..	
								Plaice (1), ...	4	..	..	
								,, (2), ...	273	..	..	
								,, (3), ...	723	..	..	
									—1000	..	..	
								Lemon Dab, ..	7	..	..	
								Witch (1), ...	3	..	..	
								Com. Dab, ..	29	..	..	
								Thornback, ..	10	..	..	
									1059	..	..	
12. ,,	Oct. 3.	..	..	..	10 to 15½	6.0 a.m.	10.10 a.m.	Codling, ...	1	5	6	Net split badly.
								Haddock, ...	..	47	47	
								Whiting, ...	..	10	10	
								Gurnard.	..	22	22	
								Plaice (1), ...	1	..	..	
								,, (2), ...	7	..	..	
								,, (3), ...	41	..	..	
									— 49	13	62	
								Com. Dab, ..	12	36	48	
								Long Rough Dab,	..	7	7	
								Angler, ...	..	5	5	
									62	145	207	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No thrown Overboard.	Total No.	
13. Burghead Bay.	1905. Oct. 3.	..	..	..	8 to 15½	10.50 a.m.	3.30 a.m.	Codling, ...	..	11	11	Net split badly.
								Haddock, ...	..	378	378	
								Whiting, ...	..	52	52	Fifteen squids.
								Gurnard, ...	..	28	28	
								Brill ..	2	..	2	
								Plaice (1), ...	15	..	..	
								,, (2), ...	62	..	..	
								,, (3), ...	107	..	..	
									—184	82	266	
								Com. Dab, ..	24	107	131	
								Black Sole, ..	1	..	1	
								Long Rough Dab,	..	6	6	
								Angler, ...	5	2	7	
									216	666	882	
14. ,,	,,	..	..	..	8 to 14	4.25 p.m.	8.45 p.m.	Codling, ...	1	8	9	Wind W., strong breeze.
								Haddock (1), ..	5	96	101	
								Grey Gurnard, ..	..	216	216	
								Turbot, ...	1	..	1	
								Brill, ...	12	..	12	
								Plaice (1), ...	8	..	..	
								,, (2).	187	..	..	
								,, (3), ...	817	..	..	
									—1012	208	1220	
								Lemon Dab, ..	1	..	1	
								Com. Dab, ..	130	492	622	
								Long Rough Dab,	..	36	36	
									1162	1056	2218	
15. ,,	Oct. 4.	..	..	..	8 to 13	7.30 a.m.	11.45 a.m.	Codling, ...	..	9	9	
								Haddock (1), ..	2	..	..	
								,, (2), ..	26	..	..	
									— 28	325	353	
								Whiting, ...	..	47	47	
								Grey Gurnard. ..	..	43	43	
								Brill, ...	3	..	3	
								Plaice (1), ...	2	..	..	
								,, (2), ...	111	..	..	
								,, (3), ...	577	..	..	
									—690	102	792	
								Lemon Dab, ..	5	..	5	
								Witch (1), ...	10	4	14	
								Com. Dab,.. ..	108	160	268	
								Long Rough Dab,	..	14	14	
								Black Sole, ..	1	..	1	
								Angler, ...	5	6	11	
								Thornback, ..	4	5	9	
									854	715	1569	
16. ,,	,,	..	..	..	8 to 13	5.30 p.m.	10.0 p.m.	Codling, ...	..	6	6	
								Haddock, ...	..	416	416	
								Whiting, ...	..	103	103	
								Grey Gurnard, ..	..	38	38	
								Plaice (2), ...	153	..	..	
								,, (3), ...	673	..	..	
									—826	93	919	
								Lemon Dab, ..	3	..	3	
								Com. Dab, ..	102	296	398	
								Angler, ...	..	12	12	
								Thornback, ..	..	3	3	
									931	967	1898	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
1. Burghead Bay.	1905. Nov. 1.	46·4	48·9	49·0	8 to 10	5.15 p.m.	8.20 p.m	Codling, ...	..	23	23	Wind E., moderate; sea moderate.
								Haddock, ...	..	2852	2852	
								Whiting, ...	..	90	90	
								Gurnard, ...	..	117	117	
								Turbot, ...	1	..	1	
								Brill, ...	7	..	7	
								Plaice (2), ...	149	..	..	
								,, (3), ...	530	..	..	
									—679	326	1005	
								Com. Dab, ..	86	136	222	
								Long Rough Dab,	..	7	7	
								Thornback, ..	7	..	7	
									780	3551	4331	
2. ,,	Nov. 2.	45·7	48 4	49·0	8 to 13	5.0 a.m.	8.15 a.m.	Codling, ...	..	47	47	Wind N.E., strong; sea rough.
								Haddock, ...	..	2748	2748	
								Whiting, ...	..	198	198	
								Gurnard, ...	..	204	204	
								Plaice (2), ...	59	..	..	
								,, (3), ...	242	..	..	
									—301	144	445	
								Com. Dab, ...	21	194	215	
								Thornback, ..	2	..	2	
									324	3535	3859	
3. Dornoch Firth.	,,	46·8	49·1	48·5	8 to 13	10.20 am.	1.30 p.m.	Cod, ...	7	..	7	
								Codling, ...	12	..	12	
								Haddock (2), ..	25	..	..	
								,, (3), ..	63	..	..	
									— 88	2270	2358	
								Whiting, ...	14	..	14	
								Coal-fish, ...	1	..	1	
								Gurnard, ...	..	27	27	
								Plaice (2), ...	17	..	..	
								,, (3), ...	34	..	..	
									— 51	18	69	
								Lemon Dab, ..	6	8	14	
								Com. Dab, ...	9	46	55	
									188	2269	2557	
4. ,,	,,	..	..	..	6 to 10	2.40 p.m.	6.0 p.m.	Cod, ...	2	..	2	
								Codling, ...	11	18	29	
								Haddock (2), ..	39	..	..	
								,, (3), ..	20	..	..	
									— 59	582	641	
								Whiting, ...	12	106	118	
								Gurnard, ...	..	14	14	
								Plaice, ...	143	39	182	
								Com. Dab, ..	..	26	26	
								Angler, ...	..	1	1	
									227	786	1013	
5. Off Lybster.	Nov. 3.	..	..	..	18 to 30	4.0 a.m.	7.20 .m.	Cod, ...	40	..	40	
								Codling, ...	62	1	63	
								Haddock, ...	..	28	28	
								Whiting, ...	..	13	13	
								Gurnard, ...	..	202	202	
								Plaice, ...	8	2	10	
									110	246	356	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name	No. taken to Market.	No. thrown Overboard.	Total No.	
6. Burghead Bay.	1905. Nov. 4.	..	..	..	6 to 10	10.55 a.m.	3.0 p.m.	Haddock, ...	..	332	332	Wind S.E., strong breeze; sea rough.
								Whiting, ...	..	22	22	
								Gurnard, ...	..	36	36	
								Brill, ...	2	..	2	
								Plaice, ...	535	21	556	
								Com. Dab, ..	4	71	75	
								Long Rough Dab,	..	3	3	
									541	485	1026	
7. ,,	,,	..	..	..	5 to 9	3.45 p.m.	7.50 p.m.	Cod, ...	1	..	1	
								Codling, ...	..	5	5	
								Haddock, ...	..	606	606	
								Whiting, ...	..	52	52	
								Gurnard, ...	..	19	19	
								Turbot, ...	3	..	3	
								Brill, ...	2	..	2	
								Plaice, ...	1015	31	1046	
								Witch, ...	1	..	1	
								Com. Dab. ..	12	104	116	
								Angler, ...	..	4	4	
								Thornback, ..	3	..	3	
									1037	821	1858	
8. ,,	Nov. 6.	..	..	..	5 to 9	6.0 a.m.	10.0 a.m.	Codling, ...	1	8	9	Wind E.N.E.; heavy sea.
								Haddock, ...	..	57	57	
								Whiting, ...	..	15	15	
								Gurnard, ...	..	71	71	
								Turbot, ...	4	..	4	
								Brill, ...	7	..	7	
								Plaice, ...	695	38	733	
								Com. Dab,.. ..	16	115	131	
								Long Rough Dab,	..	2	2	
									723	306	1029	

II.—OBSERVATIONS ON THE OTOLITHS OF SOME TELEOSTEAN FISHES.

By Thomas Scott, LL.D., F.L.S., Mem. Soc. Zool. de France.

(Plates I.-V.).

Contents.

		PAGE.
(1)	Preliminary Remarks,	48
(2)	List of Fishes whose Otoliths are described,	52
(3)	Systematic description of the Otoliths,	53
(4)	Literature bearing on the Otoliths of Fishes,	80

I.—Preliminary Remarks.

Rather more than twenty-five years ago a portion of my leisure was devoted to a study of the post-tertiary and surface geology of the Clyde Valley. Consequently, the rich fossiliferous beds that were exposed about that time in connection with the excavations for the James Watt Wet Dock at Greenock were of special interest to me as well as to all engaged in this study. It was about that time and in connection with these researches that my attention was first directed to those curious bodies known as the otoliths, or earstones of fishes.

These studies had made me acquainted with the late Dr. David Robertson, of Glasgow, and subsequently of Millport, whose name is so intimately associated with the Marine Biological Station at the latter place. This gentleman, who already possessed large collections of natural history objects of various kinds, had among them an extensive series of the otoliths of recent and known fishes, and these collections I had the frequent privilege of inspecting.

If I remember rightly, one of the reasons which induced Dr. Robertson to make this collection of otoliths was that such objects were expected to occur, or had already been noticed, in the fossiliferous clays then under examination, and that, therefore, a familiarity with the recent forms might help in identifying the kinds of fishes such fossil otoliths might belong to.

With Dr. Robertson's assistance, always freely given to those engaged in natural history pursuits, I soon became interested in these things. Later on, when carrying out the work assigned to me by the Fishery Board for Scotland, the food of fishes engaged my attention from time to time, and in order to obtain the information desired it was necessary to examine the stomachs of many of the fishes captured. As this examination proceeded it became manifest that small fishes were often captured by the larger specimens for food, as their remains sometimes formed a considerable proportion of the contents of the stomachs examined. Frequently, however, the otoliths or earstones were the only parts that remained, or that were least affected by the action of the digestive fluid; it was therefore obvious that a familiarity with the earstones of fishes

already known might be useful as a means whereby we could ascertain what was the species of fish that those found in the stomachs belonged to.

Of course, the usefulness of the earstones for this purpose depends on whether the difference between those of one species of fish and those of another is sufficiently distinct and constant, either in their size, form, or sculpture. This information, however, could only be acquired by the comparative examination of the earstones of many kinds of fishes and also of large and small examples of the same kinds. Unfortunately, I have not been able to give so much attention to this research as it deserved, nevertheless a good deal of time has been devoted to it, and though the results have been in some respects disappointing, several interesting facts have emerged which will be referred to presently.

The earstones of about seventy species of fish are described in the sequel and, with one or two exceptions, the descriptions are illustrated by enlarged photographs. Before proceeding, however, to describe the various forms, the following remarks may not be out of place, and the first thing I wish to refer to is the *position* of the earstones.

The earstones or otoliths of teleostean fishes are contained within special chambers—the ear-chambers—one on each side of the head and situated between the eye and the base of the skull. There are usually several stones in each chamber, one being comparatively large and the others very small. The form of the large stone is generally well defined, but the others are irregular in shape, and therefore, in this paper, the term *earstone* or *otolith* will refer only to the large stone. The otoliths are not outgrowths from adjoining parts of the skull, but are free within the ear cavity, and are covered by a thin membrane to which nerves are attached.

I have endeavoured to ascertain whether the size of the earstones was in any way correlated with the intensity of the sense of hearing, that is, whether the possession of large or small earstones was an indication of a higher or lower development of the sense of hearing, but have been unable to obtain any positive evidence bearing on this question. For example, haddock, coal-fish (especially in the earlier stages), lythe, and also cod have their sense of hearing tolerably acute. This was demonstrated over and over again at the Rothesay Aquarium, and these fish have large earstones. The conger, on the other hand, which has comparatively small earstones, appears to be a dull and listless fish. But it has been noticed that lumpsuckers, and more especially the young of that species, have a keenly intelligent look, yet their earstones are extremely small compared with the size of the fish.

The position which the earstones *in situ* occupy in relation to the head of the fish has been observed in a number of cases, and is referred to in the descriptive part of the paper. It may be stated here, however, that in the majority of species where careful observation could be made, it was observed that the two earstones were placed lengthways, or nearly so, with the head. They were not, however, usually parallel to each other, but diverged more or less posteriorly. In the case of many of the larger fishes—except the Pleuronectidæ—the earstones are elongated, and have one end truncated, often obliquely, and the other end angular or produced to a more or less sharp point, as is well exemplified by those of the whiting. The truncated end is usually directed towards the front of the head, but there are a few fishes, such as the herring and some others, where the anterior end is pointed. It may also be remarked that the earstones in these larger fishes have frequently one side concave and the other convex. The convex sides usually face each other, and are com-

paratively smooth, while any sculpture with which the earstone may be ornamented is more frequently found on the outer or concave side. The upper margin of the earstone is also the one which is likely to have the edge notched or crenulated, whereas the lower margin is often tolerably even and gently curved.

The earstones of the Pleuronectidæ are generally more or less circular and sometimes nearly circular, in other cases they are broadly oval, and they are nearly always flat and thin. Their true position in relation to the head is, for this reason, and also because of the remarkable change that takes place in order that both eyes may be accommodated on the same side, not so obvious as in the case of those whose eyes retain their normal position.

Secondly, a few general remarks about the size, structure, and form of the earstones of different fishes and their value as a means for the identification of species may be useful here. As already stated, it is many years ago since the earstones of fishes were taken up as a systematic study. This study was undertaken for the purpose of ascertaining if, failing other evidence, the species of a fish could be determined by the earstones alone. I soon became satisfied that, except in certain cases, they could not be altogether relied upon for this purpose, especially when dealing with young fishes whose otoliths have not yet attained the form and structure peculiar to the adult. But though it may frequently be difficult to distinguish the *species* of a fish where the otoliths are the only parts left by which it may be identified, yet they may be fairly reliable as a guide for ascertaining the family and also sometimes the genus to which the fish belongs. It is not difficult, for example, to distinguish the earstones of the more typical of the Gadoids, and especially of those of most of the genus *Gadus*—they are usually so massive in structure as to differ in this respect alone from those of almost all other groups of fishes with which I am familiar. Yet there are one or two species belonging to this family that possess earstones so different from those of the genus *Gadus*, that if it were the case that no other parts of the fishes were available for determining the family they belonged to, one would be inclined to ascribe them to some other than that of the gadidæ. I have already referred to the family Pleuronectidæ as possessing earstones more or less rotundate, flat and thin, and thus presenting characters by which they differ from most of the other teleostean fishes mentioned here. But though the peculiarities in shape and structure that characterise the earstones of fishes may not generally be reliable for the identification of species when unsupported by other evidence, still there are several fishes that possess otoliths so distinct, that by means of them alone the species may be determined with almost absolute certainty. In support of this statement I need only refer to the following species:—The earstones of the black goby, *Gobius niger*, possess characters by which they may be distinguished with tolerable certainty from those of other fishes. They are nearly flat, and of a broadly rhomboid form, as may be seen on pl. ii. B., figs. 19 and 20, and pl. v., fig. 6.

The earstones of the whiting have also a form unlike that of the otoliths of any other fishes known to me; they are considerably elongated, and are obliquely truncate at one end, while the opposite end is drawn out into a tapering extremity which ends in a sharp point (*see* figs. 30 and 31 on pl. ii. A.).

The hake has earstones so different in shape and so thin that when placed beside the massive otoliths of the cod and coal-fish, belonging to the same family, they suggest doubts as to whether these species are so closely related to one another as their position indicates.

The megrim or whiff is the only kind of fish I have met with that exhibits a fairly constant difference in the shape of the right and left earstones. At first I imagined this difference to be merely accidental, but the examination of several specimens, both large and small, revealed similar differences in all of them.

The earstones of the argentine have also a peculiar shape, and are unlike any of those that have been examined. They may be described as scaphoid or boat-shaped, except that the length and depth are nearly the same Two pairs of these earstones are represented on pl. i. B., figs. 44 and 45, and photographs of them considerably enlarged will be found on pl. iv., fig. 9.

The earstones of very young and immature fishes may, but frequently do not, possess the characters peculiar to the species as seen in the adult form, and it is this fact that makes the identification of fishes by the earstones alone unsatisfactory, whereas if the fishes be of adult size, or nearly so, the uncertainty of determination is greatly minimised. There can, for example, be little or no difficulty in recognising the earstones of adult whiting or codfish or of those of the hake.

Besides the difference in the shape of the earstones of fishes there is also sometimes considerable differences observed in the proportional sizes of those of different fishes—that is, it does not always follow that a large fish belonging to one species will have earstones proportionally larger than a smaller fish belonging to another species, for we sometimes find that the difference is the other way. For example, the earstones of a lumpsucker fifteen and a half inches long measured 1·5mm. by 1·3mm.; a lemon dab twelve inches long had earstones that measured 3·5mm. by 2mm., while those of a long rough dab ten inches long, or only two-thirds the length of the lumpsucker, measured 6mm. by about 4·5mm—four times the size of those of the lumpsucker. Then, again, a catfish, the length of which was twenty-seven inches, possessed earstones 4mm. long by 2·5mm. at the widest part, while a hake of about the same length as the catfish was found to have earstones nearly 25mm. long by about 9mm. at the widest part. In further contrast with the earstones of the fishes just mentioned, it may be stated that a codfish measuring fully three feet in length had earstones of about the same width as those of the hake, but they were nearly 7mm. shorter, their length reaching only to 18mm., but the difference in length was fully made up by their more massive structure. The weight of these two earstones was about 22 English grains, or, more correctly, 1·485 grammes, while the weight of the two otoliths from the hake was about 12 English grains, or ·735 grammes. It may also be mentioned that the two earstones of a codfish which measured forty inches in length weighed nearly 30 English grains—and it should be noted that this was the weight of them after they had been thoroughly dried.

Moreover, the earstones of teleostean fishes appear to consist almost entirely of calcareous matter, for when those from a tolerably large codfish were subjected to a red heat they remained practically unaltered in size or in shape, but were so brittle that they were easily crushed between the finger and thumb. On the other hand, when otoliths were placed in dilute hydrochloric acid they completely dissolved away with much effervescence, leaving but the merest trace of organic matter.

This calcareous matter does not form a homogeneous mass, but is deposited in layers, and the density of each alternate layer is usually less or greater than the one immediately preceding. In some cases these layers are arranged so regularly as to imply a more or less regular and periodic activity or quiescence in the secreting tissues by which the earstones are formed. The result of this alternating activity and quiescence

is well seen in the structure of the otoliths of several species of the Pleuronectidæ, the shape of which is more or less circular, and they are so thin as to be almost transparent, especially when just removed from the ear-chamber. It is evident that the calcareous matter that is added to these earstones from time to time is deposited chiefly around the circumference, and only to a small extent laterally. In several of the Gadidæ, on the other hand, considerable additions are made to the thickness as well as round the edges of the otoliths. In not a few other fishes the form of the earstones is so irregular that the calcareous matter of which they are composed cannot have been added symmetrically as in the case of the earstones of the Pleuronectidæ.

An attempt is being made to utilise these concentric growth-lines for the purpose of ascertaining the age of the fish they belong to, somewhat after the manner a botanist reckons the age of an exogenous tree by counting the number of alternating light and dark rings exhibited in a cross section of the wood; and it is probable that an estimate of the fish's age founded on these growth-lines may be approximately correct as regards plaice or any other fish whose earstones have a regular form and are sufficiently thin to show the concentric lines clearly. But it is doubtful how far such a method can be relied upon if applied to such fish as the bream, mullet, hake, herring, and others having earstones irregular in shape. Moreover, it is probable that the abundance or scarcity of food that the fish have to live upon, or variations in the kinds of the food, may retard or quicken the deposition of calcareous matter, and may lead to the formation of pseudo rings, whole or incomplete, that may tend to complicate or in some measure to nullify the calculation.

The discussion of these questions is, however, outside the scope of the present paper, which is merely intended to contain notes descriptive of the sizes and forms of the earstones of a number of the fishes that have come under my own observation.

The plates which illustrate this paper were prepared from photographs made by my son, Andrew Scott, A.L.S. The earstones represented by the photographs were collected at various times and mounted on slides, by myself, but only a limited number of them were selected for mounting. Those represented on Plates I., II., and III. are nearly twice the natural size, while Plates IV. and V. show them considerably enlarged.

II.—LIST OF FISHES WHOSE EARSTONES ARE DESCRIBED IN THE PRECEDING NOTES—ALPHABETICALLY ARRANGED.

	PAGE.
Agonus cataphractus (Linn.), Pogge,	56
Ammodytes tobianus, Linn., Lesser sand-eel,	69
Anarrhichas lupus, Linn., Catfish,	59
Anguilla vulgaris, Leach, Fresh-water eel,	79
Argentina sphyræna, Linn., Argentine,	76
Atherina presbyter, Cuv., Sand smelt,	60
Bothus maximus (Linn.), Turbot,	70
Callionymus lyra, Linn., Dragonet,	58
,, *maculatus*, Bonepart, Spotted dragonet,	58
Clupea harengus, Linn., Herring,	77
,, *pilchardus*, Bloch., Pilchard,	78
,, *sprattus*, Linn., Sprat,	78
Conger niger (Risso), Conger-eel,	79
Coregonus lavaretus, Penn., Powan,	76
Cottus scorpius, Linn., Sea scorpion,	55
Cyclopterus lumpus, Linn., Lumpsucker,	59
Drepanopsetta platessoides (Fabr.), Long rough dab,	69
Enchelyopus viviparus (Linn.), Viviparous blenny,	60
Esox lucius, Linn., Fresh-water pike,	77

PAGE.
Gadus æglefinus, Linn., Haddock, - - - - - - 62
,, *callarias*, Linn., Codfish, - - - - - - 61
,, *Esmarkii*, Nilsson, Norway pout, - - - - - 64
,, *luscus*, Linn., Brassy, - - - - - - - 63
,, *merlangus*, Linn., Whiting, - - - - - - 65
,, *minutus*, Linn., Poor cod, - - - - - - 64
,, *pollachius*, (Cuv.), Pollack, - - - - - - 66
,, *poutassou*, Risso, Couch's whiting, - - - - - 64
,, *virens*, Linn., Coalfish, - - - - - - - 65
Gobius minutus, Smel., Speckled goby, - - - - - 58
,, *niger*, Linn., Black goby, - - - - - - 58
Hippoglossus vulgaris, Flem., Halibut, - - - - - 69
Labrus bergylta, Ascan., Ballan wrasse, - - - - - 61
,, *mixtus*, Linn., Striped wrasse, - - - - - 61
,, *rupestris*, Linn., Jago's goldsinny, - - - - - 61
Lepidorhombus whiff, (Walb.), Megrim, - - - - - 71
Leuciscus rutilus, Linn., Roach, - - - - - - 77
Lophius piscatorius, Linn., Angler fish, - - - - - 57
Lumpenus lampretiformis, (Walb.), Sharp-tailed lumpenus, - - - 60
Merluccius merluccius, Linn., Hake, - - - - - - 66
Molua molva (Linn.), Ling, - - - - - - - 67
Mugil chelo, Cuv., Thick-lipped grey mullet, - - - - - 60
Mullus barbatus, Linn., Red mullet, - - - - - - 54
Nerophis lumbriciformis, Will., Worm pipefish, - - - - 79
Onos cimbrius (Linn.), Four-bearded rockling, - - - - 67
,, *tricirratus* (Brün.), Three-bearded rockling, - - - - 67
Perca fluviatilis, Linn., Fresh-water perch, - - - - - 53
Pholis gunnellus, Linn., Butterfish, - - - - - - 59
Phycis blennoides, Brün., Greater fork-beard, - - - - - 66
Platophrys laterna (Walb.), Scaldfish, - - - - - - 72
Pleuronectes cynoglossus, Linn., Witch sole, - - - - - 74
,, *flesus*, Linn., Flounder, - - - - - - 73
,, *limanda*, Linn., Dab, - - - - - - 74
,, *microcephalus*, Don., Lemon sole, - - - - - 73
,, *platessa*, (Linn.), Plaice, - - - - - - 72
Raniceps raninus (Linn.), Lesser fork-beard, - - - - 68
Salmo (?) fario, Linn., Brown trout, - - - - - - 76
,, *salar*, Linn., The salmon, - - - - - - 76
Scomber scombrus, Linn., Mackerel, - - - - - - 57
Scorpæna dactyloptera, De la Roche, Blue mouth, - - - - 55
Sebastes norvegicus, (Ascan.), Norway haddock, - - - - 54
Solea lutea, Risso, Solenette, - - - - - - - 75
,, *variegata*, Don., Variegated sole, - - - - - 75
,, *vulgaris*, Guensel., Black sole, - - - - - - 75
Sparus centrodontus, De la Roche, Common sea bream, - - - 54
Trachinus draco, Linn., Greater weaver, - - - - 57
,, *vipera*, Cuv., Lesser weaver, - - - 57
Trigla gurnardus, Linn., Grey gurnard, - - - - 55
,, *lineata*, Gmel., Streaked gurnard, - - - - - 56
,, *lucerna*, Linn., Sapphirine gurnard, - - - - 56
,, *pini*, Bloch, Red gurnard, - - - - - - 56
Zeugopterus punctatus, Bloch, Müller's top-knot, - - - - 71

III.—Systematic Description.

Nomenclature followed.—*A History of Scandinavian Fishes*, by B. Fries, C. U. Ekström, and C. Sundevall, 2nd edit., revised by Prof. F. A. Smitt (1893–95).

Arrangement followed.—Dr. Francis Day, *The Fishes of Great Britain and Ireland*, 2 vols. (1880–84).

Fam. Percidæ.

Genus *Perca*.

Perca fluviatilis, Linn. Fresh-water Perch. Pl. iii. B., figs. 54–57; pl. v., fig. 13.

Four specimens of the fresh-water perch were examined—one about 14 inches long, one 8 inches, one 7 inches, and one 6½ inches. The earstones of the largest specimen measured 10·5mm. in length and about 5·5mm at the widest part, while those of the other three specimens measured respectively 7mm. by 3·5mm. and 6mm. by 3mm. The larger earstones are thus proportionally the shorter ones, the first being equal to about one thirty-fourth part of the entire length of the fish, the next about the one-thirtieth, and the last rather longer. These earstones are very irregular in outline, and the greatest width is towards the posterior end. The lower margin is tolerably even and slightly arcuate, but the upper is irregular, with a prominent notch near the proximal end; this end is narrow and bluntly rounded. Both the posterior end and the upper margin are distinctly but irregularly crenulate; they are also moderately compressed and thin. The earstones of the smaller fishes have a general resemblance to those of the large one, but they are distinctly less crenulated, and the surface is not so rugose. The specimens seem to vary to some extent in form and sculpture.

Fam. Mullidæ.

Genus *Mullus.*

Mullus barbatus, Linn. Surmullet or Red Mullet. Pl. iii. B., fig. 49; pl. v., fig. 23.

The fish from which the earstones were taken measured scarcely 8¾ inches in length. The earstones are broadly ovate in outline, the posterior extremity is truncated, while the proximal end is narrow and bluntly rounded; the lateral margins are obscurely crenulate, and the surface is somewhat rugose. The earstones of the red mullet are apparently proportionally smaller than those of the fresh-water perch. Those just described measured only about 4·5mm. long by about 3mm. in greatest width, and are thus about equal to little more than one-fiftieth part of the length of the fish.

Fam. Sparidæ.

Genus *Sparus.*

Sparus (Pagellus) centrodontus, De la Roche. Sea Bream. Pl. ii. B., figs. 6 and 7.

The earstones of two examples of this species are shown on Plate ii. B. The larger of the two fishes measured 17 inches in length, and the smaller 15 inches. The earstones of the first (fig. 6) measured 15·5 mm. along their greatest length, and 8mm. in depth, and those of the smaller one (fig. 7) 14mm. by 7·5mm. In their outline and markings these earstones are somewhat similar to those of the large fresh-water perch, but the lower margin is rather more arcuate, and they are more incurved when seen from above. They are also considerably larger in proportion to the length of the fish, being about one twenty-seventh or twenty-eighth part of the extreme length.

Fam. Scorpænidæ.

Genus *Sebastes.*

Sebastes norvegicus (Ascan.). Norway Haddock. Pl. iii., B., figs. 50–52.

The earstones of three small examples of *Sebastes* are represented on Plate iii. B. The fishes measured 5 inches, 5½ inches, and 6 inches in

length respectively. The earstones, which are tolerably flat, are broadly oval in outline, those of the largest of the three fishes (fig. 50) measure fully 7mm. in length and 4·5mm. in width, the greatest width being near the middle. The lower margin is moderately convex and even, the posterior end is broadly truncate, but the proximal end terminates in a short narrow process; the upper margin, from the posterior end forward to about the middle of the otolith is slightly arcuate and even, but it then slopes abruptly towards the narrow proximal extremity. The lateral surfaces are moderately smooth. The earstones of the smallest of the three fishes (fig. 51) measure 6·4mm. by 4mm., and closely resemble the others in form and sculpture. The earstones of these young *Sebastes* are comparatively as large as those of the sea bream.

Genus *Scorpæna.*

Scorpæna dactyloptera, De la Roche. The Blue-mouth. Pl. iii. B., fig. 53.

The earstones of a *Scorpæna* 14 inches long are represented by the photograph (fig. 53). They are moderately large, measuring 14mm. in length and about 6 7mm. in width, the greatest width being a little in front of the middle. The lower margin is tolerably arcuate and obscurely crenated; the posterior extremity is truncated, and the margin slopes obliquely forward. The proximal portion of the earstone is moderately long and narrow; the upper margin, which is obscurely crenate or lobed, extends from the posterior angle in a nearly straight line, slightly diverging from the lower margin, to a little beyond the middle, where it terminates in an abrupt break, and from this break to the anterior extremity the earstone is comparatively narrow. Both the inner and outer sides of the earstones are nearly smooth. These earstones were equal to about one-twenty-fifth part of the entire length of the fish.

Fam. Cottidæ.

Genus *Cottus.*

Cottus scorpius, Linn. Sea Scorpion. Pl. iii. B., figs. 63–65.

The earstones represented by fig. 63 (Pl. iii. B.), and which are about 6mm. in length by 3mm. in depth, were obtained from a large variety of *Cottus scorpius* (var. *grœnlandicus*), but the size of the fish was not recorded. The middle portion of the lower margin is nearly straight, then it turns slightly upwards at both ends; the upper margin is nearly parallel with the middle portion of the lower, but this part of the upper margin, beginning at the posterior end, extends only to a little beyond the middle of the otolith, where it terminates somewhat abruptly, the remaining part of the otolith being narrow and ending in a moderately sharp-pointed extremity. The posterior end is bluntly rounded. A second and more typical specimen of *C. scorpius*, which measured $6\frac{3}{8}$ inches in length, had earstones only a little smaller than the other, their form being also slightly different (fig. 65). Fig. 64 represents the otoliths of a very small *Cottus* belonging to the same species.

Genus *Trigla.*

Trigla gurnardus, Linn. The Grey Gurnard. Pl. i. B., figs. 46–52; pl. iv., figs. 12 and 13.

The earstones of seven fishes of different sizes are represented on Plate i. B. The largest fish was about 15 inches in length and the smallest 7 inches, but though the earstones differ considerably in size they retain to a large extent their characteristic form and sculpture. Their general outline may be thus briefly described. The upper and lower margins are arcuate, but the one rather more so than the other. One end is obliquely truncated, while the other is bifid or forked, and a distinct groove extends from the apex of the fork to almost the opposite end of the earstone. The earstones from the largest fish (15 inches long) measured 4·8mm. in length by about 4mm. in depth, and are thus comparatively small in proportion to the size of the fish, being only equal to an eightieth part of its length. They are represented by fig. 46. The other fishes in the series measure about 13½ inches, 13⅛ inches, 12½ inches, 9⅛ inches, 7½ inches, and 7 inches in length, and the length of their earstones stated in the same order is nearly 4·5mm., 4·0mm., 4·3mm., 3·0mm., 2·7mm., and 2·5mm., their greatest width being about one-fifth less than the length. They were all nearly flat or only slightly incurved. Figs. 12 and 13, pl. iv., represent figs. 50 and 51, on pl. i., B., considerably enlarged.

Trigla pini, Bloch. The Red Gurnard. Pl. i. B., fig. 53; pl. iv., fig. 15.

The earstones represented by fig. 53 are from a red gurnard 345mm. (nearly 13¾ inches) in length. They have a general resemblance to those of the grey gurnard, except that the lower margin is produced posteriorly into a sharp point. The extreme length of the earstones is about 5·5mm. by 3·5 in depth. Fig. 15, pl. iv., shows the earstones considerably enlarged.

Trigla lineata, Gmel. The Streaked Gurnard. Pl. i. B., figs. 54 and 55; pl. iv., fig. 20.

The two specimens of *Trigla lineata* whose earstones are represented here measured respectively 10¼ inches and 8 inches in length. The otoliths, which do not differ much in size, being about 4mm. long by fully 2·5mm. in depth, are in their form and markings somewhat similar to those of *Trigla gurnardus*. Fig. 20, pl. iv., shows the earstones, represented by fig. 54, greatly enlarged.

Trigla lucerna, Linn. The Sapphirine Gurnard. Pl. i. B., fig. 56; pl. iv., fig. 21.

The earstones of these species have also a general likeness to those of *Trigla gurnardus*. The specimen from which those represented here was obtained measured 10½ inches long, and the earstones were about 3·8mm. by 2·5mm.

Fam. Cataphractidæ.

Genus *Agonus*.

Agonus cataphractus, Linn. The Pogge. Pl. ii. B., fig. 18; pl. iii. B., figs. 44–46; pl. v., fig. 27.

Four examples of *Agonus* ranging from about 6 inches to 4½ inches in length were examined for their earstones. These were found to have a narrow oval form, rather obtuse at the one end and pointed at the other

Those of the largest fish measured 5·4mm. in length by about 2mm. in depth (*see* fig. 45, pl. iii. B.), while those of the smallest (fig. 18, pl. ii. B.) measure 5mm. by about 2mm. It will be noticed that the earstones of the pogge are moderately large in proportion to the length of the fish. Those of the smallest specimen are about the one twenty-third part of its entire length.

Fam. PEDICULATIDÆ.

Genus *Lophius.*

Lophius piscatorius, Linn. The Angler-fish. Pl. iii. B., figs. 61 and 62; pl. iv., fig. 31; pl. v., fig. 19.

The earstones from a fairly large angler, 36 inches long, are represented by fig. 61 on pl. iii. B. They are comparatively broad, and their outline is somewhat irregular; the lower margin, which has a stout rib extending nearly from end to end, is obtusely geniculated, the angular part being nearly intermediate between the two extremities. The upper margin is arcuate and thin, and at the anterior end where it meets the lower margin it forms a blunt-pointed angle, but the posterior end is obliquely truncated. Numerous and somewhat obscure lines radiate from the middle portion of the lower rib to the edge of the upper margin, which may be crenulate or notched. These earstones are about 10·5mm. in length by about 7mm. in depth. The earstones of the smaller angler, the size of which has not been recorded, have the upper margin more regularly arcuate, while the lower want the angular outline of the larger otoliths. They measure about 5·5mm. by 3·5mm. The angler's earstones are small when compared with the length of the fish, those of the large specimen mentioned being only a little over one-ninetieth part of the entire length of the fish.

Fam. TRACHINIDÆ.

Genus *Trachinus.*

Trachinus vipera, Cuvier. The Lesser Weaver-fish. Pl. ii. B., figs. 8 and 9.

The earstones of the lesser weaver-fish are narrow and somewhat ovate in outline; both ends are pointed. Those represented by the figures on pl. ii. B. have thin surfaces slightly decorticated, so that the markings are obscure. The larger of the two fishes represented (fig 8) measured 127mm. long (about 5 inches), and the earstones were fully 6mm. in length by 2·5mm. in depth; the smaller fish measured 119 mm., and its otoliths were slightly smaller than the others.

Trachinus draco, Linn. The Greater Weaver-fish. Pl. ii. B., fig. 10.

The specimen of *Trachinus draco*, from which the earstones represented by fig. 10 were obtained measured 11¾ inches in length. The earstones, though somewhat similar in shape to those of the lesser weaver just described, were considerably larger, being at least 10mm. long by fully 4·5mm. in depth.

Fam. SCOMBRIDÆ.

Genus *Scomber.*

Scomber scombrus, Linn. The Mackerel. Pl. iii. B., fig. 36; pl. v., fig. 33.

The earstones of the mackerel are comparatively small. The one represented by figure 36 is from a fish of average size and about 3·5mm. in length. It has a general resemblance to the earstones of the herring, being narrow, with the sides parallel, the posterior end obtusely rounded and unequally bifurcated in front, the lower branch being produced into a narrow-pointed extremity.

Fam. Gobiidæ.

Genus *Gobius.*

Gobius niger, Linn. The Black Goby. Pl. ii. B., figs. 19 and 20; pl. v., fig. 6.

In this species the earstones are large in proportion to the size of the fish, and their broadly rhomboid form is so unlike that of the earstones of any of the other kinds of fishes examined that they appear to be characteristic of this particular species and to indicate that it might be possible to identify the fish almost entirely by the earstones.

The two fishes from which the earstones shown on Pl. ii. B. were obtained measured 105mm. in length, and their earstones are about 4mm. long by fully 3mm. in width. These earstones are thus about equal to one twenty-fifth part of the length of the fish.

Gobius minutus, Gmel. The Speckled Goby. Pl. ii. B., figs. 21–24.

The largest of the four fishes represented by the earstones shown on pl. ii. B., figs. 21 to 24, measured about 3 inches in length. The other three were smaller, the largest being 54 and the smallest 43mm. The earstones of the larger specimen were obscurely quagrangular in form and measured about 2·2mm. across the longest side, the width being slightly less. The earstones of the other specimens were very small, and resembled minute circular discs, the largest being little more than 1mm. in diameter.

Fam. Callionymidæ.

Genus *Callionymus.*

Callionymus lyra, Linn. The Dragonet. Pl. iii. B., figs. 10–14; pl. v., figs. 10 and 11.

The earstones of the dragonet are very small, and they are subovate in outline; the lower margin is nearly straight, but the upper is boldly arcuate. The posterior end is rather blunt, but the anterior extremity ends in most of the specimens in a short point. In some of them it is slightly bifid, and the upper margin is also obscurely crenulated.

The earstones of five fishes of different sizes are shown on plate iii. B. The fishes measure 10 inches, 8¼ inches, and 7¾ inches in length, while the length of other two (figs. 13 and 14) is doubtful. The earstones of the largest fish are about 3mm. long, which is equal to about one eighty-fourth part of the entire length of the fish. The earstones of the others are somewhat smaller and rather more pointed at the extremities.

Callionymus maculatus, Bonap. The Spotted Dragonet. Pl. iii. B., figs. 1–9; plate v., figs. 18 and 24.

Nine examples of this *Callionymus* have their earstones represented on pl. iii. B. The sizes of the fishes are, three at 150mm., one at 130mm., two at 112mm., one at 100mm., and two at 80mm. Their earstones closely resemble those of *Callionymus lyra* both in shape and size, except that in one or two of them the anterior end is rather more distinctly notched.

Fam. Discoboli.

Genus *Cyclopterus.*

Cyclopterus lumpus, Linn. The Lumpsucker. Pl. iii. B., fig. 58; pl. v., fig. 15.

The earstones of the lumpsucker are exceedingly small when compared with the size of the fish. In an example 15½ inches long the earstones measure only 1·4mm. in length by about 1mm. in depth, or about one two-hundred-and-eightieth part of the length of the fish. They are subrotund in form, but one side is straight or nearly so, while the other is boldly arcuate or gibbous. Both ends are rounded, but one of them, where it joins the nearly straight lateral margin, is moderately angular, as shown by the enlarged photograph (fig. 15, pl. v.).

Fam. Gobiesocidæ.

Genus *Anarrhichas.*

Anarrhichas lupus, Linn. The Cat or Wolf-fish. Pl. iii. B., figs. 40–43; pl. v., fig 21.

The earstones of the cat-fish are small in comparison with the size of the fish. Those of a specimen 27½ inches long measured about 4mm. in length by about 2·2mm. in depth, so that these earstones are only about the one hundred and seventy-fourth part of the length of the fish. They have a somewhat rugged appearance, resembling a rudely formed arrow-head, being broadest and thickest at the (?) posterior end, then tapering to a sharp point at the opposite extremity. The earstones of a fish 12 inches long did not differ greatly in shape from those of the larger example, but were considerably smaller, being only about 2·7mm. long by about 1·6mm. in depth (*see* fig. 43). They were proportionally rather larger than those of the larger fish, but small compared with those of the Gadoids. The earstones of other two examples of *Anarrhichas*, 12½ inches and 13½ inches in length, are represented by figures 42 and 41.

Fam. Blenniidæ.

Genus *Pholis.*

Pholis gunnellus, Linn. The Butter-fish. Pl. iii. B., figs. 38 and 39.

The earstones of the butter-fish are also very small. They are of an oval shape, but neither in form nor sculpture is there anything very characteristic about them. Those obtained from a fish 4½ inches long measured about 1mm. by ·6mm.

Genus *Enchelyopus.*

Enchelyopus (*Zoarces*) *viviparus*, Linn. Viviparous Blenny. Pl. iii. B., fig. 37 ; pl. v., fig. 31.

The viviparous blenny possesses earstones that somewhat resemble those of the mackerel in size as well as in form, but they appear to be rather larger in proportion to the size of the fish, and their upper margin is rather more boldly arcuate. A fish measuring 12 inches possessed earstones 4mm. in length by 2mm. in depth. They were thus about equal to one seventy-sixth part of the length of the fish.

Genus *Lumpenus.*

Lumpenus lampretiformis, Walb. Sharp-tailed Lumpenus. Pl. i. B., figs. 51–63 ; pl. iv., figs. 22, 23, and 26, 27.

The earstones of this species are small and oblong in shape. The upper margin is obscurely crenulated ; the anterior end is slightly notched, or pointed, while the other is subtruncate or bluntly rounded. Those represented by the figs. 57 and 58 are from two fishes 295mm. long, and measure about 3mm. in extreme length by 2mm. in width. Another fish 176mm. long had earstones measuring 2·5 by 1·3mm. (*see* fig. 63, pl. i. B., and fig. 27, pl. iv.).

Fam. Atherinidæ.

Genus *Atherina.*

Atherina presbyter, Cuvier. Sand Smelt. Pl. iii. B., figs. 34 and 35 ; pl. v., figs. 22 and 26.

The sand smelt has tolerably large earstones compared with the size of the fish. The larger of the two specimens examined, which measured about 5 inches in length, had earstones 4mm. long by 2·2mm. in depth, while those of the smaller fish, which was 3¼ inches in length, measured 2·3mm. by 1·5mm. The earstones of the larger fish were equal in length to about the one thirty-second part of the entire length of the fish. Both margins are even and arcuate, one end is bluntly rounded, but the other, in the earstones of the larger fish, terminates in a sharp and slightly hooked process, and in those of the smaller the same extremity is bluntly pointed.

Fam. Mugilidæ.

Genus *Mugil.*

Mugil chelo, Cuvier. The Thick-lipped Grey Mullet. Pl. iii. B., fig. 48; pl. v., fig. 12.

The earstones of the grey mullet are distinctly incurved and somewhat twisted, but this is not very clearly shown in the photograph. The lower margin is slightly thickened and nearly parallel with, but rather shorter than, the upper. The posterior end is abruptly truncated, the edge being crenulated, and in some examples deeply incised; the anterior extremity is obliquely truncated, the edge being thin and slightly irregular, while the angle is produced into a short tooth.

The fish from which the otoliths were obtained measured 15½ inches in length, and its earstones are 9mm. by 4·5mm.—they are thus equal in length to about the one forty-fourth part of the length of the fish.

Fam. LABRIDÆ.

Genus *Labrus.*

Labrus bergylta, Ascan. The Ballan Wrasse. Pl. ii. B, fig. 12–14; pl. v., fig. 8.

Three specimens of this *Labrus* have their earstones represented on pl. ii. B. They measured about 387mm., 330mm., and 254mm. respectively. The earstones are comparatively small—those of the larger fish (fig. 12) are about 5·4mm. in length by about 3mm. in depth. The length of these earstones is thus equal to about the one-seventieth part of the entire length of the fish. The specimen next in size had earstones slightly smaller (fig. 14), while the earstones of the third specimen (fig. 13) are a little over 4mm. long. The lower margin of the larger earstones is slightly arcuate and crenulated, especially the proximal half of it. The upper margin slopes upward in a nearly straight line from each end, so as to form an obtuse angle near the middle. The front end is deeply bifurcate, but the other terminates in a blunt point (*see* pl. v., fig. 8, which shows the otoliths greatly enlarged). The other earstones do not differ much from those described, except that the upper margin is not so distinctly angular.

Labrus mixtus, Linn. The Striped Wrasse. Pl. ii. B., fig. 15.

The earstones of this *Labrus* have a close resemblance to those of the ballan wrasse, and could scarcely be distinguished from them. Those represented by fig 15 were obtained from a fish 11¼ inches in length, and measure fully 5mm. each.

Labrus (Ctenolabrus) rupestris, Linn. Jago's Goldsinny. Pl. ii. B., fig. 16.

This is a smaller species of *Labrus* than the others, and the earstones are proportionally small. The fish which is here represented by its earstones measured about 4¼ inches in length (108mm.), and the size of its earstones is 3·2 by 1·6mm. They resemble those of the other species in their general character.

Fam. GADIDÆ.

Genus *Gadus.*

Gadus callarias, Linn. (syn, *Gadus morhua*, Linn.). The Codfish. Pl. i. A., figs. 1–10.

The otoliths of nearly all the species of *Gadus*, especially in those of adult size, are usually large, and massive in structure. One side is slightly concave and the other convex. The concave or exterior side is usually ornamented with ridges and furrows which are more regular and distinct in the otoliths of fishes that are young, or half-grown fishes. Those otoliths from codfish, particularly from examples 20 inches

long and upwards, differ in shape from the earstones of other species of *Gadus* in being distinctly wider at the anterior end, instead of having the upper and lower margins parallel or nearly so. The lower edge, which is longer than the upper, is only slightly convex, and in some cases nearly straight. A thick rib extends along the lower aspect of the convex or inner side, as indicated by the photographs (fig. 2), but the stones become thinner towards the upper edge. The upper edge is slightly convex and shorter than the lower. Anterior end obliquely truncated. Posterior end narrow, bluntly rounded, and terminating in a shallow depression. Upper and lower margins usually irregularly but distinctly crenulated. The pair of earstones represented on the plate by fig. 1 were removed from a codfish 40½ inches long; they measure about 21mm. in length by fully 10mm. in depth.* Figure 2 on the same plate represents the earstones of another fish 36½ inches long, which measure about 18mm. by fully 9mm. Below I give in tabular form the sizes of the earstones of other fishes represented on pl. i. A.

Figures on Plate i. A.	Length of Fish.	Earstones.	
		Length.	Depth.
3	15 inches.	About 13·0mm.	Nearly 6·0mm.
4	27½ ,,	,, 15·5mm.	7·5mm.
5	21 ,,	,, 14·5mm.	About 6·5mm.
6	10 ,,	,, 10·5mm.	,, 4·0mm.
7	9 ,,	,, 9·5mm.	,, 3·7mm.
8	5⅞ ,,	,, 6·5mm.	,, 2·5mm.
9	4¾ ,,	,, 5·7mm.	,, 2·3mm.
10	4⅓ ,,	,, 5·3mm.	Fully 2·0mm.

Gadus æglefinus, Linn. The Haddock. Pl. ii. A., figs. 1–5 and 9–16; pl. iv., figs. 1 and 2.

The earstones of tolerably large specimens of haddock have the upper margin nearly straight, and parallel with the lower margin; the crenulation of this margin is not very strongly marked, but the lower margin, which is slightly convex, is distinctly crenated. Among the haddocks examined for the purposes of this paper, one was thin and emaciated, and its earstones were not only comparatively narrow and elongated, but they were also devoid to a considerable extent of the grooves and ridges so characteristic of earstones of the normal type; this pair of earstones is represented by fig. 3., pl., ii. A.

A fairly large number of haddocks have been examined, and I find that most of those about 8 or 9 inches long have their earstones obliquely truncated in front, and that posteriorly the upper and lower margins converge, though somewhat unequally, to form a narrow, blunt pointed extremity. They are also laterally incurved, so that the hollow surface is toward the outside, the convex side being inside, as in those of the codfish. The earstones of the smaller haddocks are not so distinctly truncated in front, and the upper and lower margins are not parallel, but converge from the widest part near the anterior end gradually to the posterior extremity.

* These earstones are thus equal to about the one forty-ninth part of the entire length of the fish. In the other example specially referred to they are about the one fifty-first part of its length. The earstones appear to be proportionally longer in the smaller fish.

The outer surface was more distinctly ornamented with small rounded ridges and furrows extending to both margins, producing a crenulated edge nearly all round. The largest fishes—4 in number—which are represented here by photographs of their earstones, range from 17¾ inches to 18½ inches in length. The length of the earstones varied from a little over 16mm. to 18mm., and the variation in depth is slightly over 1mm. The annexed Table gives the sizes of the various fishes and of their earstones:—

Figure on the Plate.	Length of Fish.	Earstones.	
		Length.	Depth.
1 (Pl. ii. A.) ...	18 inches, ...	17·0mm. ...	6·2mm.
2 ,, ...	18½ ,, ...	17·3mm. ...	6·3mm.
3 ,, ...	17¾ ,, ... (Fish very emaciated.)	One 18·0mm. and one 18·5mm.	About 5·6mm.
4 ,, ...	17¾ ,, ...	One 16·2mm. and one about 17mm. ...	6·3mm.
5 ,, ...	14⅜ ,, ...	16·0mm. ...	*5·0mm. to 5·5mm.
9 ,, ...	13½ ,, ...	14·7mm. ...	Fully 5·0mm.
10 ,, ...	12 ,, ...	13·3mm. ...	4·5mm.
11 ,, ...	10⅜ ,, ...	11·5mm. ...	4·3mm.
12 ,, ...	9¾ ,, ...	11·5mm. ...	4·3mm.
13 ,, ...	8¾ ,, ...	11·2mm. ...	4·3mm. to 4·5mm.
14 ,, ... 15 ,, ... †16 ,, ...	6½–5⅞ ,, ...	8–8·5mm. ...	About 3·0mm.

It will be observed that the length of the haddock's earstones in proportion to the length of the fish is greater than in the case of the codfish. In the two largest haddocks referred to here the earstones are nearly equal to the one twenty-seventh part of the length of the fish, while in one example, 8¾ inches in length, they reach to about one-twentieth part of the length of the fish.

Gadus luscus, Linn. The Brassie or Bib. Pl. ii. A., figs. 17–24; pl. iv., fig. 3.

The larger examples of the brassie possess earstones even more massive in structure than those of the haddock or codfish. The outer surface, which is distinctly incurved, is also more coarsely rugose, being ornamented with somewhat irregular and comparatively large rounded bosses, especially on the lower aspect of the exterior surface. These bosses, and to some extent the whole outer surface as well, have a polished and glassy appearance. The inner surface is convex and nearly smooth. The anterior end is obliquely truncated, and the anterior portion of the upper margin is nearly straight and parallel with the lower; then it gradually converges towards the lower edge till both meet in the moderately sharp-pointed posterior extremity. The massive structure of these otoliths is observable even in the smaller specimens. A brassie about 14 inches

* Another haddock, 14 inches long, had massive earstones 16mm. in length by 6·5mm. in width. These are shown on pl. iv., fig. 2.

† The pair of earstones represented by fig. 16, pl. ii. A., are shown greatly enlarged on pl. iv., fig. 1, and the ridges and furrows on the outer surface are more clearly indicated in the figure.

long had very massive otoliths; they measured about 13·5mm. in length by 6·5mm. at the deepest part (these are represented by fig. 24). Those of a somewhat smaller fish were equally massive but rather shorter, measuring about 12·2mm. by 6mm. A number of other specimens of the same species have been examined, and measurements of six of them with the corresponding sizes of their earstones are given in the Table annexed.

Figure on the Plate.	Length of the Fish.	Earstones.	
		Length.	Depth.
17 (Pl. ii. A.)	89mm.	About 5·0mm.	2·5mm.
18 ,,	110mm.	,, 6·0mm.	3·0mm.
19 ,,	162mm.	,, 8·0mm.	Fully 4·0mm.
20 ,,	210mm.	,, 10·5mm.	4·5mm.
21 ,,	11¼ inches.	,, 11·0mm.	5·3mm.
22 ,,	11½ ,,	,, 11·4mm.	5·5mm.

In the larger examples of the brassies referred to here the proportion that the length of the earstones bears to the length of the fish is about the one twenty-sixth part, but it appears to become greater in the smaller fishes as in the case of the haddocks.

Gadus minutus, Linn. The Poor Cod.

This species is nearly allied to the last, and appears to possess somewhat similar earstones. No specimens are represented by the photographs.

Gadus esmarkii, Nilsson. The Norway Pout. Pl. ii. A., figs. 25-28.

Four specimens of *Gadus esmarkii* are represented by their earstones on pl. ii. A. They measured respectively 6⅝ inches, 5¾ inches, 4¼ inches, and 4 inches. Their earstones have a tolerably close resemblance to those of small *Gadus luscus*, but they are scarcely so massively formed, and are rather longer and narrower. Those removed from the largest specimen of *Gadus esmarkii* measured about 7·5mm. in length by fully 3mm. in depth, and those of the next three specimens measured about 6·5mm., 5·2mm., and 5mm. in length, and their depths varied in a corresponding degree. The earstones of the largest specimen were, as indicated by the foregoing measurements, about the one twenty-second part of the entire length of the fish.

Gadus poutassou, Risso. Couch's Whiting. Pl. ii. A., fig. 29; pl. iv., fig. 5.

This species is represented by a single pair of otoliths; they are from a fish 155mm. (fully 6 inches) in length, and measure 8·5mm. long by nearly 3mm. in depth. In their shape and sculpture they have a general resemblance to those of *Gadus esmarkii*, but are rather more slender and elongated. The anterior end is bluntly rounded, the upper and lower margins taper in a nearly uniform manner to the sharp-pointed distal extremity, and both margins are crenulated. The exterior side is only slightly incurved and moderately rugose, and the inner surface is nearly smooth.

Gadus merlangus, Linn. The Whiting. Pl. ii. A., figs. 6–8, 30 and 31.

The earstones of numerous whitings have been examined, and all, except those of very small specimens, agree in the peculiar form by which they may be distinguished from other species of *Gadus*. They are elongated and narrow. The lower margin is tolerably even and slightly convex. The anterior end is obliquely truncated, and with the edge usually crenulate. The upper margin, for about two-thirds of its length, from the anterior extremity, is nearly straight and parallel with the lower edge, then it gradually converges towards the lower margin, so that the posterior end is narrow and tapering and has a sharp-pointed termination. The earstones are somewhat concave outwardly, and slightly convex and nearly smooth on the inside. The lower edge is tolerably thick, while the upper, especially where it begins to taper towards the posterior end, is compressed and thin.

Photographs are given of the earstones of five whitings which measured respectively 14 inches, $12\frac{1}{8}$ inches, $11\frac{3}{8}$ inches, $11\frac{3}{4}$ inches, and 9 inches in extreme length, and the size of their earstones given in the same order is as follows :—20mm. long by 5mm. in greatest width (fig. 30), 16mm. by about 4·5mm. (fig. 8), 16·5mm. by nearly 5mm. (fig. 7), 15mm. by about 4·7mm. (fig. 6), and 12·5mm. by about 4mm. (fig. 31). The earstones of two young whitings, about 68mm. ($2\frac{3}{4}$ inches) in length, but which are not represented among those photographed, measured 3·5mm. by about 1·5mm., which is fully twice the length of those of a lumpsucker $15\frac{1}{2}$ inches long.

By comparing the length of the earstones of a number of whiting of average size with the length of the fish they were taken from I found that, though the proportion varied to some extent, the length of the earstones approximated to about one-eighteenth part of the extreme length of the fish.

The proportion between the length of the earstones and of the fish they belong to varies considerably in the different kinds of fish. An examination of numerous examples of fish belonging to various species seems also to indicate that where the earstones are massive in structure, as in some of the Gadoids, they are shorter in proportion to the length of the fish than those that are thin and narrow. This may tend to explain why the earstones of the whiting are generally proportionally more elongated than those of the haddock or codfish.

Gadus virens, Linn. The Saithe or Coal-fish. Pl. i. A., figs. 14–16.

The earstones of large coal-fish are very massive in structure. Fig. 14 represents those of a fish of average size, but I am unable to state the exact length of the fish, though it could not be much under 36 inches. These earstones measure about 24mm. long by about 8mm. in greatest width. The upper and lower margins are tolerably straight and nearly parallel, and they are slightly crenulated along the edges. The front end is somewhat obliquely truncated, but at the posterior end the upper and lower margins converge so that they meet and terminate in a blunt point. They are also slightly twisted, and have the outer side incurved and slightly rugose, while the inner side is convex and nearly smooth.

Figs. 15 and 16 represent the earstones of two saithe about 15 inches long; they are narrow and elongated, and small when compared with those of the whiting. These earstones measure from 11mm. to about 11·5mm. in length, which is equal to about the one thirty-third part of

the length of the fish. This shows a somewhat marked difference from those of the whiting 14 inches long that measured 20mm. in length, or about the one-eighteenth part of the length of the fish.

Gadus pollachius (Cuv.). The Pollack or Lythe. Pl. i. A., figs. 11–13.

The lythe has earstones closely resembling those of the saithe in shape, in size, and sculpture. Fig. 11 represents the otoliths of a lythe 31 inches long; they measure about 20mm. in length by about 8mm. in greatest width. The length of these otoliths in proportion to the length of the fish is scarcely equal to half the length of those of the whiting referred to above, but what is wanting in length is made up by their more massive structure. Figs. 12 and 13 represent the earstones of two smaller fishes, but their lengths have not been recorded.

Genus *Merlucius*.

Merlucius merluccius (Linn.). The Hake. Pl. iii. A., figs. 32–35.

The earstones of the hake differ remarkably from those of other British Gadoids. They are thin and leaf-like, and are somewhat ovate in outline; they are broadest near the anterior end, and thence taper gradually backwards to the narrow distal extremity. The lower side has an evenly, but not very boldly, rounded edge that extends unbroken from the front to the posterior end. The upper edge is very thin and more or less finely serrated, the divisions between the serrations being in some parts very distinct; near the anterior end this margin rises into a prominent angle and forms the widest (or deepest) part of the earstone. Immediately posterior to this angle the margin is slightly concave, and this imparts to the angular prominence a somewhat gibbous appearance, as shown in the figure; from this point the margin slopes gradually to the distal end. The earstones of comparatively small fishes show the same gibbous appearance. The posterior end of the earstones is somewhat narrow and sharp-pointed. The fish from which the largest earstone, shown on pl. iii. A. (fig. 33), was taken was a tolerably large one, but its length was not recorded. This earstone measures about 27·5mm. long by fully 9mm. in greatest width. The next largest of the otoliths represented by the figures were from a rather smaller fish than the one just referred to, but its length has also not been recorded. These otoliths are about 25mm. in length, and their greatest width nearly 9mm. Two otoliths from a hake 16 inches long (fig. 34) measure nearly 17mm. by about 6mm., and another fish 14½ inches long was furnished with earstones 16mm. in length by about 5·5mm. in greatest depth. In these last two examples the length of the earstones is equal to one twenty-fourth and one twenty-third part of the entire length of the fishes they were taken from.

Genus *Phycis*.

Phycis blennoides (Brün.). The Greater Forkbeard. Pl. i. A., fig. 27.

The earstones from a moderately large specimen of the greater forkbeard are represented by fig. 27 on pl. i. A. This fish, the size of which was not recorded, possessed tolerably large earstones. They measure about 16·5mm. in length by 6·5mm. in depth. The upper margin, which is nearly straight, has the edge moderately sharp and irregularly serrate, while the anterior extremity is obliquely truncated. The lower margin is boldly arched and somewhat angular in the middle, and converges

posteriorly towards the upper margin more than it does forward, and the posterior end is therefore moderately narrow and is also bluntly rounded, as shown by the photograph. The earstones are slightly concave outwardly and considerably thickened towards the anterior end, especially on the lower aspect.

Genus *Molua.*

Molua molva (Linn.). The Ling. Pl. i. A., figs. 19–26.

The earstones represented by fig. 19 were obtained from a medium-sized ling, but the exact length of the fish was not stated. These earstones have a general resemblance to those of the coal-fish and lythe. The anterior end, however, is not angular but forms a bold curve, which merges into the upper margin. This margin is only slightly arched in the middle part, then slopes posteriorly to the sub-central and narrow rounded distal extremity; lower margin nearly straight except near the posterior end, where it converges to meet the upper margin. The otoliths are about 20mm. in length by about 8mm. in their greatest width. The earstones of young ling apparently differ to some extent from those of larger fish in their form and structure. Fig. 22 represents the earstones of a fish 22½ inches long, and though the general contour is similar to the larger otoliths, the upper margin is not regular. These earstones measure only about 9mm. in length. Fig. 23 represents the earstones obtained from a ling about 10½ inches long, and which measure fully 5·5mm. Figs. 24 to 26 represent the earstones of smaller specimens of ling ranging from 8¾ inches to 7 inches in extreme length.

Genus *Onos.*

Onos tricirratus (Brün.). The Three-Bearded Rockling. Pl. i. B., figs. 9–12; pl. iv., fig. 18.

The three-bearded rocklings possess earstones that are narrow and elongated; the upper and lower margins are nearly parallel, and when viewed from the side are seen to be slightly sigmoid in outline and somewhat twisted. Those represented by fig. 11 were obtained from a fish 15 inches long, and measure nearly 8mm. in length—equal to about the one twenty-sixth part of the entire length of the fish—and they are about 4 times longer than broad. These earstones appear, however, to vary a good deal in length, for those taken from another fish only a little shorter than the one just referred to measured about 6·2mm., but the width is about the same as that of the other. It was also observed that the otoliths of small fishes did not possess the sigmoid outline that characterises the adult examples. Two specimens 11⅞ inches and 8 inches long respectively had earstones measuring 4·5mm. and 3·5mm —the last wanted the sigmoid appearance already referred to (*see* figs. 10 and 9).

Onos cimbrius (Linn.). The Four-Bearded Rockling. Pl. i. B., figs. 13–17; pl. iv., fig. 10–11.

This species possesses earstones quite distinct from those of the three-bearded rockling; their outltne is obscurely triangular, two sides being nearly equal and shorter than the third side, and this difference is noticeable in the earstones of even small examples. Those represented by fig. 13 were removed from the ear-chambers of one of the largest of the fishes examined. This fish measured 260mm. (fully 10 inches), while the extreme length of the earstones was only 5·0mm. and the greatest width 2·5mm. These earstones are thus only about the one-fiftieth part of the

entire length of the fish. The annexed table contains the measurements of a few of the other fishes examined and of the sizes of their otoliths.

Figure on the plate. (i. B.)	Length of the fish.	Earstones.	
		Length.	Depth.
14	220mm.	3·7mm.	2·0mm.
15	185mm.	3·1mm.	1·7mm.
16	177mm.	3·1mm.	1·7mm.
17	165mm.	3·1mm.	1·7mm.

The earstones of the three smallest fishes are almost identical in size and shape.

Genus *Raniceps.*

Raniceps raninus (Linn.). The Lesser Fork-beard. Pl. i. B., figs. 1–8; pl. iv., fig. 6.

The earstones of the lesser fork-beard or tadpole fish are tolerably large; their outline forms a nearly regular oval; both the lower and upper margins are moderately thin and convex, and converge towards both ends which are narrow and rounded, but the posterior extremity is more pointed than the other. A thickened but obscurely defined rib extends along the middle line from end to end, and gives a massive appearance to the otolith. The largest fish represented here was 12 inches long, and its earstones measured—one, fully 14mm., the other 15mm. in length and about 7mm. in greatest width, so that in this example the length of the earstones is equal to about the one twenty-second part of the entire length of the fish.

Fig. 5 represents the earstones of a fish about $8\frac{3}{4}$ inches long, and as they measure about 11mm. in length they show almost the same proportion to the length of the fish as the other—viz., about one-twentieth part. Fig. 7 represents the earstones of another fish that measured about 180mm., and as the earstones are nearly 10mm. in length, it seems to bear out what has been already stated, that in some species and within certain limits the smaller fishes possess earstones relatively larger in proportion to the length of the fish than the adult specimens. The annexed Table gives the length of a number of the fishes examined, with the sizes of their otoliths:—

Figure on the Plate. (i. B.)	Length of the Fish.	Earstones.	
		Length.	Depth.
1 ...	12 inches, ...	1 fully 14 and 1 nearly 15mm.	7·0mm.
2 ..	$10\frac{1}{2}$,, ...	Average of the two, 12·5mm.	6·0mm.
3 ..	$9\frac{3}{4}$,, ...	12·3mm. ...	5·5mm.
4 ...	$9\frac{1}{4}$,, ...	12·0mm. ...	5·3mm.
5 ...	$8\frac{3}{4}$,, ...	11·2mm. ...	4·5mm.
6 ...	$7\frac{7}{8}$,, ...	10·7mm. ...	4·5mm.
7 ...	$7\frac{1}{8}$,, ...	9·8mm. ...	4·5mm.
8 ...	4 ,, ...	2·4mm. ...	1·0mm.

The last example had earstones so small as to be greatly out of proportion to the length of the fish when compared with the others in the series. I mention the fact in order that further attention may be drawn to it.

Fam. Ophidiidæ.

Genus *Ammodytes.*

Ammodytes tobianus, Linn. The Lesser Sand-eel. Pl. i. B., figs. 64 and 65.

The earstones of the sand-eels are very small, and their general outline is oval, but somewhat narrow and pointed at the posterior end. The earstones represented by fig. 64 were obtained from a fish 7 inches long, and they measured 3·5mm. by about 1·6mm., while those represented by fig. 65 are only about 2·5mm. by 1·0mm., and were obtained from a fish 125mm. (5 inches) in length.

Fam. Pleuronectidæ.

Genus *Hippoglossus.*

Hippoglossus vulgaris, Flem. The Halibut. Pl. iii. A., figs. 1–6 and 14.

The earstones represented by fig. 1 are those of a halibut that weighed 179 lbs. (or within 2 lbs. of 13 stone). The fish was captured in 1884, when I obtained the head of it for examination; the length of the fish was not recorded. The otoliths measure from 17mm. to 18mm. in length by about 11mm. in width, but the two differ slightly in size. Those represented by fig. 14 were removed from a small halibut about 18¼ inches long, and these otoliths measure about 8·5mm. in length by about 5mm. in depth. In this example the length of the earstones is only equal to about one fifty-fourth part of the entire length of the fish. The earstones represented by figs. 3 and 4 are from two fishes that are each about 11¾ inches in length, and they measure 6mm. by about 3·5mm., while those represented by figs. 4 and 5 are from fishes measuring respectively 260mm. and 220mm. in length.

In this species, as in most of the Pleuronectidæ, the earstones are flat and moderately thin. Those of the large halibut mentioned above have a somewhat irregular outline; on one side the margin is nearly straight, while the margin opposite is somewhat convex, and exhibits in one of the otoliths a distinctly crenulated edge. One end is obliquely truncate, but in the case of one of the stones the other end has a wide shallow notch, while the other otolith is furnished with a hook-like process. The earstones of the smaller fishes are ovate, and have a rather more regular outline; the posterior end is somewhat truncated, but the anterior end is narrow and rounded.

Genus *Drepanopsetta.*

Drepanopsetta platessoides (Fabr.). Long Rough Dab. Pl. iii. A., figs. 7–13.

In this species the earstones of the larger fishes are broadly ovate, the length being only about one-third more than the greatest width. The upper margin is distinctly arched, but the lower is only slightly and irre-

gularly convex. One end is subtruncate, but the other is broadly rounded. The earstones of a considerable number of long rough dabs have been examined, and it has been noticed that though the larger examples retained their characteristic shape there was some variation in the proportion of their sizes to the length of fishes they belonged to. The two largest of the fishes among the number selected for this paper measured respectively 370mm. and 317mm. in length, their earstones—represented by figs. 7 and 8—are almost identical in size, and measured about 7·5mm. and 5mm. in length and width. It has been observed that the length of the earstones of most of the Pleuronectids examined are shorter in proportion to the length of the fish than those of the more typical Gadoids. The earstones of the two fishes mentioned above averaged, roughly, about the one forty-fifth or forty-sixth part of the average length of the fishes. It has also been noticed that where there is an increase in the width of the otoliths there is to some extent a corresponding decrease in the length.

In the annexed Table the length of other five examples of long rough dabs are given, with the lengths of their earstones:—

Figure on the Plate. (iii. A.)	Length of the Fish.	Earstones.	
		Length.	Depth.
9	10 inches.	About 6·5mm.	One 4·5mm. and one 5·0mm.
10	8 ,,	,, 5·3mm.	About 3·8mm.
11	7 ,,	,, 4·8mm.	,, 3·5mm.
12	5 ,,	Fully 3·0mm.	,, 2·5mm.
13	3½ ,,	About 2·5mm.	,, 2·0mm.

The earstones of the smaller fishes become more and more rotundate as the length of the fishes decrease.

Genus *Bothus*.

Bothus maximus (Linn.). The Turbot. Pl. i. B., fig. 33.

The earstones represented by fig. 33 were from a turbot of about the average size (about 20 inches in length). One of them, which is barely 6mm. over all, in its general outline is very like one of those of the large halibut already referred to (fig. 1, pl. iii. A.), but much smaller, and it is fully 4mm. in width; the other earstone, which is nearly of the same length as the first, but about 4·5mm. in depth (or width), has a somewhat different form, and differs also in having the entire margin distinctly crenulated. This difference between these two earstones may be only accidental, but the otoliths of another fish to be presently described show that such variation may be normal. Whether it be so in the present case, however, can only be ascertained by the examination of several specimens of different sizes, but not the very young, where variations of this kind tend to disappear.

The earstones of the brill, *Bothus rhombus*, are not represented among the specimens photographed, but they appear to resemble those of the turbot.

Genus *Zeugopterus.*

Zeugopterus punctatus (Bloch). Müller's Topknot. Pl. i. B., figs. 42 and 43.

The earstones represented by the figures 42 and 43 are from two fishes, one of them being 8½ inches and the other 5½ inches in length. These earstones are small and somewhat oval in shape, but deeply notched and truncate in front. One side, the inner one, is slightly convex and is longitudinally grooved, but the reverse side is smooth. Those of the larger fish are nearly 4mm. long by 2·5mm. in greatest width; those of the other fish are 3mm. in length, and rather wider than the larger one.

Genus *Lepidorhombus.*

Lepidorhombus Whiff (Walb.). Sail Fluke, Whiff, or Megrim. Pl. i. B., figs. 31 and 32; pl. ii. B., figs. 1–5; pl. v., figs. 1 and 2.

The earstones of a megrim about 17 inches long are represented by fig. 1, pl. ii. B., and fig. 2, pl. v., and they measure about 7mm. in length by nearly 5mm. in greatest width. The length of these earstones is thus about the one-sixtieth part of the entire length of the fish.

In the megrim, as has been already stated, the earstone on the left side differs somewhat in shape from the one on the right side, and this difference is observable even in the earstones of the smaller fishes, but perhaps not in very young specimens; I find that in such specimens the characteristics peculiar to the species or genus are usually obscure or undeveloped. This will be more readily perceived by comparing the photographs of the earstones of the larger megrim mentioned above with those of the two smaller fishes represented by figs. 31 and 32, pl. i. B., and which measure respectively 168mm. and 87mm. in length. Compare also with the earstones represented by fig. 5, pl. ii. B., which are those of a fish 11 inches in length.

In the examination of large fishes or of those of moderate size the difference in the shape of the earstones is readily noticed, one of them being pear-shaped—that is, broadly truncated and somewhat emarginate at the posterior end, with the lateral margins boldly rounded and converging towards the narrow anterior extremity; the lower edge is tolerably even, but the other is scarcely so regular. The curve of the two sides is slightly different, and this makes the anterior extremity appear as if it were turned somewhat upward. Each earstone is also slightly incurved on the outer aspects, the inner being correspondingly convex.

The other earstone, like the last, is also widest posteriorly, but the posterior end is obliquely truncated and deeply, and sometimes irregularly, notched. The entire lower edge is boldly curved and tolerably even, but the upper margin, though it has the posterior portion nearly straight or slightly rounded, and more or less distinctly crenulated, is towards the front end interrupted by a considerable break in its continuity; this break appears to be more distinct in the earstones of larger fishes, and the presence of this break causes the anterior extremity to terminate in a tolerably sharp point.

I have already given the size of the earstones of the largest fish examined, and the sizes of a few of the others will be found in the annexed Table.

Figure on the Plate.	Length of the Fish.	Earstones.	
		Length.	Width.
2 (Pl. ii. B.)	16¼ inches.	About 6·5mm.	4·5mm.
3 ,,	14 ,,	,, 5·3mm.	4·0mm.
4 ,,	12 ,,	,, 5·0mm.	3·5mm.
5 ,,	11 ,,	,, 5·0mm.	One 3·5mm., other rather less.
32 (Pl. i. B.)	165·0mm.	,, 3·6mm.	2·5mm.
33 ,,	87·0mm.	,, 2·0mm.	1·5mm.

It will be noticed that while in the case of the first four the earstones are only about one-sixtieth or sixty-fourth part of the length of the fishes they belonged to, the earstones of the smaller fishes are proportionally larger, as in some other examples previously mentioned.

Genus *Platophrys.*

Platophrys laterna (Walb.). The Scald-fish. Pl. i. B., fig. 30.

The earstones of a single example of the scald-fish are represented here. They are from a fish measuring 138mm. (about 5½ inches) in length, and are of an oblong form. The posterior end is truncated, and there is a small notch at the anterior extremity. They measure about 3mm. long by about 2mm. in width.

Genus *Pleuronectes.*

Pleuronectes platessa (Linn.). The Plaice. Pl. iii. A., figs. 15–21.

The earstones of seven examples of plaice, the length of which ranges from 610mm. (about 24 inches) to 64mm., are shown on pl. iii. A. The large pair have a tolerably massive structure, and are of an oval shape; the posterior end is moderately broad and somewhat obliquely truncated, while the anterior end is tolerably narrow and rounded; the lower margin is evenly, but not very boldly, rounded or much thickened. The upper edge, which is thicker than the other, is moderately straight but of a somewhat irregular outline, and exhibits a shallow notch near the middle. They measure about 12mm. long by about 7·5mm. broad. They are thus about one-fiftieth part of the entire length of the fish. The other earstones represented by the photographs are from comparatively small fishes, the lengths of which, and of their earstones, are given in the annexed Table.

Figure on the Plate. (iii. A.)	Length of the Fish.	Earstones.	
		Length.	Width.
16	287mm.	About 6·5mm.	Nearly 4·5mm.
17	273mm.	,, 6·2mm.	About 4·5mm.
18	273mm.	,, 6·0mm.	,, 4·0mm.
19	160mm.	,, 4·0mm.	,, 2·8mm.
20	91mm.	,, 2·5mm.	,, 2·0mm.
21	64mm.	,, 2·0mm.	,, 1·5mm.

The earstones of two other plaice, each about 456mm. long (not represented among the photographs), measured fully 6·5mm. in length by about 5·5mm. at their greatest width, and 9mm. by nearly 6mm., and thus agreeing fairly well with the others in their proportion to the length of the fishes they belonged to.

On comparing the earstones of the smaller halibut with those of the larger specimens of long rough dabs and plaice, a certain similarity may be traced both in the general form of the otoliths and of their markings as well as in the proportion of the length to the depth (or width). It will be seen that they are all broadly oval in outline, their lower edge is evenly rounded, and the widest part of the otolith is apparently at the posterior end. The earstones of *Pleuronectes flesus* and *Pleuronectes limanda*, and of one or two others, are also somewhat similar in form to those referred to. There is, however, at least one notable exception in the Genus *Pleuronectes*, *P. cynoglossus*, or the Witch Sole, to be referred to presently, the earstones of which are nearly circular in outline instead of being oval.

Pleuronectes microcephalus, Don. The Lemon Dab. Pl. i. B., figs. 19–25.

The earstones of the lemon dab are comparatively small and are not very distinctly characterised. Fig. 19 represents those of a fish 15 inches long, and they only measure a little over 4mm. by about 2·5mm. To show how small these earstones are it is only necessary to mention that those of a long rough dab scarcely as large as this species had earstones nearly double their length, while the earstones of a plaice that was at least 4 inches shorter were one and a half times as long. In the annexed Table the sizes of several other lemon dabs are given whose earstones are represented by photographs on the accompanying plates.

Figure on the Plate. (i. B.)	Size of the Fish.	Earstones.	
		Length.	Depth.
20	12 inches.	3·5mm.	2·0mm.
21	7¾ ,,	3·0mm.	1·5mm.
22	6¾ ,,	2·8mm.	1·5mm.
23	5½ ,,	2·5mm.	1·3mm.
24	4¾ ,,	2·0mm.	1·0mm. fully.
25	3½ ,,	1·7mm.	1·0mm.

The earstones represented by fig. 20 have the upper and lower margins nearly parallel, one end is obliquely truncated, but the other is pointed; in the smaller specimens both ends are rounded, and they are all proportionally smaller than those of the plaice or the long rough dab.

Pleuronectes flesus, Linn. The Flounder or Fluke. Pl. i. B., fig. 18.

The earstones represented by fig. 18 were obtained from a fish of average size, but its exact length was not recorded, and they are the only examples included among the photographs of the present series. They have an outline somewhat resembling the earstones of the plaice, and measure about 6·5mm. in length by fully 4·5mm. at the widest part.

They are broadly ovate, and the margins are obscurely crenulated; they are also moderately thin, and at the time they were removed from the fish the concentric growth-lines were very distinct.

Pleuronectes limanda, Linn. The Dab. Pl. ii. B., figs. 28 and 29; pl. iii. A., figs. 27–31.

The earstones represented by figs. 27 and 28, pl. iii. A., are from dabs of moderate size (8 to 9 inches long), but their exact length was not recorded. They have a tolerable resemblance to the earstones of young halibut, represented by figs. 2 to 5 on the same plate (pl. iii. A.). They measure about 5mm. in length by about 3mm. in depth. Figs. 29 to 30 represent the earstones of fishes measuring $7\frac{3}{4}$ inches, $5\frac{3}{4}$ inches, and $4\frac{1}{2}$ inches long, while the earstones themselves measure about 4·5mm., 3·5mm., and 3mm. respectively, their width being about two-thirds of the length.

Pleuronectes cynoglossus, Linn. The Witch Sole. Pl. i. B., figs. 26–29; pl. iii. A., figs. 22–26; pl. iv., fig. 30.

The witch sole has earstones which differ very distinctly in shape from all the other species of Pleuronectes referred to here. They are large in proportion to the size of the fish, very flat, and nearly circular in outline, and it is in this latter respect that they differ so distinctly from the other species.

The largest of the witch soles mentioned here measured 16 inches in length, and its earstones (pl. iii. A., fig. 22) were fully 8mm. across their longest diameter by about 7·5mm. across the narrowest part. The lower margin is nearly straight, but otherwise the outline is almost circular. The longest diameter of these earstones is about one-fiftieth part of the entire length of the fish. The other specimens whose earstones are represented here were of various sizes, and all of them smaller than the one referred to above. The length of the different specimens and the size of their earstones are given in the annexed Table.

Figure on the Plate.	Length of the Fish.	Earstones.	
		Length.	Width.
26 (pl. i. B.)	170mm.	3·5mm.	3.5mm.
27 ,,	165mm.	3·5mm.	3·2mm.
28 ,,	160mm.	3·5mm.	3·3mm.
29 ,,	153mm.	3·2mm.	3·0mm. fully.
23 (pl. iii. A.	12 inches.	5·5mm.	5·0mm.
24 ,,	$11\frac{1}{2}$,,	One 5·5mm. and one 5·0mm.	One 5·0mm. and one 4·7mm.
25 ,,	$10\frac{1}{2}$,,	5·0mm.	4·5mm.
26 ,,	$9\frac{3}{4}$,,	4·3mm.	4·2mm.

It will be observed that the earstones represented by fig. 26 (pl. iii. A.) have about the same proportion to the length of the fish as that of the larger examples specially referred to, while a slight variation is observable in the length of the earstones of the smaller fishes.

Genus *Solea.*

Solea vulgaris, Quensel. The Black Sole. Pl. i. B., fig. 34; pl. iv., fig. 17.

A single pair of earstones are represented among the photographs given here. They are from a fish of scarcely average size, its entire length being only 12½ inches, but they represent the characteristic form and size of the earstones of *Solea vulgaris.* The earstones of this specimen were 5mm. across the longer diameter, by fully 4mm. in width, so that they are equal to about one sixty-third part of the entire length of the fish. A smaller specimen, whose earstones are not represented on the plate, measured about 240mm., and its otoliths about 3·5mm. by 3mm. fully. The earstones of this specimen were therefore only about the one sixty-ninth part of the length of the fish.

These earstones have an obscurely quadrilateral outline, a side and an end being nearly at right angles with each other. The remaining side and end are slightly arched, as shown in the figure. The earstones of the smaller fish just mentioned have also an outline similar to that described.

Solea variegata, Don. The variegated Sole or Thickback. Pl. i. B., figs. 35 and 36; pl. iv., figs. 28 and 29.

The earstones of two specimens of this species of sole, nearly of the same size, are shown on pl. i. B., and by figures considerably enlarged on pl. iv. The specimens measured respectively 140mm. and 137mm. in length. Their earstones are flat, almost circular, disks measuring about 3mm. across the longer, by nearly 2·5mm. across the shorter diameter. The size of these earstones in proportion to the length of the fish is therefore greater than that of the black soles mentioned above.

Solea lutea, Risso. The Solenette. Pl. i. B., fig. 37–41; pl. iv., figs. 24 and 25.

A number of solenettes have been examined for their earstones, and a few of them are represented among the photographs. These earstones are very small and have little to characterise them except that they are flat, and nearly circular in outline. The size of the different fishes and of their earstones are given in the annexed Table.

Figure on the Plate.	Length of the Fish.	Earstones.	
		Length.	Width.
37 (pl. i. B.; pl. iv., fig. 24).	117mm.	3·0mm.	2·2mm.
38 (pl. i. B.; pl. iv., fig. 25).	98mm.	2·0mm.	1·5mm.
39 (pl. i. B.)	90mm.	About 2·0mm.	1·5mm.
40 ,,	76mm.	1·7mm.	1·5mm.
41 ,,	64mm.	1·5mm.	1·5mm.

Fam. SALMONIDÆ.

Genus *Salmo.*

Salmo salar, Linn. The Salmon. Pl. ii. B., fig. 31; pl. v., fig. 9.

The earstone represented by fig. 31., pl. ii. B., measures about 7mm. in length and about 3·6mm. in depth. The length of the fish they were obtained from has not been recorded; I may mention, however, that those represented by fig. 9 on pl. v. are from a salmon weighing about 10 lbs., but, as in the previous example, the length of this fish was not stated. The earstones are of an oval form, with both ends moderately narrow and bluntly pointed, but one end is more drawn out than the other, as shown in fig. 9.

Salmo (?) *fario*, Linn. The Brown Trout. Pl. ii. B., fig. 30.

The earstones represented on pl. ii. B. are from a trout weighing three quarters of a pound, which was caught in Loch Thom, near Greenock, many years ago.

Genus *Coregonus.*

Coregonus lavaretus, Penn. The Powan (or Pollan). Pl. ii. B., figs. 25–27; pl. v., fig. 29.

The earstones represented on pl. ii. B. are from Loch Lomond powans measuring 8½ inches, 8 inches, and 7½ inches in length. Those from the first two fishes are nearly of the same size—viz., about 5·5mm. long by 3mm. in greatest width, one of the ends—(?) the anterior—is moderately broad and has a rounded margin, but the other end is pointed; the lower margin is tolerably even, while the upper, which anteriorly is nearly parallel with the lower, slopes from about the middle to the pointed extremity at the posterior end. The earstones of the smaller fish measure about 5mm. in length and 2·5mm. in depth, and these have the posterior end rather more pointed than in the others.

Genus *Argentina.*

Argentina sphyræna, Linn. The Hebridean Smelt. Pl. i. B., figs. 44 and 45; pl. iv., fig. 9.

The Hebridean smelt is one of a small number of fishes that possess earstones of a shape so unlike those of other fishes that there can be little difficulty in determining the species the fish belongs to by the earstones alone. The earstones of two specimens are represented by the photographs—figs. 44 and 45, pl. i. B. Fig. 9, pl. iv., gives a greatly enlarged representation of those in fig. 44. The fishes from which these earstones were obtained measured 8½ inches and 8 inches respectively, while the earstones themselves measured about 3·5mm. in extreme length and depth—the length and depth being about equal. These earstones, which differ in form from those of the other fishes mentioned in this paper, may be described as broadly scaphoid or boat-shaped, the short lower margin representing the keel, and the longer upper margin with its two small prominences being the deck, while the obliquely truncated anterior end represents the bow, and the other and nearly rectangular end the stern. The extreme length of these earstones is rather more than the one-sixtieth part of the length of the fish.

Fam. ESOCIDÆ.

Genus *Esox.*

Esox lucius, Linn. The Fresh-water Pike. Pl. iii. B., fig. 60; pl. v., fig. 20.

The fresh-water pike from which the earstones represented on pl. iii. B. were obtained was of moderate size, but its length has not been recorded. There were three otoliths of moderate size in each ear-chamber, and one or two smaller ones. The largest stones measured about 9mm. in length by 5mm. in greatest width. They are very irregular in outline, especially along the upper margin and round the (?) anterior end. The lower margin is tolerably even and slightly arcuate; the anterior end is broad and deeply notched, and the anterior portion of the upper margin, which is nearly straight, is separated from the posterior portion by an abrupt break in its continuity—this latter portion being narrow, and tapering gradually to the pointed distal extremity. One of the other two stones is narrow and elongated, and fully 4·5mm. in length; the third stone is small and subtriangular in outline, as shown in the photograph.

Fam. CYPRINIDÆ.

Genus *Leuciscus.*

Leuciscus rutilus (Linn.). The Roach or Braise. Pl. iii. B., fig. 59; pl. v., fig. 5.

The earstones represented by fig. 59, pl. iii. B., are from a roach about $5\frac{1}{2}$ to 6 inches in length. They are somewhat reniform in general outline, and the surface is ornamented with radiating grooves which terminate in the irregularly crenulated or jagged margins. They are about mm. across the widest part by about 3mm. in depth. The peculiar form and structure of these earstones are more obvious in the enlarged photographs on pl. v., fig. 5. They do not resemble any of the others described in this paper.

Fam. CLUPEIDÆ.

Genus *Clupea.*

Clupea harengus, Linn. The Herring. Pl. iii. B., figs. 15–24; pl. v., figs. 3 and 4.

The earstones of a series of ten herrings of different sizes are represented on pl. iii. B. The largest of the series (fig. 15) measured $12\frac{3}{8}$ inches (about 314mm.) in length, and the smallest (fig. 24) about 125mm. In these earstones the lower margin, which is only slightly arcuate, is obscurely crenulated along the edge, but is otherwise unbroken; the upper margin is nearly straight and parallel with the lower, but its continuity is interrupted by a distinct break near the middle, and in consequence of this break the anterior half of the earstone is very narrow, and only about half the width of the posterior portion. The posterior end is

broadly rounded, and the posterior portion of the upper margin is also crenulated. The sizes of the various specimens referred to and of their earstones are given in the annexed Table:—

Figure on the Plate.	Length of the Fish.	Earstones.	
		Length.	Depth.
15 (Pl. iii. B.)	314mm.	Not quite 4·5mm.*	Fully 2·0mm.
16 ,,	292mm.	About 5·0mm.	,, 2·0mm.
17 ,,	279mm.	,, 4·5mm.	,, 2·0mm.
18 ,,	266mm.	Nearly 5·0mm.	About 2·0mm.
19 ,,	235mm.	Fully 5·0mm.	Nearly 2·5mm.
20 ,,	230mm.	,, 5·0mm.	2·5mm.
21 ,,	215mm.	3·5mm.	Scarcely 2·0mm.
22 ,,	205mm.	About 3·5mm.	Fully 1·5mm.
23 ,,	156mm.	,, 2·7mm.	About 1·5mm.
24 ,,	125mm.	,, 2·0mm.	Fully 1·0mm.

The comparative sizes of the earstones of the herrings given here varied to some extent, ranging from about the fiftieth to the sixtieth part of the length of the fish they belonged to.

Clupea sprattus, Linn. The Sprat. Pl. iii. B., figs. 25–32; pl. v., figs. 15–17.

The earstones of the sprat are extremely small, and easily missed. They resemble those of the herring to some extent, but are comparatively shorter and broader, and even very small specimens exhibit this characteristic difference. The earstones of the largest of the sprats examined for this paper, and which measured about $3\frac{3}{4}$ inches in length, were only about 1·5mm. in extreme length by 1mm. in depth. Other two sprats, $3\frac{1}{2}$ inches long, showed scarcely any difference in the size of their earstones from that of the specimen just referred to (*see* figs. 27 and 28). The position of these otoliths in the ear chamber is similar to that of the herring—that is, the narrow part of the earstone is towards the front of the head, and the upper margin is more irregular in outline than the lower. The earstones represented by fig. 29 are from a fish $3\frac{5}{16}$ inches (84mm.) long, and are about 1mm. in length by 0·7mm. in depth. The otoliths represented by figs. 30 to 32 are from sprats measuring 72mm., 67mm., and 60mm. long.

Clupea pilchardus, Bloch. The Pilchard. Pl. iii. B., fig. 33; pl. v., fig. 32.

The earstones of the pilchard, as will be seen from the photograph, are somewhat similar to those of the herring, both in form and size, except that they are rather more pointed at the anterior end. The fish from which these earstones was obtained was $6\frac{3}{4}$ inches (171mm.) in length, and the earstones themselves measured 3mm. by about 1·2mm.

* The earstones of this specimen were imperfect.

Fam. MURÆNIDÆ.

Genus *Anguilla.*

Anguilla vulgaris, Leach. The Eel. Pl. i. B., figs. 67–69; pl. v., fig. 25.

The largest specimen of the eels whose earstones are represented here measured about 24 inches in length, and the other two 16 inches and 12½ inches respectively; their earstones are very small, those from the largest fish are only about 3·5mm. long by 2mm. in depth. Those belonging to the fish next in size (16 inches) measured fully 2·5mm. by 1.7mm., while those of the smallest specimen (12½ inches) measured 2mm. by 1.5mm. The earstones of the largest of the three fishes are only about one-seventieth part of the entire length of the fish; they are thus smaller in proportion to the length of the fish than most of the others described here.

Genus *Conger.*

Conger niger, Risso. The Conger. Pl. i B., fig. 66; pl. iv., fig. 14; pl. v. fig. 7.

Among the earstones represented here are those of two specimens of conger—one 28½ inches in length, the other 54 inches. The first are represented by fig. 66, pl. i. B., an enlarged photograph of which is shown by fig. 14, pl. iv.; while those of the larger fish are represented by fig. 7, pl. v. The smaller earstones are nearly 9mm. long by about 3·5mm. in depth, but the length of the larger specimens was 11·5mm.; they are thus equal to about the one hundred and twenty-third part of the entire length of the fish. The earstones of the smaller fish are moderately thin and of a narrow oval outline, being widest near the middle and with one end narrowly rounded and the other narrow and angular. Those of the larger fish are tolerably massive, the sides are nearly parallel but somewhat sinuous in outline, and the ends, like those of the smaller fish, are one of them bluntly rounded, while the other is angular. The surface of the earstones does not appear to be ornamented with any regular markings except one or two shallow longitudinal ridges.

Fam. SYNGNATHIDÆ.

Genus *Nerophis.*

Nerophis lumbriciformis, Will. The Worm Pipe-fish.

The earstones of a specimen of this pipe-fish have been in my collection for many years (since March 19, 1885—the date when the fish was captured at Lunderston Bay, Firth of Clyde). They are so exceedingly small that they have not been photographed with the others represented here. They are compressed, and resemble circular disks, except that one end is slightly notched, the notch being a little on one side of the middle line. They are somewhat like certain small Foraminifera, such, for example, as *Biloculina depressa*, but more diminutive. Their true form can only be made out satisfactorily under the microscope, with a 1-inch objective. They measure across their longest diameter about ·26mm. (about $\frac{1}{96}$ of an inch), while their shortest diameter is about ·19mm. The earstones of these fishes are so exceedingly small that they are easily overlooked.

IV.—Literature.

The following are some papers in which the otoliths of fishes are more or less specially dealt with:—

Dr. Reibisch.—"Ueber die Eizahl bei *Pleuronectes platessa* und die Altersbestimmung dieser Form aus den Otolithen." *Wissensch. Meeresuntersuch.*, 1899. Neue Folge Bd. 4, Abthlg. Kiel, p. 231. (This work I have not seen.)

Dr. C. Fryd.—"Die Otolithen der Fisch in Bezug auf ihre Bedeutung für Systematic und Altersbestimmung." Dissertat. Kiel, 1901. (I have not seen this paper.)

Dr. J. T. Jenkins.—"Altersbestimmung durch Otolithen bei den Clupeiden." *Wissensch. Meeresuntersuch.*, 1902. Neue Folge Bd. 6, Abthlg. Kiel, p. 83.

J. T. Cunningham.—"Zones of Growth in the Skeletal Structures of the Gadidæ and Pleuronectidæ." *Twenty-third Annual Report of the Fishery Board for Scotland*, Pt. III., p. 125, et sec., pls. vii.-ix., 1905.

Dr. W. Wallace.—"Preliminary Investigations on the Age and Growth rate of Plaice." *International Investigations, Marine Biol. Assoc. Report*, pp. 199-225, pl. i., 1895.

Dr. Adolf Severin Jensen.—"On Fish Otoliths in Bottom Deposits of the Sea." *Meddelelser fra Kommissionen for Havundersögelser.* Ser. Fiskeri Bd. 1, pp. 1-14, with figures in the text, 1905.

Some observations on Fish Otoliths by the writer will also be found in Part III. of the *Twentieth* and *Twenty-first Annual Reports of the Fishery Board for Scotland*, p. 486 and p. 218, 1902 and 1903.

EXPLANATION OF THE PLATES.

a=anterior end of otolith; *u*=upper margin of otolith.

PLATE I. A.

Fig. 1-10.	Earstones of	Codfishes, various sizes	slightly enlarged.
Fig. 11-13.	,,	Lythe, ,,	,,
Fig. 14-16.	,,	Coal-fishes, ,,	,,
Fig. 17-18.	,,	(?) Ling, ,,	,,
Fig. 19-26.	,,	Ling, ,,	,,
Fig. 27.	,,	a Greater Forkbeard,	,,

PLATE I. B.

Fig. 1-8.	Earstones of	Lesser Forkbeard, various sizes	slightly enlarged.
Fig. 9-12.	,,	several 3-Bearded Rocklings, various sizes	,,
Fig. 13-17.	,,	several 4-Bearded Rocklings, ,,	,,
Fig. 18.	,,	one Flounder,	,,
Fig. 19-25.	,,	several Lemon Dabs, various sizes	,,
Fig. 26-29.	,,	four Witch Soles, ,,	,,
Fig. 30.	,,	one Scald-fish, ,,	,,
Fig. 31-32.	,,	two Megrims	,,
Fig. 33.	,,	one Turbot	,,
Fig. 34.	,,	one Black Sole	,,
Fig. 35-36.	,,	two *Solea variegata*	,,
Fig. 37-41.	,,	several Solenettes, various sizes	,,
Fig. 42-43.	,,	two Müller's Topknots	,,
Fig. 44-45.	,,	two Argentines	,,
Fig. 46-52.	,,	several Grey Gurnards, various sizes	,,
Fig. 53.	,,	one Red Gurnard	,,
Fig. 54-55.	,,	two Streaked Gurnards	,,
Fig. 56.	,,	one Sapphirine Gurnard	,,
Fig. 57-63.	,,	several Lumpenus, various sizes	,,
Fig. 64-65.	,,	two Sand-eels	,,
Fig. 66.	,,	one *Conger*	,,
Fig. 67-69.	,,	three Fresh-water Eels	,,

PLATE II. A.

Fig. 1–5 and 9–16.	Earstones of Haddocks, various sizes	.	slightly enlarged.
Fig. 6–8 and 30, 31.	,, Whitings, ,,	.	,,
Fig. 17–24.	Earstones of Brassies, various sizes	. .	,,
Fig. 25–28.	,, Norway Pouts, various sizes	.	,,
Fig. 29.	,, one Couch's Whiting	. .	,,

PLATE II. B.

Fig. 1–5.	Earstones of Megrims, various sizes	. .	slightly enlarged.
Fig. 6–7.	,, two Sea Breams	. .	,,
Fig. 8–9.	,, two Lesser Weavers	. .	,,
Fig. 10.	,, one Greater Weaver	. .	,,
Fig. 11.	,, one Bass	. . .	,,
Fig. 12–14.	,, three Ballan Wrasses	. .	,,
Fig. 15.	,, one Striped Wrasse	. .	,,
Fig. 16.	,, one Jago's Goldsinny	. .	,,
Fig. 17.	,, one Lesser Grey Mullet	. .	,,
Fig. 18.	,, one Pogge	. . .	,,
Fig. 19–20.	,, two Black Gobies	. . .	,,
Fig. 21–24.	,, four Speckled Gobies	. .	,,
Fig. 25–27.	,, three Powans	. . .	,,
Fig. 28–29.	,, two Dabs	. . .	,,
Fig. 30.	,, one Trout	. . .	,,
Fig. 31.	,, one Salmon	. . .	,,
Fig. 32.	,, one Sand-eel	. . .	,,
Fig. 33.	,, one *Liparis*	. . .	,,

PLATE III. A.

Fig. 1–6 and 14.	Earstones of Halibut, various sizes	.	slightly enlarged.
Fig. 7–13.	Earstones of Long Rough Dabs, ,,	.	,,
Fig. 15–21.	,, Plaice, ,,	.	,,
Fig. 22–26.	,, Witch Soles ,,	.	,,
Fig. 27–31.	,, Dabs ,,	.	,,
Fig. 32–25.	,, Hake ,,	.	,,

PLATE III. B.

Fig. 1–9.	Earstones of Spotted Dragonets, various sizes	.	slightly enlarged.
Fig. 10–14.	,, Dragonets, ,,	.	,,
Fig. 15–24.	,, Herrings, ,,	.	,,
Fig. 25–32.	,, Sprats, ,,	.	,,
Fig. 33.	,, one Pilchards	. . .	,,
Fig. 34–35.	,, two Atherines	. . .	,,
Fig. 36.	,, one Mackerel	. . .	,,
Fig. 37.	,, two Viviparous Blennies	. .	,,
Fig. 38–39.	,, two Butterfishes	. . .	,,
Fig. 40–43.	,, four Catfishes	. . .	,,
Fig. 44–46.	,, three Pogges	. . .	,,
Fig. 47.	,, one *Chimæra*	. . .	,,
Fig. 48.	,, one Grey Mullet	. . .	,,
Fig. 49.	,, one Red Mullet	. . .	,,
Fig. 50–52.	,, three Norway Haddocks	. .	,,
Fig. 53.	,, one *Scorpæna dactyloptera*	.	,,
Fig. 54–57.	,, four fresh-water Perches	. .	,,
Fig. 58.	,, one Lumpsucker	. . .	,,
Fig. 59.	,, one Roach	. . . .	,,
Fig. 60.	,, one fresh-water Pike	. .	,,
Fig. 61–62.	,, two *Lophius*	. . .	,,
Fig. 63–65.	,, three *Cottus*	. . .	,,

PLATE IV.

Fig. 1.	Earstones of a small Haddock	. .	considerably enlarged.
Fig. 2.	,, a Haddock, 14 inches long	.	,,
Fig. 3.	,, a *Gadus luscus*	. . .	,,
Fig. 4.	,, a *Gadus esmarkii*	. . .	,,
Fig. 5.	,, a *Gadus poutassou*	. . .	,,

Fig. 6.	Earstones of a	Lesser Forkbeard	considerably enlarged.
Fig. 7.	,,	a Lesser Forkbeard (very young)	,,
Fig. 8.	,,	a small Ling	,,
Fig. 9.	,,	an Argentine	,,
Fig. 10 and 11.	,,	two 4-Bearded Rocklings	,,
Fig. 12 and 13.	,,	two Grey Gurnards	,,
Fig. 14.	,,	a small *Conger*	,,
Fig. 15.	,,	a Red Gurnard	,,
Fig. 16.	,,	a Turbot	,,
Fig. 17.	,,	a Black Sole	,,
Fig. 18.	,,	a 3-Bearded Rockling	,,
Fig. 19.	,,	a Fresh-water Eel	,,
Fig. 20.	,,	a Streaked Gurnard	,,
Fig. 21.	,,	a Sapphirine Gurnard	,,
Fig. 22, 23, 26 and 27.	Earstones of four Lumpenus		,,
Fig. 24 and 25.	Earstones of two Solenettes		,,
Fig. 28 and 29.	,,	two *Solea variegata*	,,
Fig. 30.	Earstones of a Witch Sole		,,
Fig. 31.	,,	*Lophius piscatorius*	,,

PLATE V.

Fig. 1 and 2.	Right and left earstones of two Megrims		considerably enlarged.
Fig. 3 and 4.	Earstones of two Herrings		,,
Fig. 5.	Earstones of a Roach		,,
Fig. 6.	,,	a Black Goby	,,
Fig. 7.	,,	a *Conger*, 54 inches long	,,
Fig. 8.	,,	a Ballan Wrasse	,,
Fig. 9.	,,	a Salmon, weighing 10 lbs.	,,
Fig. 10 and 11.	,,	two Common Dragonets, 112mm. long	,,
Fig. 12.	,,	a Lesser Grey Mullet	,,
Fig. 13.	,,	a Fresh-water Perch	,,
Fig. 15.	,,	a Lumpsucker, 15½ inches long	,,
Fig. 16–17.	,,	three Sprats	,,
Fig. 18 and 24.	,,	two Spotted Dragonets	,,
Fig. 19.	,,	a *Lophius*, 36 inches long	,,
Fig. 20.	,,	a Fresh-water Pike	,,
Fig. 21.	,,	a Catfish, 27 inches long	,,
Fig. 22 and 26.	,,	two Atherines, 3¼ and 5 inches long	,,
Fig. 23.	,,	a *Mullus barbatus*	,,
Fig. 25.	,,	a Fresh-water Eel	,,
Fig. 27.	,,	a Pogge, 5¾ inches long	,,
Fig. 28.	,,	a Lemon Dab, 15 inches long	,,
Fig. 29.	One Earstone of a *Coregonus*, 8 inches long		,,
Fig. 30.	Earstones of a *Cyclogaster liparis*		,,
Fig. 31.	One Earstone of a Viviparous Blenny		,,
Fig. 32.	,,	a Pilchard	,,
Fig. 33.	,,	a Mackerel	,,

Photo by A. Scott.

Otoliths of Teleostean Fishes.

Photo by A. Scott.

Otoliths of Teleostean Fishes.

Photo by A. SCOTT.

Otoliths of Teleostean Fishes.

Photo by A. Scott.

Otoliths of Teleostean Fishes.

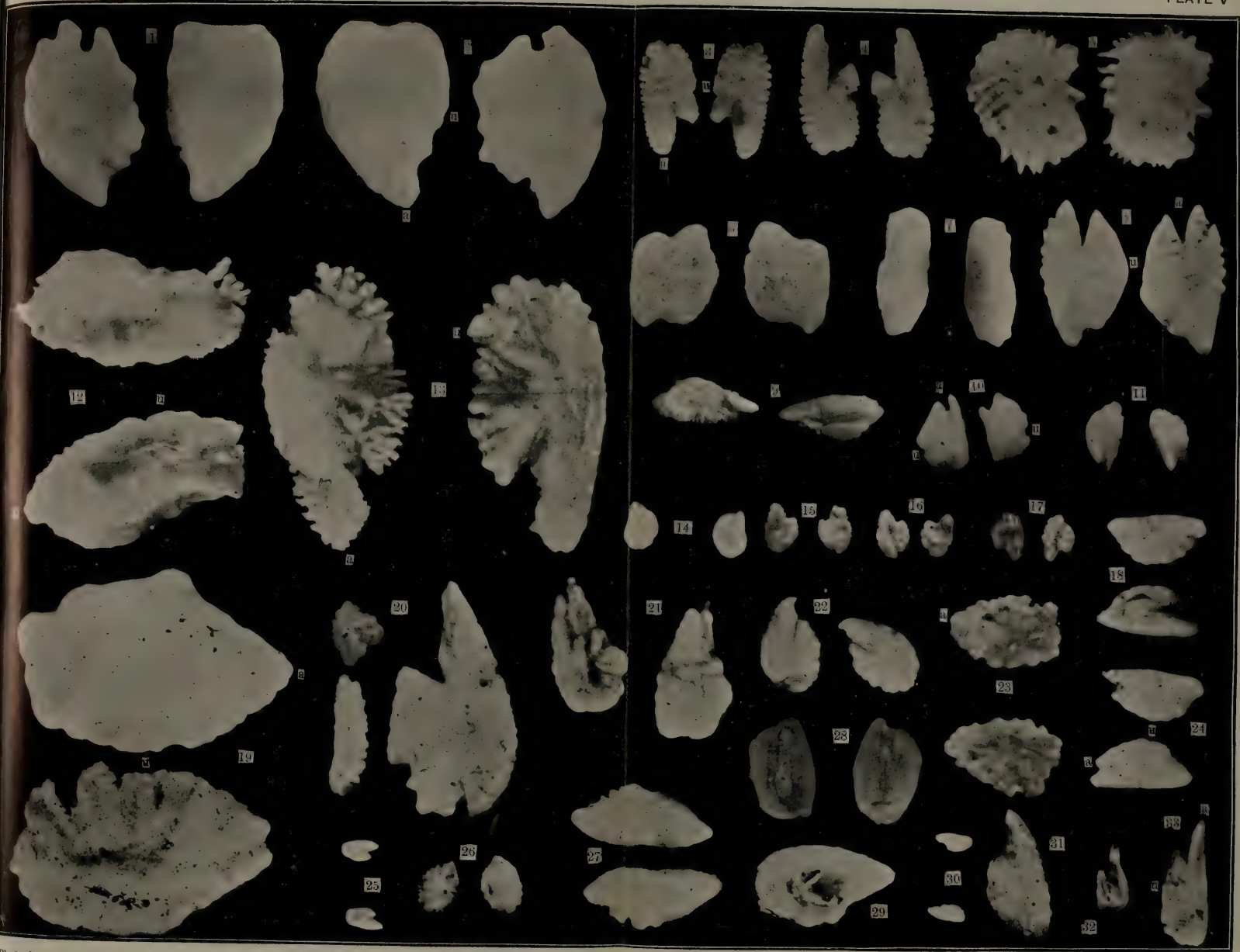


Photo by A. Scott.

Otoliths of Teleostean Fishes.

III.—THE FOOD VALUE OF THE HERRING.

By T. H. Milroy, M.D., B.Sc., F.R.S.E., Professor of Physiology, Queen's College, Belfast.

CONTENTS.

	PAGE.
Previous Analyses of Herrings,	83
Methods of Analysis,	85
Analyses of May Loch Fyne Herrings,	86
,, ,, July ,, ,,	88
,, ,, September ,, ,,	89
,, ,, October ,, ,,	90
,, ,, November ,, ,,	92
,, ,, December Helmsdale ,,	93
,, ,, ,, Loch Fyne ,,	94
,, ,, ,, Lochboisdale ,,	95
,, ,, February ,, ,,	96
Tables of Ratios,	97
Summary of Results,	101
Remarks on Nutritive Value of Spent Herrings, with some additional Tables illustrating differences in Composition of these Fish,	103

The Nutritive Value of the Herring at Different Periods.

It is extremely important that we should possess definite information with regard to the changes which the herring undergoes during its development. This is especially true with regard to the chemical changes in its composition, as, merely looked at from the economic standpoint, it is advisable to determine the periods at which the fish is most valuable as a food and those at which it is least valuable. As a problem in biological chemistry, it is also extremely important to arrive at accurate information with regard to the metabolic changes which take place in the fish before, during, and after, the spawning period.

On looking up the literature on the subject, I have been unable to find any work dealing with the changes in composition of the edible parts of the herring which must occur during the reproductive life of the fish.

There have, of course, been analyses published of the chemical composition of the herring in the fresh, salted, and pickled conditions, but no reference is made to the condition of the herring at the time of the analysis beyond certain vague statements such as "in fine condition," etc. Payen ("Subst. Alimentaires," p. 488) gives analyses of salted herrings. König, in his large work on "Nahrungs-Mittel," Bd. i., pp. 201-7, gives some of his own analyses as well as those of others.

Almén gives a very detailed account of the analyses of the flesh of various fish in a communication by him to the Royal Society at Upsala ("Analyse des Fleisches einiger Fische. Mitgeteilt der Königlichen Gesellschaft der Wissenschaften zu Upsala, am 7ten April, 1877"—Upsala 1877.)

Among the fish examined by Almén was the little herring (*Clupea harengus* v. *membræ*). By far the most important contribution on the subject of the food value of fishes is undoubtedly the report by Atwater

in the U. S. Commissioner's Report on Fish and Fisheries. 1888, Part xvi., 1892). This report deals with the chemical composition and nutritive values of food fishes and aquatic invertebrates. Analyses were made of the flesh of 123 specimens of American fishes belonging to 52 species, and among these are given analyses of fresh, salted, and pickled herrings. He also collects all the analytical literature and gives a table of the maximal, minimal, and average amounts of the food principles present in the herring as given by different authorities.

I give it here in order to show that there are marked variations in the analytical results, especially as regards the fat.

	Water.	Water-free Substance.	Protein i.e. N × 6·25.	Fats.	Ash.
Maxima.	76·11	30·97	19·12	11·01	1·9
Minima.	69·03	23·89	15·31	4·89	1·5
Average.	72·10	27·90	17·75	8·02	1·69

Atwater adopted all the precautions which he thought necessary to render his analyses accurate, and devotes some part of his paper to a criticism of the methods of analyses employed by his predecessors, explaining in some cases the differences in the results by probable analytical errors. A very important and most probable cause of divergence in the analytical results was a difference in the condition of the herring at the time of the analysis. As we shall see, there are great differences in composition of the muscle of the herring at different periods, and these differences are to be observed in herrings obtained from the same waters, when they are examined at different months of the year.

For purposes of comparison it is extremely desirable that the herrings should be obtained from the same district at regular intervals for at least two years, and that analyses should be made of muscles and genitalia.

This would be a work of no great difficulty if three or four persons were occupied with the investigation, but it could not be covered by a single worker unless he devoted his whole time to the work. I have been unable to devote more than a comparatively small portion of my time during the last two years to the work, and it is ouly during the last year that I obtained satisfactory material for the research.

The work, therefore, will deal with herrings mainly obtained from the Loch Fyne district during 1905 and 1906.

Only these fish were employed for analysis which had arrived at the laboratory in absolutely fresh condition. During the summer months they were sent in a double walled japanned tin carrier, an ice-salt mixture filling the space between the two walls. At other times they were sent with salt sprinkled over them or without any preservative.

The fish were measured and weighed, and the ovaries or milt removed, weighed, and examined microscopically, the ova being measured by means of an ocular micrometer. The measurement for length was made from end of snout to end of tail fin; for girth, in front of the dorsal fin around the thickest part of the fish. The measurements are given in centimetres.

The weights of the fish and reproductive organs are given in grammes.

Methods of Analysis.

It was impossible to adopt many precautions which might have been desirable, owing to the necessity for carrying through the analysis as quickly as possible.

Such estimations as these of the percentage of water in the muscles and reproductive organs cannot be carried out in such a way as to absolutely prevent loss of weight from any other cause than the removal of water.

(1) *Water percentages.*—The skin was removed, then as much of the the muscular tissue as could be conveniently obtained was minced up extremely fine by being passed through a mincing machine.

Specimens were taken between watch glasses and dried in a warm oven at a temperature between 60°–70°C., under conditions where oxidation was prevented as far as possible, the final drying being carried out in vacuo.

The same procedure was adopted in the case of the reproductive organs.

(2) *Nitrogen and Phosphorus estimations.*—It was of course necessary to estimate the amount of nitrogenous material in the muscles and genitalia, and it was also thought advisable to estimate the amount of phosphorus.

The total nitrogen was estimated in a small portion of muscle and also in a similar quantity of ovary or milt respectively, the method that was adopted being that of Kjeldahl.

For purposes of convenience the numbers for the total nitrogen are not given in the tables, but are converted into terms of protein by multiplying the amount of the total nitrogen by the usual factor, 6·25. This is, of course, simply a matter of convenience, some of the nitrogen being present in other forms than protein. As, however, by far the most important nitrogenous constituent in the muscles and genitalia is the protein, probably not more than 2 per cent. of other nitrogenous constituents being present, it is sufficient to state the amounts of total nitrogen in terms of protein.

The phosphorus was estimated in a portion of the fluid obtained after incineration by the Kjeldahl method.

The fluid was rendered ammoniacal, then acidified with nitric acid, and the phosphate then precipitated by ammonium molybdate. The phosphomolybdate precipitate was subsequently dissolved in ammonia, and the phosphate precipitated by magnesia mixture. The triple phosphate was then received on an ash-poor filter paper, washed, dried, and incinerated. It was then weighed and the weight of the $Mg_2P_2O_7$ was then calculated in terms of P_2O_5, and given as such in the tables.

(3) *Fat.*—The finely powdered dried material (muscles or genitalia) was placed in a Soxhlet filter paper tube and extracted with ether in the usual way for about 36–48 hours. Only about 3–4 grammes of the dried material were taken, so that the extraction ought to have been fairly complete. The fat was freed from ether and weighed in the usual way.

In the tables the amounts of proteid, fat, and P_2O_5 are given in two forms, first, in grammes per 100 grammes fresh muscle and fresh ovaries or milt; secondly, in terms of grammes in total fresh muscle or genitalia respectively, as calculated for the average fish of the batch under examination.

It was thought advisable not only to give the percentage amounts of proteid, fat, and P_2O_5, but also the absolute amounts in the muscles and genitalia respectively of the same fish. The weight of the muscles of the fish was obtained roughly by deducting $\frac{1}{3}$ of the total weight, this fraction being supposed to cover the weight of the head and bones.

Tables are also given showing the ratios which exist between the weight of the fish and that of the reproductive organs at different periods, and also those existing between the more important constituents of muscles and genitals.

LOCH FYNE HERRING, MAY 10, 1906.

(*Otter.*)

Length.	Girth.	Weight.	Condition
Cm.	Cm.	Gm.	
25	11½	113	Very immature, probably previously spent herring from condition of ovarian capsule.
23½	11	101	
22½	12	104	
23½	11	102	
23	10½	93	There were large numbers of very small ova present, varying in size from ·07–·15mm.
23	10	90	
23	10½	88	
21½	10½	80	
22½	10½	85	
22	10	80	
21½	10	74	
22	10	75	
22 9cm.	10·7cm.	90·4gm.	Average.

Weight of genitals (fresh) of 12 herrings, 2·5 grammes. The water percentage of these genitals was 71·52.

Analyses of the muscles of these herring :—

Females—

(*a*) Amounts stated in percentages of fresh material.

In grammes per cent.	Water.	Proteid.	Fat.	P_2O_5
	72·69	18·98	7·25	·68

(*b*) Grammes in the total muscles of the average fish of this series.

	Proteid.	Fat.	P_2O_5
In grammes, . .	11·38	4·35	·40

ARDRISHAIG, MAY 11, 1906.

These herring were very small, and, with one exception, contained very immature ovaries. One herring (No. 11) contained ovaries which weighed 14·75 grammes, and the ova which were present measured 1·2mm. in diameter and were being discharged.

The immature ovaries, although they contained large numbers of very small ova, were evidently comparatively recently spent (*see* following pages for measurements and analyses).

	Length.	Girth.	Weight.	Condition.
	Cm.	Cm.	Gm.	
Series A. 1	20	8·5	58	The ova were very immature. The weight of the 10 pairs of genitals was 2·4gm. in the fresh condition.
2	20·5	9	60	
3	20·5	9·5	67	
4	20·5	9·5	67	
5	20·5	9	64	
6	21	9	72	
7	21·5	10	75	
8	22·5	9	75	
9	21	9·5	70	
10	25	11	116	
Average,	21·3cm.	9·4cm.	72·4gm.	
.11	23	10	91	Ovaries weighed 14·75 gm., and their ova measured 1·2mm.

Analyses of the muscles of these herring :—

Females—

Series A—(fish with immature ovaries previously spent).

(*a*) Amounts stated in percentages of fresh material.

	Water.	Proteid.	Fat.	P_2O_5
In grammes per cent.	73·01	17·55	5·85	·82

(*b*) Grammes in the total muscles of the average fish in the series.

Proteid.	Fat.	P_2O_5
8·47	2·82	·39

B—(herring with mature ovaries).

(*a*) Amounts stated in percentages of fresh material.

Water.	Proteid.	Fat.	P_2O_5
72·9	20·58	3·52	.51

(*b*) Grammes in total muscles of fish.

Proteid.	Fat.	P_2O_5
12·34	2·11	.48

JULY 29, 1905.*

Length.	Girth.	Weight.	Weight of Genitals.
Cm.	Cm.	Gm.	Gm.
24	12	116	0·35
22	11·5	96	0·46
23·5	12	99	0·20
23	13	120	0·67
23	11·5	91	0·20
22·5	12	105	0·74
23	12	107	0·33
24	12·5	124	1·18
21·5	11	82	0·49
22·5	12	105	0·43
22·5	11·5	102	0·39
22	11	92	0·22
23	12	97	0·15
24	13	127	0·50
22·5	12	100	0·44
25	13	137	0·53
24	12·5	119	0·81
22	11	88	0·20
22	11	92	0·20
23	13	120	0·65
Avg. 22·9	11·9	100·9	0·45

These herring were still in immature condition; the ova were only slightly larger than in the herrings caught on May 10.

Analyses of the muscle (fresh) :—

(*a*) Amounts stated in percentages of fresh material.

Water.	Proteid.	Fat.	P_2O_5
71·60	18·18	7·32	·45

(*b*) Grammes in the total muscles of the average fish.

Proteid.	Fat.	P_2O_5
12·18	4·90	·30

Analyses of the genitals (fresh) :—

(*a*) Grammes in 100 grammes of fresh material.

Water.	Proteid.	Fat.	P_2O_5
72·5	13·52	8·92	·77

(*b*) Grammes in the amount of genitals present in the average fish of series.

Proteid.	Fat.	P_2O_5
·05	·03	·003

* For analyses of the muscles of herrings caught in Loch Fyne during the latter part of May and beginning of June 1906, *see* pp. 103–107.

ARDRISHAIG, SEPTEMBER 15, 1905.

These herring were very small, the average length of six females being 20cm., and the average weight 80 grammes. The weight of the ovaries in these six herrings was 5·70 grammes weighed in the fresh condition—that is to say, the average weight per fish was ·95 grammes. The ova were very immature, varying in size from 15mm.–·45mm.

The male herrings had approximately the same measurements, the average length of eleven being 20cm., and the average weight ·75 grammes. The testes from these eleven herrings weighed 10·65 grammes in the fresh condition, *i.e.*, ·97 grammes per fish.

Analyses:—

Females—

I.—Muscles.

(*a*) Amounts stated in percentages of fresh material.

Water.	Proteid.	Fat.	P_2O_5
63·68	19·28	11·81	·64

(*b*) Grammes in total muscles of average fish.

Proteid.	Fat.	P_2O_5
10·41	6·37	·34

II.—Ovaries.

(*a*) Grammes in 100 grammes fresh ovaries.

Water.	Proteid.	Fat.	P_2O_5
66·02	18·91	7·34	1·23

(*b*) Grammes in ovaries of average fish.

Proteid.	Fat.	P_2O_5
0 17	0·07	·011

Males—

I.—Muscles.

(*a*) In percentages of fresh material.

Water.	Proteid.	Fat.	P_2O_5
61·68	18·65	14·25	·52

(*b*) Per average fish in total muscles.

Proteid.	Fat.	P_2O_5
9·32	7·12	·25

II.—Testes.

(*a*) In 100 grammes fresh material.

Water.	Proteid.	Fat.	P_2O_5
72·00	22·18	2·84	—

(*b*) In total testes of average fish.

Proteid.	Fat.	P_2O_5
0·21	0·27	—

OCTOBER, 1905 (Loch Fyne).

Some of these herrings were in rather a more mature condition than others, and so the females have been divided into two series for analysis; first, those with ovaries containing ova of about ·28mm. in diameter, and, secondly, those whose ova averaged ·59mm.

SERIES A.

Length.	Girth.	Weight.	Condition.
Cm.	Cm.	Gm.	
28	15	206	The ovaries from these 7 herrings weighed collectively 17gm., and the average size of ova was ·28mm.
27	13·5	150	
25	13	147	
24·5	12·5	130	
23·5	12	115	
23·5	12·5	122	
26	13	148	
25cm.	13cm.	144·5gm.	Average.

SERIES B.

Length.	Girth.	Weight.	Condition.
Cm.	Cm,	Gm.	
29·5	16	257	The ovaries from these 8 herrings weighed collectively 74gm., and the average size of the ova was ·59mm.
28·5	15·5	220	
27·5	13·2	167	
24·5	12·5	129	
24	12·2	119	
25	14·5	220	
29·5	15·5	229	
28	14	197	
27cm.	14cm.	192gm.	Average.

Males.

Length.	Girth	Weight.	Condition.
Cm.	Cm.	Gm.	
28·5	16	242	The testes from 4 of these herrings weighed collectively 96gm.
30·5	17	275	
27	14·4	157	
27	13·2	157	
27·5	14·5	185	
25	12·5	135	
25·5	12·5	143	
25·5	3	143	
26	12	119	
27	13	145	
27	12·2	123	
26·7cm.	13·6cm.	166gm.	Average.

Analyses of Females :—

Series A.

Muscles.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
69·97	12·78	14·25	·53

(*b*) In total muscles of average fish.

	Proteid.	Fat.	P_2O_5
	12·39	13·82	·51

Ovaries.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
78·21	17·26	2·53	·71

(*b*) In ovaries of average fish.

	Proteid.	Fat.	P_2O_5
	·41	·33	·01

Series B.

Muscles.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
70·46	14·84	12·70	·57

(*b*) Per average fish.

	Proteid.	Fat.	P_2O_5
	14·80	12·51	·55

Ovaries,

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
68·02	22·45	4·80	·93

(*b*) Per average fish.

	Proteid.	Fat.	P_2O_5
	2·08	·44	·05

Males—

Muscle.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
68·91	16·18	12·63	·50

(*b*) Per average fish.

	Proteid.	Fat.	P_2O_5
	18·44	14·39	·57

Testes.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
72·13	22·62	2·25	·86

(*b*) Per average fish.

	Proteid.	Fat.	P_2O_5
	5·42	·54	·13

ARDRISHAIG, NOVEMBER 6, 1905.

These herring were large and in good conditon, and the ova were almost mature. They have been divided into two sets, females and males, the measurements of which are as follows :—

I. *Females.*

Length.	Girth.	Weight.	Weight of Ovaries.
Cm.	Cm.	Gm.	Gm.
30	16·5	275	35·7
31	16	270	38·2
33	17·5	326	51·6
31	16	255	31·8
30	16	261	25·6
31	16	260	18·9
32	16·5	297	31·6
32	17	290	35·2
32	16·5	275	31·4
30	16·5	276	28·8
32	16·5	304	32
29	15	210	20·1
30	15	204	15·4
29	14	192	15·8
Avg. 30·8cm.	16cm.	264gm.	29·5gm.

The ova were from ·8–1mm. in diameter.

II. *Males.*

Length.	Girth.	Weight.	Weight of Testes.
Cm.	Cm.	Gm.	Gm.
31	17	279	44·5
31	17	316	52
31	16	277	40·6
29	14	215	31·4
30	16	257	40·9
33	16	296	37·3
32	16	287	40·1
30	17	290	41·1
31	17	303	46·6
31	16	252	35·6
31	15·5	230	26·8
29	14·5	195	24·4
30	16	255	44·6
Avg. 30·7cm.	16cm.	265·5gm.	38·9gm.

Analyses :—

Females—

Muscle.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
66·34	19·87	10·85	·59

(*b*) In total muscles of average fish.

Proteid.	Fat	P_2O_5
52·45	28·64	1·55

Ovaries.

(*a*) In percentages of fresh material.

Water.	Proteid.	Fat.	P_2O_5
68·04	25·04	2·85	·91

(*b*) Per average fish.

Proteid.	Fat.	P_2O_5
7·38	·84	·26

Males—

Muscle.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
68·22	17·94	10·84	·46

(*b*) Per average fish.

Proteid.	Fat.	P_2O_5
31·77	19·18	·81

HELMSDALE HERRINGS, DECEMBER 6, 1905.

Two herrings (females) were taken for analysis from a batch containing fish of approximately the same size. Their measurements were :—

Length.	Girth.	Weight.	Weight of Ovaries.
Cm.	Cm.	Gm.	Gm.
29	14·5	195	26
29	14·5	194	35
Avg. 29cm.	14·5cm.	194·5gm.	30·5gm.

Size of ova, ·8–1·2mm. These herring had evidently commenced to spawn.

Analyses :—

Muscle.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
70·50	23·01	2·75	·77

(*b*) Per average fish (total in muscles).

Proteid.	Fat.	P_2O_5
28·76	3·4	·96

Ovaries.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
65·73	27·76	3·34	1·19

(*b*) Per average fish.

Proteid.	Fat.	P_2O
9·82	1·00	·34

Loch Gair, December 13, 1905.

These fish were very large, with ovaries of greater weight than in any other herrings which were analysed. The ova varied in size from ·9mm. to 1·2mm.

The following were the measurements:—

Females.

Length.	Girth.	Weight.	Weight of Ovaries.
Cm.	Cm.	Gm.	Gm.
31	17·5	326	63
30·5	15	268	43
30·5	16·5	272	30
31	16·5	330	48
30·5	16	285	47
31	17·5	318	51
Avg. 30·7cm.	16·5cm.	299·8gm.	47gm.

Males.

Length.	Girth.	Weight.	Weight of Testes.
Cm.	Cm.	Gm.	Gm.
31	17	298	61
31	17	320	55
Avg. 31	17cm.	309gm.	58gm.

Analyses:—

Females.

Muscle.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
67·36	20·56	8·18	·68

(*b*) Per average fish.

Proteid.	Fat.	P_2O_5
41·12	16·36	1·37

Ovaries.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
67·33	25·72	2·89	1·03

(*b*) Per average fish.

	Proteid.	Fat.	P_2O_5
	12·08	1·35	·48

Males.

Muscle.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
68·31	21·45	9·24	·73

(*b*) Per average fish.

	Proteid.	Fat.	P_2O_5
	44·18	19·03	1·51

Testes.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
72·10	22·05	3·73	2·10

(*b*) Per average fish.

	Proteid.	Fat.	P_2O_5
	12·78	2·16	1·21

LOCHBOISDALE HERRING, DECEMBER 28, 1905.

These fish were either spawning or spent. They have therefore been divided into two classes for examination—one, Series A, spawning, the ova varying in size from ·9mm. to 1·4mm; the other, Series B, spent. The males were not examined.

SERIES A.

Length.	Girth.	Weight.	Weight of Ovaries.
Cm.	Cm.	Gm.	Gm.
27·5	13·5	165	18
26·5	14	157	14·8
26	13·5	141	25
26	12	127	11·5
26·5	13	168	20·3
26	14	160	18·3
26	13	150	19·4
25	12	115	10·5
26	13·5	150	18·8
Avg. 26cm.	13cm.	148gm.	17·4gm.

SERIES B (spent).

Length.	Girth.	Weight.
Cm.	Cm.	Gm.
23	12	153
28	12	140
Avg. 25·5cm.	12cm.	146·5gm.

Series A (spawning).

Muscles.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
74·12	18·91	2·02	·66

(*b*) Per average fish.

	Proteid.	Fat.	P_2O_5
	18·15	1·93	·61

Ovaries.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
70·00	24·75	3·72	·93

(*b*) Per average fish.

	Proteid.	Fat.	P_2O_5
	4·23	·63	·16

Series B.

Muscles.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
75·30	19·69	1·55	·77

(*b*) Per average fish.

	Proteid.	Fat.	P_2O_5
	18·53	1·51	·75

FEBRUARY 8, 1906.

These herring were in the spent condition. Six females were taken for examination. Their measurements were as follows :—

Length.	Girth.	Weight.
Cm.	Cm.	Gm.
26	11	115
28	12	143
28	12	155
29	13	156
29	12	150
28	12	136
Avg. 28cm.	12cm.	142·5gm.

7½ pairs of spent ovaries were taken from herrings sent at this time, and were found to weigh 9·51 grammes. These were dried and analysed.

I.—Muscles.

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
78·97	18·05	0·68	·73

(*b*) Per average fish.

	Proteid.	Fat.	P_2O_5
	16·60	0·62	0·66

II.—Ovaries (spent).

(*a*) In percentages.

Water.	Proteid.	Fat.	P_2O_5
82·07	3·78	11·83	·91

(*b*) Per average fish.

	Proteid.	Fat.	P_2O_5
	·29	·09	·016

Before discussing these results it will prove of some advantage to compare the ratios which exist between the weight of the fish and the weight of the ovaries, as well as certain other ratios.

Ratio of Weight of Fish to Weight of Ovaries at Different Seasons:—

District and Period.	Weight of Fish.	Weight of Ovaries.	Condition.
Loch Fyne—May 10, . . .	434·6	1	Immature.
,, May 11—Series A, .	301·6	1	Immature.
,, May 11—Series B, .	6·1	1	Mature.
,, July 29, . . .	224·2	1	Immature.
,, Sept. 15, . . .	84·2	1	Immature (Ova ·15-45mm.).
,, Oct.—Series A, . .	60·2	1	Immature (Ova ·28mm.).
,, Oct.—Series B, . .	20·8	1	Immature (Ova ·59mm.).
,, Nov. 6, . . .	8·9	1	Almost mature (Ova ·8-1mm.).
Helmsdale—Dec. 6, . . .	6·3	1	Almost mature (Ova ·8-1·2mm.).
Loch Fyne—Dec. 13, . . .	6·3	1	Mature (Ova ·9-1·2mm.).
Lochboisdale—Dec. 28—Series A, .	8·5	1	Spawning.
,, Dec. 28—Series B, .	Spent.	Spent.	Spent.
,, Feb. 8, . . .	,,	,,	Spent.

Ratio of Proteid to Fat in the Muscles and Ovaries respectively:—

District and Period.	Muscles. Proteid : Fat.	Ovaries. Proteid : Fat.	Condition.
Loch Fyne—May 10, . .	2·61 : 1	– –	Immature.
,, May 11—A, .	3·00 : 1	– –	Immature.
,, May 11—B, .	5·84 : 1	– –	Mature.
,, July 29, . .	2·48 : 1	1·51 : 1	Immature.
,, Sept. 15, . .	1·63 : 1	2·57 : 1	Immature (Ova ·15-·45mm.).
,, Oct.—A, . .	0·89 : 1	6·82 : 1	Immature (Ova ·28mm.).
,, Oct.—B, . .	1·16 : 1	4·67 : 1	Immature (Ova ·59mm.).
,, Nov. 6, . .	1 83 : 1	8·78 : 1	Almost mature (Ova ·8-1mm.).
Helmsdale—Dec. 6, . .	8·36 : 1	8·31 : 1	Almost mature (probably about to spawn).
Loch Fyne—Dec. 13, . .	2·51 : 1	8·9 : 1	Mature (about to spawn).
Lochboisdale—Dec. 28—A, .	9·36 : 1	6·65 : 1	Spawning.
, Dec. 28—B, .	12·70 : 1	– –	Spent.
,, Feb. 8, . .	26·54 : 1	3·12 : 1	Spent.

Ratio of total Proteid of Muscles to total Proteid of Ovaries.

District and Period.	Muscle Proteid :	Ovarian Proteid.	Condition.
Loch Fyne—May 10, . .	–	–	
,, May 11—A, .	–	–	
,, May 11—B, .	–	–	
,, July 29, . .	243·6 :	1	Immature.
,, Sept. 15, . .	61·2 :	1	Immature (Ova ·15–·45mm.).
,, Oct.—A, . .	30·2 :	1	Immature (Ova ·28mm.).
,, Oct.—B, . .	7·1 :	1	Immature (Ova ·59mm.).
,, Nov. 6, . .	7·1 :	1	Almost mature (Ova ·8–1mm.).
Helmsdale—Dec. 6, . .	2·9 :	1	Almost mature (Ova ·8–1·2mm.).
Loch Fyne—Dec. 13, . .	3·3 :	1	Mature (about to spawn).
Lochboisdale—Dec. 28—A, .	4·2 :	1	Spawning.
,, Dec. 28—B, .	–	–	Spent.
,, Feb. 8, . .	57·2 :	1	Spent.

Ratio of total Fat of Muscles to total Fat of Ovaries.

District and Period.	Fat of Muscles :	Fat of Ovaries.	Condition.
Loch Fyne—July 29, . .	163·3 :	1	Immature.
,, Sept. 15, . .	91 :	1	Immature (Ova ·15–·45mm.).
,, Oct.—A, . .	41·8 :	1	Immature (Ova ·28mm.).
,, Oct.—B, . .	28·4 :	1	Immature (Ova ·59mm.).
,, Nov. 6, . .	34 :	1	Almost mature.
Helmsdale—Dec. 6, . .	3·43 :	1	Almost mature (about to spawn).
Loch Fyne—Dec. 13, . .	12·1 :	1	Mature.
Lochboisdale—Dec. 28—A, .	3 :	1	Spawning.
,, Feb. 8, . .	6·8 :	1	Spent.

COMPOSITION OF MUSCLES AND OVARIES IN HERRINGS (Average Fish of each Series).

	Per Fish.					Muscle.							Ovaries.						
						Per Cent. in Fresh Muscle.				Per Average Fish.			Percentages.				Per Fish.		
	Length.	Girth.	Weight.	Wt. of Ovaries.	Size of Ov.	Water.	Proteid.	Fat.	P_2O_5	Proteid.	Fat.	P_2O_5	Water.	Proteid.	Fat.	P_2O_5	Proteid.	Fat.	P_2O_5
	Cm.	Cm.	Gm.	Gm	Mm.														
May 10, . . .	22·9	10·7	90·4	·208	v. imat.	72·69	18·98	7·25	·68	11·38	4·35	·40							
May 11, Series A, . .	21·3	9·4	72·4	·24	,,	73·01	17·55	5·85	·82	8·47	2·82	·39							
,, ,, ,, B, . .	23	10	91	14·75	1·2	72·90	20·58	3·52	·81	12·34	2·11	·48							
July 29, . . .	22·9	11·9	100·9	·45	v. imat.	71·60	18·18	7·32	·45	12·18	4·90	·30	72·5	13·52	8·92	·77	0·05	0·03	·003
Sept. 15. . . .	20	–	80	95	·15–·45	63·68	19·28	11·81	·64	10·41	6·37	·34	66·02	18·91	7·34	1·23	0·17	0·07	·011
Oct Series A, . .	25	13	144·5	2·4	·2–·3	69·97	12·78	14·25	·53	12·39	13·82	·51	78·21	17·26	2·53	·71	·41	0·33	·01
,, ,, B, . .	27	14	192	9·2	·4–·5	70·46	14·84	12·70	·57	14·80	12·51	·55	68·02	22·45	4·80	·93	2·08	0·44	·05
Nov. 6, . . .	30·8	16	264	29·5	·8–1	66·34	19·87	10·85	·59	52·45	28·64	1·55	68·04	25·04	2·85	·91	7·38	0·84	·26
Dec. 6 (Helmsdale), .	29	14·5	194·5	30·5	·8–1·2	70·50	23·01	2·75	·77	28·76	3·43	·96	65·73	27·76	3·34	1·19	9·82	1·00	·34
,, 13, (Loch Gair), .	30·7	16·5	299·8	47	·9–1·2	67·36	20·56	8·18	·68	41·12	16·36	1·37	67·33	25·72	2·89	1·03	12·08	1·35	·48
,, 28, Series A, . .	26	13	148	17·4	·8–1·4	74·12	18·91	2·02	·66	18·15	1·93	·61	70·00	24·75	3·72	·93	4·23	0·63	·16
,, ,, ,, B, . .	25·5	12	146·5	–	Spent.	75·30	19·69	1·55	·77	18·53	1·51	·75							
Feb. 8. . . .	28	12	142·5	1·26	Spent.	78·97	18·05	0·68	·73	16·60	0·62	·66	82·07	11·83	3·78	·91	·29	0·09	·016

MALES.

Average Composition of Muscles and Testes.

Date.	Length.	Girth.	Weight.	Weight of Testes.	Muscle. Per Cent in Fresh Muscle. Water.	Proteid.	Fat.	P_2O_5	Muscle. In Total Muscles of Average Fish. Proteid	Fat.	P_2O_5	Testes. In Percentages. Water.	Proteid.	Fat	P_2O_5	Testes. Total in Testes per Average Fish. Proteid.	Fat.	P_2O_5
Cm.	Cm.	Cm.	Gm.	Gm.														
Sept. 15, 1905 (Loch Fyne), .	20	–	75	·97	61·68	18·65	14·25	·52	9·32	7·12	·25	72·00	22·18	2·84	–	0·21	0·027	–
Oct., 1905 ,, .	26·7	13·6	166	24	68·91	16·18	12·63	·50	18·44	14·39	·57	72·13	22·62	2·25	·86	5·42	0·54	·13
Nov. 6, 1905 ,, .	30·7	16	265·5	38·9	68·22	17·94	10·84	·46	31·77	19·18	·81	–	–	–	–	–	–	–
Dec. 13, 1905 ,, .	31	17	309	58	68·31	21·45	9·24	·73	44·18	19·03	1·51	72·10	22·05	3·73	2·10	12·78	2·16	1·21

On looking over these tables, especially the one given on pp. 99, one is struck by the very marked variations in the composition of the muscle of the female at different periods during its reproductive life. In all probability much the same changes occur in the case of the muscles of the male herring during the growth of the testes, but the data which are given are insufficient to warrant one in drawing definite conclusions on this point.

Summary of Results.

(1) The tables on pp. 97, 98, show clearly the alteration in the ratio between the weight of the fish and the weight of the ovaries before, during, and after spawning, the variations being produced by the proportionately much greater increase in the ovaries than in the rest of the fish during the period of maturation.

(2) As the muscles constitute the main source of the nutritive value of the herring, it is most important to recognise the variations in their composition. These are most striking, especially as concerns the percentage of fat, and as this food principle possesses such a high caloric value, any marked decrease in its amount lowers the nutritive value of the fish to a serious extent.

The lowest fat percentage which was obtained occurred in the large spent herrings obtained from Lochboisdale in February last, and the total amount of fat present in the collective muscles of the average fish was exceedingly small. The percentage amount of water in these muscles was higher than normal, but the proteid and P_2O_5 percentages were but little affected.

The herrings obtained from the same district at the close of December of last year contained a slightly larger percentage of fat in their muscles, and of the two series of fish examined those which were spent contained rather less than those which were spawning.

In the herrings obtained from Helmsdale at the beginning of December, the fat percentage was but little above that of the Lochboisdale spawning fish. Some of these herring were evidently just about to spawn, the ovaries being very large.

The herrings obtained from Loch Gair about the middle of December show a moderately high percentage of fat, but still markedly lower than in any Loch Fyne herrings caught during the months of September, October, and November. The highest percentage of muscle fat was found in October fish.

In the summer fish from Loch Fyne, where the ovaries were in an immature condition the fat percentage was usually about that which is often given as the average for the herring. The fat percentage of the herring muscles, therefore, continues rising during the three months, probably, of August, September, and October. It begins to fall slightly in November, markedly in December, most markedly during spawning and continues at a low level until the fish begin to feed again.

The variations in the total amount of fat present in the muscles of the fish are practically the same as those observed in the percentages, except in cases where the herrings being extremely large—as, for example, the Loch Gair specimens—the absolute amount of fat present remains high although the percentage has commenced to fall. For further details with regard to the fat percentages the reader is referred to the tables.

The variations in the percentage amounts of proteid are less marked. It is naturally lowest when the fat percentage is highest unless in cases where the amount of water in the muscles is below the average when both proteid and fat may show a fairly high percentage.

(3) The fat percentage of the ovaries is highest, evidently, in the case of Loch Fyne herrings between the months of July and September. It is low at the time when the amount in the muscles is high. The absolute amount of fat in the ovaries per average fish is, of course, highest in the case of the large November and December fish. With the onset of spawning the absolute amount of fat begins to fall.

The total amounts of P_2O_5 in the muscles and ovaries are highest during the months of November and December.

(4) The ratio of muscle proteid to ovarian proteid practically is the same as that between total weight of fish and total weight of ovaries (*see* tables, pp. 97, 98).

(5) The ratios between the muscle proteid and muscle fat, and ovarian proteid and ovarian fat are shown clearly in the table on p. 97. The most important ratios are those between the muscle proteid and muscle fat. Owing to the rise in the fat percentage during September, October, and November, it gradually approaches that of the proteid, and in the case of the October A series actually rises above the latter.

(6) The ratio between the muscle fat and ovarian fat is given in the table on p. 98.

(7) The composite table on p. 100, giving analyses of male muscle and testes is not sufficiently complete to enable one to draw definite conclusions from it, except in so far that the male muscle evidently undergoes the same changes as the female.

In the light of the above facts, it is interesting to compare the principal feeding times for these herring with the variations in their composition. Brook and Calderwood (Report on the Food of the Herring, Fourth Annual Report of the Fishery Board for Scotland, Edin., 1886, Appendix F. No. VI., pp. 102–128) state that on the West Coast of Scotland the principal spawning time is from February to April (*e.g.*, on the Ballantrae coast), while the principal feeding time is from April to September. The principal food is copepods, which are taken practically exclusively from April to June. Towards the end of the feeding time they are practically replaced by schizopods.

The spawning takes place, just as in the case of the East Coast fish, six to eight months after the richest feeding.

Heincke ("Naturgeschichte des Herrings," p. 48) has shown that the herring after spawning seeks a place where it can get ample food to recuperate. For example, the herrings of Schley, after leaving the spawning beds in June, take three or four months to feed up in Kiel Bay. In September and October they are fattest, and then begins anew the development of the reproductive organs, which up to this time was checked. This takes up the whole autumn and winter, the fish still taking food, but it is not used for the building up of fat, but for the development of the genitalia. With the increase in the development of the genitals, the desire for food diminishes until spawning time arrives, when no food is taken at all. There are thus three periods in the yearly life of the Schley herring :—

1st. The restitution or the feeding period. This continues for 3–4 months after spawning and is the principal feeding time. The spent thin fish during this period recovers and lays on a large amount of fat.

2nd. The ripening period. This continues for 6–7 months. The herring still continues to eat but gradually with less desire, while the sexual organs increase at the expense of the fat.

3rd. The spawning period. This continues for 2 months, and during this time feeding stops.

It is possible that for a short time (a month perhaps) after spawning the herring does not take food.

There are without doubt similar periods during the reproductive life of herrings from all districts. Heincke's statements with regard to the storage and using up of the muscle fat were based on no analytical evidence.

There are still many points in connection with variations in the metabolism in herrings during spawning which require to be worked out, especially the cycle of phosphorus between muscles and ovaries.

Before concluding, I should like to refer to a subject which is at present attracting a good deal of attention, namely, the nutritive value of spent herrings.

Statements are made vaguely as to the unwholesome character of the spent fish. Now, upon what foundation does this rest? Usually upon no further evidence than the general appearance of the flesh of the fish, which is undoubtedly poorer in fat than in the maturing herring. But the nutritive value of the fish does not depend solely upon the fat which it contains; the percentage of proteid must also be considered, and if the tables of analyses be consulted, it will be seen that in this respect the spent fish compare by no means unfavourably with the maturing or mature fish.

But there is one other point which one must bear in mind, namely, that in many cases spent fish contain a large percentage of fat in their muscles, and to illustrate this I include some tables of analyses of fish caught in Loch Fyne in May and June of this year. In many cases these were fish which were undoubtedly storing fat after the discharge of ova had taken place. It is true that this storage of fat does not take place to any marked extent until three or four months have elapsed since the last spawning took place, but still the herrings present the appearance, so far as the genitals are concerned, of spent fish.

Again, the poverty of fat in the muscles of freshly spent herring may render them more digestible in the case of some individuals at least.

One must also remember that fully mature fish about to spawn are in much the same condition as freshly spent fish (*vide* Helmsdale herrings, December 6), and yet these fish would scarcely be termed unwholesome.

It would have been of extreme value to have had analyses made of herrings which had left Loch Fyne in January and gone to Kilbrannan Sound and Campbeltown district; but unfortunately I was unable to obtain specimens.

I subjoin the analyses to which I have just referred.

Attention may be specially directed to the analyses of the flesh of the large spent fish of June 2, as these show a comparatively high fat percentage.

May 16, 1906.

The herrings sent on this date from Ardrishaig were young immature fish. The genitals of 16 of these herrings weighed only 2·15 grammes, and the ova were exceedingly small, ·05–·08mm.

The following table gives the measurements and weights:—

Length.	Girth.	Weight.
Cm.	Cm.	Gm.
19	8·5	50
20	9	63
19	9	58
19	8·5	42
22	10·5	75
19	9	51
20	9 5	63
19	8	45
21	9·5	63
20	9	57
19	8·5	57
20	9	55
20	8·5	46
19	8	45
19	8·5	50
18	8	38
Avg. 19·5cm.	8·8cm.	53gm.

Analyses of the muscles of these herrings:—

(*a*) Amounts stated in percentages of fresh material.

Water.	Proteid.	Fat.
68·14	24·66	3·37

(*b*) Grammes in the total muscles of the average fish of this series.

Proteid.	Fat.
8·72	1·19

May 17, 1906 (Loch Fyne).

These herrings were much larger than those obtained on the previous day. Female fish were selected, and all were found to be in the spent condition, although large numbers of small ova (·08–·3mm.) were present in the collapsed ovaries. The weight of the ovaries from nine fish was 7·53 grammes.

Measurements, &c., were as follows:—

Length.	Girth.	Weight.
Cm.	Cm.	Gm.
23	11·5	101
25	12	142
25	11·5	117
25	11	116
25·5	12	127
23	11·5	97
24·5	12	117
25·5	11·5	133
24·5	10	103
Avg. 24·5cm.	11·4cm.	117gm.

Analyses of the muscles of these herring :—

(*a*) Amounts stated in percentages of fresh material.

Water.	Proteid.	Fat.
74·88	18·76	2·65

(*b*) Grammes in total muscles of the average fish of the series.

Proteid.	Fat.
14·63	2·06

MAY 23, 1906 (Loch Fyne).

The herrings sent on this date varied in character. Some were undoubtedly spent herring, although large numbers of young ova were to be found in the ovaries; others were as certainly young immature herring. Thus a subdivision has been made into two classes.

SERIES A.

Length.	Girth.	Weight.	Genitals.
Cm.	Cm.	Gm.	Spent and re-maturing ovaries (ova ·08 – 2mm.); weight of ovaries from four fish, 4·15gm.
28	12·5	159	
27	12·5	160	
26	12	125	
25	12	122	
Avg. 26·5cm.	12cm.	141·5gm.	

SERIES B.

Length.	Girth.	Weight.	Genitals.
Cm.	Cm.	Gm.	Very small immature ovaries (ova ·06 – 1mm.); weight of ovaries of eight fish, 2·15gm.
23·5	11·5	104	
23	10·5	89	
22	11	89	
23	11	97	
22·5	11·5	95	
22	11·5	91	
20	11	94	
21	10	94	
Avg. 22cm.	11cm.	94gm.	

Analyses of the muscles of these herrings :—

In the case of these fish additional analyses were made in order to determine the amount of coagulable proteid present. Throughout this

paper the numbers given for "proteid" refer simply to the total nitrogen calculated as proteid by multiplying the amount of the former by 6·25.

In the case of these herrings a weighed quantity of fresh muscle was mixed up thoroughly with anhydrous sodium sulphate, the mixture boiled with alcohol to coagulate the proteid, and then the powder extracted frequently with boiling distilled water until all the sulphate was removed. The remainder, consisting of coagulated proteid, was incinerated in the usual way with sulphuric acid (Kjeldahl) and the nitrogen estimated. On multiplying the latter by the usual factor the amount of coagulable proteid was obtained.

(*a*) Amounts stated in percentages of fresh material.

Series A.—

Water.	Proteid.	Coagulable Proteid.	Fat.
70·81	20·67	18·71	5·34

Series B.—

67·58	19·95	16·13	9·57

(*b*) Grammes in total muscles of fish.

	Proteid.	Coagulable Proteid.	Fat.
Series A. . .	19·42	17·58	5·01
,, *B.* . .	12·56	10·16	6·02

June 2, 1906 (Loch Fyne).

These herrings were large spent fish with young ova in the ovaries. Females were selected for analysis.

Length.	Girth.	Weight.	Genitals.
Cm.	Cm.	Gm.	
29	14	211	Weight of ovaries of these six fish, 10·7gm.
28	13	180	
27	13	170	
26	13	165	
26	13	150	
26	12	138	
Avg. 27cm.	13cm.	169gm.	

Analyses:—

(*a*) In percentages of fresh material.

Water.	Proteid.	Fat.
72·35	17·81	9·11

(*b*) Grammes in total muscles of fish.

Proteid.	Fat.
30·09	15·39

June 2, 1906 (Loch Fyne).

Fourteen young immature herrings were obtained on the same day as the spent fish of the preceding series.

Length.	Girth.	Weight.	Genitals.
Cm.	Cm.	Gm.	
24	12	109	Weight of genitals of these fish, 3·6gm.
23	11	96	
22	12	103	
21	11	83	
22	11	91	
22	10	77	
20	10	72	
21	9	62	
22	11	82	
21	9	69	
19	10	64	
19	9	56	
19	9	50	
19	9	50	
Avg. 21cm.	10cm	76gm.	

Analyses of the muscles :—

(*a*) In percentages of fresh material.

Water.	Proteid.	Fat.
63·02	21·06	12·52

(*b*) Grammes in total muscles of fish.

Proteid.	Fat.
10·74	6·38

IV.—REPORT ON THE OPERATIONS AT THE MARINE FISH HATCHERY, BAY OF NIGG, ABERDEEN, IN 1905. By Dr. T. Wemyss Fulton, F.R.S.E., Scientific Superintendent.

(Plates VI., VII.)

Last year, owing to the making of a new road at the Bay of Nigg, it was desired by the Town Council of Aberdeen, from whom the site of the hatchery is leased, that the hatchery and some of the buildings in connection with it should be transferred to an adjacent site and re-erected at their expense. This was agreed to by the Board, and the hatchery, the boiler and pump-house, and the store-house were accordingly taken down and re-built on ground lying to the north of the old site, and contiguous to it. This alteration involved a re-arrangement of the pipes to a considerable extent, and the opportunity was taken to effect some improvements which experience showed was desirable, both in connection with the pipes and pumping plant, and in connection with the buildings. The Town Council and the Burgh Surveyor, under whose charge the removal was made, gave every reasonable facility for these alterations and improvements being effected, and the hatchery is thus much better adapted for the work than it was before.

A strong wall of boulders, about two feet in thickness, has been built with concrete on the seaward face of the new site, so as to protect it from the action of the sea in storms; and this has been made continuous with the bulwark of boulders built up after the great storm in February 1900, which happened in conjunction with spring tides, when the site of the large spawning pond, then in course of construction, was flooded. Owing to the somewhat higher level of the ground at part of the new site, that next the road, it was necessary to excavate it to a small extent in order to keep the levels the same as formerly. This is required, as the water supplied to the hatching apparatus comes by gravitation from the storage or reservoir tank (*a*, fig. 1, plate VI.), to which it is pumped from the sea. Strong granite retaining walls have been built around the reservoir, and between it and the new site.

The establishment consists, in addition to the laboratory (shown at *a* in fig. 2, pl. VI.), of (1) a spawning pond, (2) a reservoir or storage tank, (3) the hatching-house, (4) boiler and pump-house, (5) a tank-house, (6) storehouse, and it may be desirable to give a brief description of the arrangements as they now exist.

The spawning pond (fig. 2, pl. VI.), which was the most costly part of the establishment, consists of a large concrete tank or pond sunk in the ground in order that it may be filled and emptied, according to the state of the tide, without pumping being required. The levels were arranged so that at high water of ordinary neap tides an average depth of four feet might be obtained in the pond. The tank is 90 feet in length by 35 feet in width, and has an average depth of 7½ feet, the bottom sloping to one end, where the depth is 10 feet; it is capable of holding about 160,000 gallons of sea water. The water is admitted from the beach by an inflow pipe 12 inches in diameter; the portion of this going through the embankment separating the pond from the beach is of iron, the remainder,

on the beach itself, being of fireclay pipes, which have answered very well, and have only given rise to trouble on one occasion, in the course of last spring, when a section had to be renewed. The end of the inflow consists of a length of an iron pipe, terminated by an upturned part, raised about two feet from the bottom, and covered with a large shield of wire-netting. This arrangement is to prevent the access of sand, debris, and weeds as far as possible. The outflowing water escapes by a flap-valve at the end of the pipe, beneath the up-turned portion, and on the same level as the rest of the pipe.

The water on entering goes into a small compartment of the pond called the filter chamber. Here it passes up through wire-netting, which may be of any dimension of mesh, and, if necessary, through filtering materi al There are two slide-valves, one controlling the connection of the filtering chamber with the sea and the other the connection between the chamber and the pond. The water may be admitted direct to the pond, or it may be pumped from the filter chamber to the reservoir tank.

The latter (*a*, fig. 1, pl. VI.) is built of concrete on a natural mound lying between the new site and the spawning pond. It is a strong tank, 29 feet long, 7 feet high, and 20 feet in breadth, and capable of holding 15,570 gallons of water. It is from it that the supply to the hatching apparatus and to the tanks in connection with the laboratory is obtained during the night. It can be filled by the pumps in about two hours and a quarter. A pipe, carried through the concrete wall at the bottom, leads the water to the hatchery; another carries a supply to the tank-house for laboratory work, and another allows it to pass into the spawning pond. The pipe going to the tank-house is shown in fig. 2, pl. VI., at *e*, and the pipe entering the pond is on the left of the letter *e*, and close to it. The water from the reservoir may be filtered or unfiltered; the iron pipe which passes through the wall of the tank is connected with a flexible hose, the end of which enters a floating box, so arranged that the supply is drawn from the surface, where there is less matter in suspension, and through flannel or other material.

The hatching-house, as now arranged, measures 49½ feet in length by 24 feet in breadth, part of it being 28 feet wide. The height of the building is 18 feet; it is lighted by 16 windows, and is painted inside in light tints, the walls being pale green and the ceiling white (fig. 1, pl. VII.).

Two material improvements were made in the re-erection of the building. A concrete floor, suitably sloped, replaces the previous wooden floor, and is a great advantage, since the water which is spilled over the floor when the work is going on now flows away into convenient gutters, which are connected with the drain going to the beach. The hatchery is much drier now, and the appearance improved. A large sink, supplied with fresh or sea water, has been erected in the middle of the floor for washing hatching boxes, &c. The other chief improvement consisted in taking in the filtering apparatus, which were previously outside, and this was effected by extending the walls and roof, the gable being put further out. For the "tumbling-boxes," which impart automatically a certain movement to the hatching boxes, two brick chambers have been built below the concrete floor, each 4 feet 4 inches by 4 feet 8 inches, and 3½ feet in depth. One is in connection with the waste water from each side of the hatchery, that is, the water which leaves the hatching boxes and is carried to the pond.

The filters consist of one large box, 8 feet by 4 feet and by 2 feet deep, and several smaller boxes, which receive the water from the larger one. All these are fitted with filters of flannel or blanketing, on frames covered with wire-netting and made tight by rubber bands; all the water which comes from the reservoir must pass up through them by pressure, and it

then passes on to the hatching apparatus. These are 22 in number, and are of the Dannevig pattern. They are shown in fig. 1, pl. VII., which is a view of the inside of one end of the hatchery. The apparatus on each side are supplied by separate pipes.

The pump-house is contiguous to the hatchery room, and opens into it. It is provided with three Worthington direct-acting steam pumps, specially made for use with sea water, and brass lined. They are shown in fig. 2, pl. VII. They are so fitted up that any one of them, or all together, can be used to pump water from the filter-chamber, either to the reservoir or to the pond; there are two suction pipes, one for the large pump and one for the two smaller pumps. Steam is supplied by an upright donkey boiler, with two tubes, which is fitted with an injector and pump, but the town water supply can be used direct, the working pressure being usually 40lbs. The pump-house measures 18 feet 10 inches by 15 feet; its position is shown at *b* in fig. 1, pl. VI.

The tank-house, which is used in connection with the scientific researches at the laboratory, is built partly over one end of the large spawning pond (fig. 2 *c*, pl. VI.), and there is a platform along this side over the pond. It is provided with six concrete tanks, four of which have plate glass in front and back, and the other two plate-glass fronts only. The latter are 6 feet 4 inches long, 4 feet 3 inches deep, and 3½ feet high; the others are 5⅓ feet in length, the other dimensions being the same as in the larger tanks. These tanks may also be used for experiments with fresh-water fishes if desired, fresh water pipes being fitted up to them. A bench runs along one side and one end of the tank-house, provided with a central leaden gutter, and suitably sloped, and pipes are carried over it to supply either sea water or fresh water to small tanks aad dishes.

The various operations in connection with the work at the hatchery have been described in previous reports. Here it may be enough to say that the adult living plaice, from which the spawn is procured, are kept in the large spawning pond from year to year, their food consisting chiefly of mussels. The plaice which die are removed from the pond as soon as observed, and a fresh stock to replace those lost in this way is obtained each autumn by sending the attendant out on trawlers working inshore, who brings them in in tubs through which a current of water is maintained.

When spawning begins, the eggs float in the water of the spawning pond, from which they are removed by a large net of mosquito netting, which is towed around the pond for an hour or so each day as a rule.

The eggs are then transferred to the hatching boxes, which receive a supply, as copious as possible, of clean filtered sea water, until hatching occurs; and when the larvæ have nearly, but not quite, absorbed the yolk they are transferred to the sea in suitable localities.

The cost of the hatching work is small. The scientific investigations carried on at the laboratory require that water should be pumped regularly to supply the tanks, dishes, and apparatus in the tank-house, and sometimes in the hatching room, and the only additional expense incurred in connection with the hatching work is for extra coal while the work is going on, for the assistance of a boy to help the attendant during the busiest weeks, and for the hire of boats to put out the fry. The total cost is estimated at under £100.

The hatchery has been of great advantage in connection with the demonstrations to fishermen from the coast of Scotland, who come each spring to the laboratory for this purpose. It forms a great attraction to them, and enables them to form useful conceptions as to what goes on naturally in the sea with respect to the reproduction of fishes, as well as furnishing them with specimens for the study of their development. As

mentioned below, four delegations of fishermen attended these demonstrations in the course of last spring.

During the season last year the eggs of the plaice were first discovered floating in the pond on 20th January, which is about the ordinary time when they first occur. Examination of the water some days earlier failed to reveal their presence, and only a few hundreds were obtained on the 20th. The number gradually increased up to about the middle of March, and after that declined, the last collection, of a few hundreds of eggs, being made on the 16th May.

The duration of the spawning in the pond was therefore about 117 days, which may be taken as approximately the period in the sea. The total number of eggs obtained was estimated at 40,110,000. The greater number were collected in March; the collections in February and April were nearly equal in quantity to one another; while in January and May comparatively few were obtained. The figures showing the quantity for each of the months, and the percentages in each month for the last three years, are as follows:—

	Number Collected.	Percentages.			
		1903	1904	1905	Mean.
January, - -	1,080,000	0·3	1·6	2·6	1·5
February, - -	9,242,000	18·0	26·1	23·0	22·3
March, - -	19,475,000	56·2	55·7	48·5	53·5
April, - - -	9,431,000	24·1	16·4	23·5	21·3
May, - -	882,000	1·3	..	2·2	1·2

In two Tables which are included in this paper, the particulars are given from day to day of the number of eggs collected and the temperature and specific gravity of the water in the pond, in the hatchery, and on the beach, and of the quantities of fry which were placed in the sea.

It will be seen that the temperature of the water in the pond when the eggs were first obtained was about 3·5°C. (33·8°F.); that it remained low to about the end of March, and that towards the end of the spawning it had risen to 10°C. (50°F.) and over it, the highest reading being on 15th and 19th May, when the temperature was 10·6°C. (51·1°F.).

During the season trouble was occasionally caused by the filters, and the death-rate was larger than usual. The number of dead eggs (including, however, the shells of the eggs which had hatched), amounted to about 15,790,000, which gives a rate of 39 per cent. The estimated number of fry put out into the sea, as given in Table II (p. 115) may be stated at 24,500,000, when allowance is made for the shells of the eggs and the debris contained in the boxes.

Most of the fry were put out off Aberdeen in March, April, and May, the first lot on the 8th of March, and the last on the 23rd May. One lot, by the request of the fishermen of the district, was taken to St. Combs, further up the coast, on the 24th of April. The fry in this lot were estimated to number about 3,517,000, which were dispatched by rail under the charge of the attendant, the water in which they were placed having been previously cooled to a temperature of 1·5°C. (34·7°F.) to obviate risks in carriage. The number of adult plaice found in the pond, when it was cleaned out after the hatching season was over, was 282, and a fair number of dead fish and the remains of some others were removed.

TABLE I.—Showing the Daily Progress at the Hatchery, and the Temperature and Specific Gravity of the Water.

Date.		Eggs Collected.	Eggs Dead.	In Pond.		In Hatchery.		On Beach.	
				Temp.	Sp. Gr.	Temp.	Sp. Gr.	Temp.	Sp. Gr.
January	1	...	...	5·2	27·2	...	...	5·9	27·2
,,	2	...	...	4·8	27·2	...	...	5·6	27·2
,,	3	...	...	5·0	27·6	...	...	6·7	27·0
,,	4	...	...	5·2	27·5	...	...	6·7	27·4
,,	5	...	...	5·3	27·4	...	...	6·4	27·6
,,	6	...	...	5·3	27·4	...	...	6·3	27·5
,,	7	...	...	4·8	27·7	...	...	4·8	27·6
,,	8	...	...	...	...	...	...	...	...
,,	9	...	...	4·7	27·6	...	...	6·0	27·6
,,	10	...	...	4·3	27·9	...	...	...	...
,,	11	...	...	4·7	27·9	...	...	6·8	27·7
,,	12	...	...	4·2	27·6	...	...	...	...
,,	13	...	...	3·6	27·9	...	...	...	...
,,	14	...	...	3·8	27·9	...	...	...	...
,,	15	...	...	...	...	...	...	...	...
,,	16	...	...	2·8	28·0	...	...	5·2	27·2
,,	17	...	...	3·0	27·9	...	...	5·7	27·5
,,	18	...	...	3·3	27·6	...	...	5·7	27·6
,,	19	...	...	3·4	27·7	...	...	5·1	27·7
,,	20	A few hundred.	...	3·5	27·8	...	...	5·2	27·7
,,	21	...	...	4·0	27·5	...	...	5·8	27·5
,,	22	40,000	...	...	...	...	...	...	...
,,	23	40,000	...	3·8	27·8	...	...	5·2	27·6
,,	24	40,000	...	4·4	27·7	...	...	5·1	27·4
,,	25	80,000	...	4·1	27·8	...	...	4·9	27·3
,,	26	160,000	...	3·6	27·8	...	...	4·7	27·6
,,	27	160,000	...	3·7	27·7	...	...	4·2	27·4
,,	28	80,000	...	4·7	27·7	...	...	...	...
,,	29	...	...	...	...	...	...	...	...
,,	30	320,000	...	4·9	27·9	...	...	5·8	26·9
,,	31	160,000	...	4·2	27·7	...	...	...	27·5
February	1	200,000	...	3·9	27·7	4·4	27·8	4·0	27·6
,,	2	120,000	...	3·3	27·8	3·7	27·6	3·9	27·8
,,	3	320,000	...	3·0	27·9	2·7	27·7	4·4	27·7
,,	4	180,000	...	3·2	27·8	4·7	27·6	5·6	27·8
,,	5	...	...	...	...	...	...	...	...
,,	6	200,000	...	4·8	27·6	6·0	27·8	...	...
,,	7	320,000	...	4·2	27·6	4·8	27·7	5·0	27·5
,,	8	160,000	...	4·0	27·6	4·4	27·7	4·2	27·5
,,	9	200,000	...	4·9	27·5	5·4	27·6	5·2	27·4
,,	10	280,000	...	4·4	27·5	5·0	27·6	5·2	27·5
,,	11	200,000	...	3·2	27·6	2·8	27·7	4·0	27·7
,,	12	...	...	...	...	...	...	...	...
,,	13	200,000	...	...	...	...	...	...	...
,,	14	580,000	...	3·4	27·8	5·7	27·2	...	...
,,	15	480,000	...	3·8	27·6	5·6	27·3	5·6	26·7
,,	16	280,000	...	4·4	27·6	6·1	27·3	...	...
,,	17	580,000	1,098,000	4·2	27·7	5·1	27·6	4·9	27·8
,,	18	336,000	...	4·8	27·9	6·2	27·5	5·8	27·8
,,	19	...	...	...	...	...	...	...	...
,,	20	732,000	...	3·3	27·8	2·8	27·8	...	...
,,	21	904,000	...	3·2	27·8	3·2	27·7	4·2	27·1
,,	22	237,000	...	3·4	27·5	3·5	27·4	...	...
,,	23	237,000	...	3·5	27·6	3·4	27.7	...	...
,,	24	430,000	...	3·6	27·6	3·9	27·8	...	...

TABLE I.—*continued.*

Date.		Eggs Collected.	Eggs Dead.	In Pond.		In Hatchery.		On Beach.	
				Temp.	Sp. Gr.	Temp.	Sp. Gr.	Temp.	Sp. Gr.
February	25	560,000	...	3·7	27·6	4·5	27·3	...	...
,,	26	...	...	...	...	...	...	...	...
,,	27	646,000	1,163,000	3·6	27·5	4·6	27·3	...	...
,,	28	860,000	...	3·6	27·7	4·8	27·4	...	...
March	1	603,000	...	4·1	27·3	5·0	27·0	5·2	24·3
,,	2	495,000	...	4·1	27·2	4·8	26·8	5·1	27·1
,,	3	474,000	...	3·8	27·2	3·8	27·2	4·6	27·5
,,	4	689,000	...	4·3	27·0	4·7	27·	5·0	27·7
,,	5	...	...	...	...	...	...	...	...
,,	6	947,000	...	...	...	...	...	...	...
,,	7	1,034,000	...	4·3	27·3	4·6	27·4	5·1	27·6
,,	8	560,000	1,077,000	4·2	27·4	4·8	27·3	5·2	27·6
,,	9	560,000	...	3·3	27·3	4·4	27·4	4·8	27·2
,,	10	517,000	...	3·8	27·5	4·2	27·4	...	...
,,	11	...	...	...	...	...	...	...	...
,,	12	...	...	...	...	...	...	...	...
,,	13	1,679,000	...	4·6	27·2	4·9	27·2	...	...
,,	14	603,000	...	5·0	27·2	5·6	27·2	...	...
	15	689,000	...	5·1	27·1	5·6	27·6	...	...
,,	16	711,000	1,391,000	...	...	...	...	...	...
,,	17	1,301,000	...	5·6	27·2	5·8	27·6	5·6	27·1
,,	18	560,000	...	...	...	...	...	...	...
,,	19	...	...	...	...	...	...	...	...
,,	20	1,077,000	...	5·4	27·2	5·7	27·1	5·6	27·3
,,	21	646,000	...	5·6	27·2	5·7	27·2	5·6	27·6
,,	22	646,000	1,390,000	6·0	27·3	6·2	27·4	5·8	27·6
,,	23	904,000	...	6·2	27·4	6·2	27·4	5·9	27·4
,,	24	646,000	...	5·9	27·3	5·8	27·5	5·9	26·5
,,	25	775,000	...	...	...	...	...	...	...
,	26	...	...	...	...	...	...	...	...
.	27	775,000	...	...	...	...	...	...	...
,,	28	517,000	1,785,000	...	...	...	...	...	...
,,	29	474,000	...	...	...	...	...	...	...
,,	30	947,000	...	...	...	...	...	...	...
,,	31	646,000	...	6·6	27·2	6·6	27·4	...	...
April	1	732,000	...	6·2	27·2	5·9	27·6	...	...
,,	2	...	...	...	...	...	...	...	...
,,	3	947,000	2,088,000	6·5	27·2	6·7	27·6	6·7	27·4
,,	4	689,000	...	7·1	27·5	7·4	27·4	8·0	27·3
,,	5	517,000	...	6·8	27·3	6·4	27·4	...	...
,,	6	646,000	...	5·8	27·3	5·6	27·5	5·4	27·5
,,	7	560,000	...	5·2	27·4	5·4	27·4	4·6	26·7
,,	8	474,000	...	...	...	...	...	...	...
,,	9	...	...	...	...	...	...	...	...
,,	10	603,000	...	4·9	27·6	5·6	27·4	6·4	27·4
,,	11	517,000	...	5·5	27·3	5·7	26·9	6·2	27·5
,,	12	301,000	...	5·8	27·4	6·4	26·9	6·4	27·3
,,	13	...	...	6·0	27·1	6·4	26·5	...	...
,,	14	517,000	2,303,000	6·3	27·1	6·5	26·9	...	...
,,	15	345,000	...	...	...	...	...	...	...
,,	16	...	...	...	...	...	...	...	...
,,	17	517,000	...	6·2	26·9	6·2	26·8	6·2	26·6
,,	18	474,000	...	6·0	27·0	5·9	27·1	6·1	27·0
,,	19	215,000	...	6·4	26·5	6·6	26·1	6·4	26·1
,,	20	258,000	...	6·5	26·6	6·7	26·1	6·8	26·4
,,	21	215,000	...	6·2	26·7	5·8	26·5	6·2	26·4
,,	22	215,000	...	6·5	26·4	6·1	26·6	6·6	26·6

TABLE I.—*continued.*

Date.		Eggs Collected.	Eggs Dead.	In Pond.		In Hatchery.		On Beach.	
				Temp.	Sp. Gr.	Temp.	Sp. Gr.	Temp.	Sp. Gr.
April	23	...	...	...	...	...	...	...	...
,,	24	...	...	6·4	26·8	6·3	26·8	...	...
,,	25	...	...	6·5	26·7	6·8	26·6	6·5	27·4
,,	26	...	...	6·7	26·6	6·6	26·9	8·9	27·1
,,	27	259,000	...	7·1	26·6	7·7	26·8	...	...
,,	28	172,000	...	7·5	26·8	7·6	26·9	7·2	24·7
,,	29	258,000	...	7·7	26·9	7·4	26·7	6·9	26·5
,,	30	...	2,195,000	...	...	...	...	...	...
May	1	108,000	...	8·2	26·2	7·6	25·3	7·6	25·8
,,	2	...	...	8·0	26·3	7·4	26·8	7·4	26·5
,,	3	258,000	...	8·2	26·3	7·8	27·3	8·2	26·3
,,	4	...	...	8·4	26·5	8·2	26·8	7·0	26·9
,,	5	260,000	...	8·4	26·7	9·2	26·9	8·0	27·2
,,	6	85,000	...	8·8	26·8	9·4	27·0	8·4	27·0
,,	7	...	...	...	...	...	...	...	...
,,	8	85,000	...	9·6	26·4	9·6	26·1	8·2	27·0
,,	9	...	...	9·6	26·8	9·2	27·2	...	...
,,	10	...	...	9·8	26·7	9·8	27·1	8·4	27·3
,,	11	86,000	1.301,000	10·4	26·6	10·2	26·8	9·0	27·3
,,	12	...	...	10·2	26·7	9·6	26·4	9·2	27·1
,,	13	...	...	...	...	...	...	...	...
,,	14	...	...	...	...	...	...	...	...
,,	15	...	...	10·6	26·9	9·8	27·0	9·3	27·1
,,	16	A few hundred.	...	9·8	27·2	10·6	26·6	9·8	27·1
,,	17	...	...	9·8	27·2	10·0	26·6	9·5	27·4
,,	18	...	...	10·4	26·4	10·0	26·8	9·5	26·3
,,	19	...	...	10·6	26·5	11·0	26·6	9·2	26·9
,,	20	...	...	10·3	26·8	10·2	26·9	9·2	26·3
Totals,		40,110,000	15,791,000						

During the spring just passed, delegations of fishermen from Elginshire, Caithness, Argyle, and Bute and Arran attended the demonstrations at the hatchery, and expressed themselves as pleased and instructed by what they learnt. I am indebted to Dr. Williamson for taking the photographs which are reproduced in the accompanying plates.

FIG. 1.

FIG. 2.

Fig 1

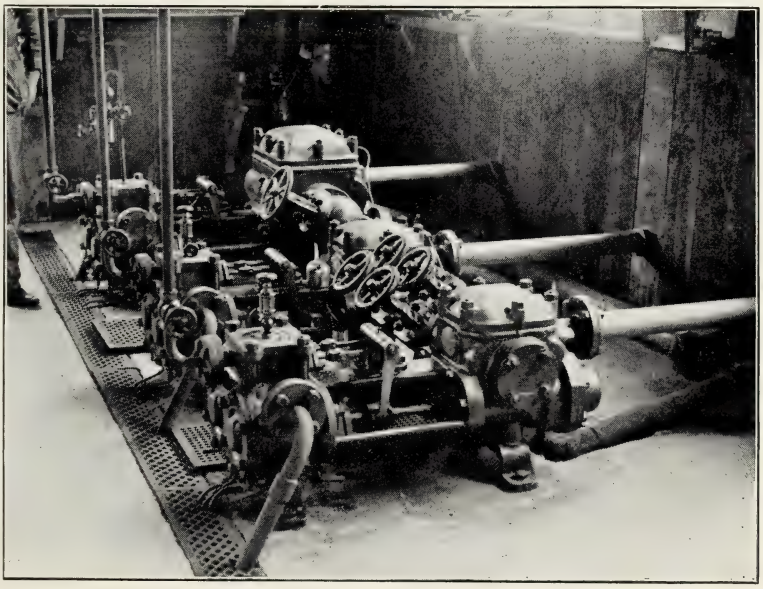


Fig. 2

TABLE II.—Showing Particulars in connection with the Distribution of the Fry.

Date.	Locality.	Depth.	Temperature	Surface Water.		Weather.	Estimated number of fry put out.
				Specific Gravity.	Temperature.		
			F.		F.		
8th Mar.	About ½-mile off Bay of Nigg, - -	14	41·4	26·2	40·6	...	1,055,000
20th ,,	Two miles East of mouth of Don -	17	41·7	27·4	42·8	Overcast,	2,930,000
29th ,,	Off Girdleness, - -	7	42·4	27·6	45·1	Sunshine,	3,518,000
5th April	Off Girdleness, - -	7½	42·1	27·2	40·8	N.-W. wind, snow,	2,931,000
24th ,,	Off St. Combs, - -	...	...	...	...	...	3,517,000
4th May	Off mouth of Don, -	12	45·3	26·9	48·9	...	2,344,000
10th ,,	Off mouth of Don, -	10	44·8	27·4	51·8	...	4,689,000
23rd ,,	Off Girdleness, - -	13	47·1	27·0	50·9	...	3,516,000
							24,500,000

DESCRIPTION OF PLATES.

PLATE VI.

Fig. 1. View of the outside of the Hatchery from the landward side. (*a*) Storage tank or reservoir ; (*b*) corner of pump-house ; (*c*) store-house.

Fig. 2. View of the large spawning pond and laboratory. (*a*) Laboratory ; (*b*) valve ; (*c*) tank-house ; (*d*) marks the place where the inflow pipe enters ; (*e*) pipe supplying the tank-house.

PLATE VII.

Fig. 1. View of the inside of the hatching room, showing the hatching apparatus on each side.

Fig. 2. View of the sea-water pumps and their connections.

V.—ON THE SPECIFIC CHARACTERS OF *GADUS LUSCUS*, *GADUS MINUTUS*, and *GADUS ESMARKII*.

By H. Charles Williamson, M.A., D. Sc., Marine Laboratory, Aberdeen.

(Plates VIII.–X.)

CONTENTS.

	PAGE.
Introduction,	116
List of Body-Dimensions,	119
List of Enumeration-Characters,	121
Discussion of the Averages,	121
The Numbers of Fin-rays,	124
The Numbers of Vertebræ,	129
The Reproduction of the Three Species,	130
The Skulls of the Three Species,	131
A Discussion of the Species,	133
A Specific Description,	135
The Diagnosis of a Species,	136
General Appearance of the Three Species,	136
Key,	138
Literature,	139
List of Tables,	141
Tables,	142–158

Introduction.

The present research is a continuation of the paper contributed to the *Twentieth Annual Report of the Fishery Board for Scotland*, Part III., entitled, "A comparison between the cod (*Gadus callarias*), the saithe (*Gadus virens*), and the lythe (*Gadus pollachius*) in respect to certain external and osteological characters." In that paper a beginning was made with the review of the species of the genus Gadus. In several instances the accepted specific descriptions are unsatisfactory; so much so is this the case that difficulty is experienced in separating certain species. A certain amount of confusion has existed in the diagnosis of *G. luscus* and *G. minutus;* and the third species, *G. esmarkii*, which has, through Dr. Fulton's trawling experiments, been shown to be common in Scottish waters, might in its smaller stages be mistaken for a young *minutus*. The three species under review are the three smallest species of the genus; in the former paper the three largest members were dealt with. A systematic study of the three forms has become necessary in order to definitely fix the specific characters. It is very seldom that a single member of a species will exhibit all the distinguishing characters well. It has thus been necessary to examine a considerable number of specimens of each species. The main purpose is to arrive at an accurate and suitable specific description, and with this end in view, both the characters in which they agree, as well as those wherein they differ, must be studied. A minute comparison is therefore instituted between the three forms, and by the method which was adopted in the previous research. The method has been to make a number of measurements on the body of the fish, in order to determine the comparative magnitude of corresponding distances

on specimens of each species, and also to determine to what extent the dimensions vary in the same species. The number of fin-rays in the unpaired fins and the number of vertebræ formed the basis of comparison. In the selection of the measurements a wide choice exists. It is important to have measurements and characters in which the different forms agree accurately defined. Such characters should not be included in the specific description; they belong to the sub-genus. The introduction into a specific description of the relation between the sizes of two characters, both of which do not lend themselves to accurate definition, should be avoided.

There are certain characters selected, to which one is guided by the general appearance of the fish. A glance at the forms when compared side by side will often indicate possible specific differences. These points of difference sometimes vanish when a number of fishes have been examined; they may be found to be peculiar, individual, and not specific. Many and varied characters may be from time to time adopted, to be dropped again on account of the difficulty of suitably measuring the quantities.

Most of the measurements which were made will be discussed in detail. The values of such characters for specific distinction is in that way determined.

All the measurements have been expressed in terms of the length of the fish.

The Fishes Examined.

All the fishes which have been studied for the purpose of this research were obtained in the North Sea, with the exception of 4 specimens of *Gadus minutus* which were kindly sent from Plymouth* by Dr. H. M. Kyle. The specimens of *luscus* and *minutus* were got chiefly in the neighbourhood of Aberdeen. The *G. esmarkii* were obtained during Dr. Fulton's trawling investigations in the North Sea. Some were obtained off Aberdeen and in the Moray Firth, others were captured in the vicinity of the Shetland Islands. The *esmarkii* were got in the small-meshed cod-end with which the ordinary trawl was covered. The *luscus* and *minutus* were taken in the ordinary trawl.

Luscus and *minutus* are often confused, and are known collectively under the names "Brassies," "Miller's Thooms," "Skelchies," "Davies," etc. They were obtained on or near hard ground within a radius of 25 miles from Aberdeen. *Luscus* was obtained on one occasion in quantity at a point 6 miles E.S.E. of Cruden Scaurs, Aberdeenshire. Out of 38 brassies, 36 were *luscus* and 2 *minutus*. Usually only an odd example of *luscus* was obtained among frequent little lots of *minutus*. *Luscus* and *minutus* are frequently got on the haddock lines, but only in small numbers. On 11th June, 1906, one *luscus*, and *four minutus* were caught on a haddock line near Aberdeen.

In the following Table are set out the various points at which *luscus* and *minutus* appeared among the fishes taken in the trawl of the s.s. "Fifeness," Aberdeen, during the spring of 1905.

* These were 4 females measuring 11, 11·3, 11·4 and 16·6cm. respectively.

Locality.	Date.	*Luscus.*	*Minutus.*
Vicinity of Aberdeen	December 16, 1904,	1	2
14 Miles E. by N. of Aberdeen...	,, 21, ,,	1	4
14 Miles E. by S. ,, ...	January 11, 1905,	3	4
16 Miles S.E. ,, ...	,, 12. ,,	...	2
4½ Miles S.E. ,, ...	,, 14, ,,	1	17
10 Miles off Aberdeen	,, 19, ,,	2	1
4½–10 Miles S.E. of Aberdeen ...	,, 21, ,,	3	6
6 Miles E.S.E. of Cruden Scaurs, Aberdeenshire	,, 23, ,,	36	2
20 Miles S.E. of Aberdeen ...	,, 27, ,,	1	35
21 Miles E. by S. of Aberdeen...	February 3, ,,	1	14
6 Miles E. of Aberdeen	,, 11, ,,	6	3
20–25 Miles S.E. of Aberdeen ...	,, 16, ,,	...	67
21 Miles E.S.E. of Aberdeen, 41–50 fms.	March 9, ,,	2	18
Vicinity of Aberdeen	,, 14, ,,	...	27
,, ,, ...	,, 31, ,,	...	25
,, ,, ...	May 13, ,,	...	29
,, ,, ...	,, 27, ,,	1	21

A proportion of the above specimens of *luscus* and *minutus* species was examined fresh; the majority were, however, examined some time after being preserved in formaline solution—a 2½ per cent. solution of formaline in fresh water.

All the specimens of *esmarkii*, with three exceptions, had been preserved from two to five years, in formaline solution mainly; some were preserved in alcohol.

The following are localities whence came some of the specimens of *esmarkii* which were examined :—

Locality.	Date.	Number of Specimens of *Esmarkii.*
Moray Firth—off Dunbeath ...	October 10, 1900	9
,, ,, Deep Hole, off Kinnaird Head	July 4, 1901	10
Moray Firth	February 7, 1905	1
Off Aberdeen, 65 fms.	June 28, 1901	7
21 Miles E.S.E. of Aberdeen ...	March 9, 1905	2
Between Orkney and Shetland Is.	October, 1900	17

The sizes and sex of all the fishes examined are shown in the following Table :—

Length. Cm.	*G. Esmarkii.*			*G. Minutus.*			*G. Luscus.*			Total at Each Size.		
	♂	♀	Sex. ?	♂	♀	Sex. ?	♂	♀	Sex. ?	*Esmarkii*	*Minutus*	*Luscus*
8	...	1	...	...	...	...	...	...	...	1	...	...
9	...	2	1	...	...	...	...	...	...	3	...	...
10	1	...	3	...	...	...	...	...	...	4	...	...
11	5	6	5	...	3	...	...	..	...	16	3	...
12	3	8	2	...	...	...	...	...	...	13	...	...
13	2	3	...	...	...	...	...	...	...	5	...	...
14	4	13	2	...	2	...	...	...	...	19	2	...
15	4	20	...	1	1	...	...	...	...	24	2	...
16	...	12	1	3	3	...	1	...	...	13	6	1
17	1	8	...	6	7	...	...	..	...	9	13	...
18	...	5	1	5	6	...	...	...	...	6	11	...
19	...	3	1	7	11	2	...	...	...	4	20	...
20	...	...	...	8	21	...	...	...	...	...	29	...
21	...	1	...	8	60	2	1	...	...	1	70	1
22	...	...	...	6	69	...	...	...	...	...	75	...
23	...	...	...	...	43	1	...	...	...	...	44	...
24	...	...	...	...	27	1	2	1	...	...	28	3
25	...	...	...	...	16	1	2	1	...	...	17	3
26	...	...	...	...	9	...	5	2	...	...	9	7
27	...	...	...	...	3	...	7	5	1	...	3	13
28	...	...	...	...	...	...	1	6	1	...	...	8
29	...	...	...	...	1	...	1	3	...	...	1	4
30	...	...	...	...	...	...	3	2	...	...	...	5
31	...	...	...	...	...	...	...	2	...	...	...	2
32	...	...	...	...	...	...	...	2	...	...	...	2
33	...	...	...	...	...	...	2	...	...	...	...	2
34	...	...	...	...	...	...	2	...	...	...	...	2
35	...	...	...	...	...	...	1	2	...	...	...	3
36	...	...	...	...	...	...	1	...	...	...	...	1
37–39	...	...	...	...	...	...	...	...	...	...	...	...
40	...	...	...	...	...	...	...	1	...	...	...	1
Total—	...	...	...	...	...	...	...	...	...	118	333	58

The Body Dimensions.

The comparison between the three species is instituted then by means of the following body dimensions:—

The Girth is measured by means of a thread passed round the fish at three points:—(1) *Pectoral Girth*—in the axilla close to the base of the pectoral fin. (2) *Girth at anus*—at the level of the anus. (3) *Girth at the root of the tail*—at the thinnest part of the caudal peduncle, *i.e.*, the part of the tail extending between the end of the third dorsal fin and the beginning of the caudal fin.

Dorso-Ventral Height of Body.—This dimension was measured by callipers. For the pectoral height the point of the callipers was put between the bases of the ventral fins, while the other point was made to touch a point in the dorsal line, immediately above. The callipers were made to touch the parts lightly. The other two points were at the level of the anus and on the root of the tail, at the narrowest part.

Diameter of the Eye.—The diameter of the eye was the horizontal diameter of the orbit.

Interorbital Space.—The interorbital space is the distance on the dorsal surface of the head between the orbits.

Greatest Length of the Ventral, Pectoral, and First Dorsal Fins.—The fin was measured from the base of the first ray, *i.e.*, in the

case of the ventral and pectoral fins the most dorsal ray—in the case of the first dorsal fin, the most anterior ray—to the tip of the longest ray.

Height of the Lateral Line above the Lateral Axis.—The lateral axis is here taken as coinciding with the straight posterior part of the lateral line. This line was continued by a thread on the measuring board along the fish, and the interval between it and the lateral line was measured at two points—viz., at the level of the anus and at the level of the base of the pectoral fin. In *luscus*, in place of the measurement at the pectoral fin, which is very close to the anus, a new point at the middle of the first dorsal fin was chosen.

Length of the Rami of Tail-Fin.—That is, the distance from the base of the first fin-rays of the caudal fin on the dorsal or ventral line of the body to the tip of the ramus of the tail.

The Spread of the Tail.—The greatest breadth of the tail-fin. For the purpose of this measurement it is not spread out to its fullest extent, but is allowed to fall on the table.

Length of the Caudal Peduncle: *dorsal.*—The part of the dorsal edge between the end of the third dorsal fin and the beginning of the caudal fin.

Greatest Height of the Unpaired Fins.—The fin is stretched out, and its greatest breadth is measured, *i.e.*, between the base and the highest point vertically above the base. This is a character which it is often impossible to get, owing to the fact that in trawled fish the fins are usually frayed or broken.

The above measurements of the eye, interorbital space, of the fins, and of the height of the lateral line were made by means of dividers.

The Distance of Different Points from the Anterior Tip of the Fish.—The anterior tip of the fish is in *luscus* and *minutus* the tip of the upper jaw, in *esmarkii* the tip of the lower jaw. The distance of each point was measured as projected on the lateral axis. The lateral axis is the line joining the anterior tip to the middle rays of the tail-fin.

These points are:—

Anterior edge of the orbit (for the length of the snout).
The base of the first fin-ray of the ventral fin.
The base of the first fin-ray of the pectoral fin.
The opercular cleft.
The hindmost part of the edge of the operculum.
The anus.
Beginning and end of each of the unpaired fins.
Beginning of the caudal fin, dorsal and ventral.
Tip of the ramus of tail, dorsal and ventral.
Point where the lateral line begins to rise up off the horizontal—the anterior end of the straight part of the lateral line.

The beginnings of the fins were marked by means of pins inserted at the base of the first ray. A pin inserted in the anus was taken as the position of the anus. A pin lying in the opercular cleft indicated that point.

For the purpose of these measurements a measuring board, similar to that which was used during the research on the "Mackerel of the East and West Coasts of Scotland" (*Eighteenth Annual Report of the Fishery Board for Scotland*, Part III., p. 295), was employed. The measurements made on the soft body of the fish are not such as permit of exact determination, and probably the errors due to the want of rigidity is greater in small fish than in large specimens. There is, however,

greater accuracy to be obtained on the whole by making the measurements on such a board as described in the 18th Report, than by merely stepping off the distances on the fish with a pair of dividers. If the fish are in good condition, in both methods greater accuracy will be obtainable than in specially soft specimens.

The measurements were made in *centimetres.*

The Measurements Represented as Percentages of one Common Standard.—All the body dimensions were converted into percentages of one standard, viz., the length of the fish.

THE LENGTH OF THE FISH is the distance from the anterior tip (premaxilla or mandible, as the case may be) to the end of the middle rays of the tail fin.

The fishes of each species have been arranged in centimetre groups. The *average* of the percentages of the length of the fish which each body dimension was found to represent was calculated for the fishes of each size. They have been arranged in Tables VII, VIII, IX, X, XI, XII. Alongside each average is added in brackets the number of fishes on which the average is based.

The average percentage for each character has then been calculated in all the fishes of each species in which the character was noted. The number of characters examined in each specimen varied very much; while in some all the characters were noted, in others one or two characters were measured.

Enumeration-Characters.

THE NUMBER OF RAYS IN THE UNPAIRED FINS.—The enumeration of the fin-rays is rendered difficult from the fact that we are dealing with small fishes. The last rays in the fins with the exception of the first dorsal are minute. The first rays of the first anal fin are sometimes liable to be missed on account of their very small size.

In a few cases the number of rays in the paired fins and the caudal fin was counted.

THE NUMBER OF VERTEBRÆ.—The number of vertebræ was counted after the fish had been boiled. The posterior vertebræ are very small; the backbone tapers down to a fine extremity. The vertebræ are not so easily counted in preserved fishes as in fresh specimens. A fish that has been preserved in formaline solution, when boiled, usually becomes distorted. This is due to unequal shrinkage; the skin is much affected in this respect, becoming very tough. The vertebra bearing the ural elements is counted as the last vertebra.

THE NUMBER OF THE VERTEBRA BEARING THE FIRST HÆMAL ARCH.—This character was noted in a number of instances.

DISCUSSION OF THE BODY DIMENSIONS.

The averages taken along with the range of variation of the character gives a more or less partial view of the species. By a comparison between the species we shall be able to see in how far any of these dimensions is of specific value. If we find that the ranges of variation in two species overlap for any one character, that character cannot be regarded as of primary rank in a specific description. In a dimension of which the ranges of variation do not overlap in two species we have a character of primary rank. The characters as set out in Table XIII. will now be examined in detail.

In respect to the *Girth*, a character in which there is a wide difference existing among the three species, so far as the eye can judge, we find a distinct enough separation between certain of the species. At the pectoral region *luscus* has a girth equal on the average to 60 per cent. of the length of the fish, thus exceeding by a considerable amount the respective girth in *minutus* and *esmarkii*. And since the range of variation in *luscus* does not overlap that of *esmarkii* the difference in the girth is of some specific value. The ranges of variation in *luscus* and *minutus* meet though they do not overlap, and between these two the character is of more or less negative value. *Minutus* and *esmarkii* overlap in their ranges of variation and this character is not therefore of value. At the anus, the girths in the three species increase a little. The girth of *minutus* now overlaps that of *luscus*. In the girth at the root of the tail, where a considerable difference exists between *minutus* and *luscus*, judging by the eye, a small difference only is shown by the percentages, but a complete separation is seen between *luscus* and *esmarkii* in respect to this character. The dorso-ventral height of the body agrees closely with the girth relations.

In all three species the horizontal diameter of the eye is on the average as great or greater than the length of the snout, *i.e.*, the distance from the tip of the jaws to the anterior edge of the orbit. *Luscus* has a distinctly smaller eye than *minutus* and *esmarkii*—which two agree exactly—but complete separation in this character does not hold between any two of the species. In the size of the interorbital space the reverse relation is seen, *luscus* having a larger average than the other two, in which there is equality. By their variation, however, they merge into one another.

In the matter of the lengths of the ventral, pectoral, and first dorsal fins, although very distinct agreements and differences are shown in the averages, still the latter are so small that they are really of no specific value. Thus in *minutus* and *esmarkii* the average size of the ventral fin is the same, while that of *luscus* is a little larger; whereas in the case of the pectoral fin, *luscus* and *esmarkii* agree closely and have a fin a little longer than *minutus*. The first dorsal fin is on the average rather larger in *luscus* than in *minutus*, but the two ranges of variation overlap. This character was not noted in *esmarkii*.

In the following characters—height of the lateral line above the lateral axis, the length of the rami of the tail, and the spread of the tail, the greatest height of the unpaired fins—only a few observations were made.

Luscus shows a considerably higher bend in the lateral line than *esmarkii*, and a little higher than *minutus*.

The lengths of the rami of the tail of the three forms agree closely, but in the spread of the tail *luscus* and *minutus* exceed *esmarkii*, being on the average half as broad again as the latter.

The length of the barbel was in *esmarkii* on the average 3 per cent. of the length of the fish; in one specimen of *minutus* the barbel was 5 per cent. of the same quantity.

Distances from the Anterior Tip of the Body.—The average for the length of the snout, *i.e.*, the distance of the anterior border of the orbit from the tip of the jaws, is the same in *luscus* and *minutus*, and 1 per cent. over that in *esmarkii*; but in the latter the snout is measured from the tip of the mandible, which projects on the average 1 per cent. in front of the premaxilla. When that amount is subtracted we get an equal average measurement for the snout in all three.

The ventral fin is situated nearest the tip of the jaws in *luscus*, next in *minutus*, and farthest back in *esmarkii*. The ranges of variation of the

first and the last meet but do not overlap; they each overlap the range of variation of this character in *minutus.* In the distance of the opercular cleft from the anterior end of the body we obtain the same average in each species, and in respect to the hind edge of the operculum, while the averages differ to the extent of 2 per cent. between *minutus* and *esmarkii*, each of these differs from *luscus* by 1 per cent. only.

The position of the pectoral fin is practically the same in all three species in respect to the distance of the base of the first fin-ray from the anterior end of the fish. The distance of the anus from the snout is a diagnostic difference between *luscus* and *minutus.* In the average, the position is at 26 per cent. in the former and at 32 at the latter; the ranges of variation do not overlap. In *esmarkii* the anus is on the the whole slightly farther back than in *minutus*, with, of course, a correspondingly greater divergence from *luscus.* Between *esmarkii* and *minutus* the ranges of variation overlap.

In the position of the first dorsal fin, there is very close agreement, and overlapping.

In the second dorsal fin all three overlap, both in respect to the point at which the fin begins, and also in the position of the end of the fin. *Luscus* and *minutus* have a longer fin-base than *esmarkii.*

In respect to the beginning of the third dorsal fin, they are all equal, but as *luscus* has a shorter fin-base than the two others—the fin ends in it a little farther anteriorly than in the other two.

The first anal fin commences close behind the anus; it ends first in *esmarkii*, and then a little distance farther posteriorly in *minutus* and *luscus.*

In the matter of the second anal all three species agree, both in its commencement and its end.

The caudal peduncle is on the average smaller in *luscus* than in *esmarkii* and *minutus*, but the ranges of variation overlap.

The bend in the lateral line rises farther back in *luscus* than in the other two. It is usually just behind the middle of the length of the body; in no case in *luscus* did it commence on the anterior half of the body; in *minutus* and *esmarkii* it did in some cases begin just on the anterior side of the middle of the body. The lateral line rises more rapidly in *luscus* than in *minutus* and *esmarkii.*

The general relation between the three forms in respect to the different characters selected has been briefly discussed, but these relationships expressed in this form are of themselves of no value from the point of view of specific description. These characters may and do indicate where specific characters may be found. For a specific description it is necessary that the selected characters be tested on one fish. A specific character which infers comparison with a fish of another species is of only secondary value. Each character must be expressed in terms of the individual fish. The size of the eye, for example, may be of specific value when it is stated in terms of the length of the snout, or of any other part of the fish, while it is of no value when compared to the size of the eye in another species.

The position of the anus is a very good guide in diagnosing certain species, and it is important in the present case. The form in which it is represented in the Tables, as being situated at a certain percentage of the length of the fish from the tip of the jaws, is not a useful one for a specific description. It should be expressed in a relationship that is more readily measured, and for this the relation between the position of the anus and the situation of the first dorsal fin. Now, an examination of the measurements of the distance of the two points shows

that among specimens of *luscus* the anus was situated exactly below the beginning of the first dorsal in three cases; in two cases it was in front of that point to the extent of 1 per cent. of the length of the fish, and in seven cases it was behind the beginning of the first dorsal to the extent of 2 per cent. of the fishes' length.

In *luscus*, then, the anus is situated below the beginning of the first dorsal fin.

In *minutus* the anus occupies a very different position in relation to the first dorsal fin. Of 34 examples of *minutus*, in 31 the anus was below the second half of the first dorsal, in one case it was below the middle point of the fin, and in two cases it was just in front of the middle point to the extent of 1 per cent. of the length of the fish. In *minutus*, therefore, the anus is under the second half of the first dorsal fin, *i.e.*, from the middle of the fin to the hind limit of its base. The amount by which the anus was in front of the middle point of the fin would not be noticeable to the eye, and for all practical purposes it would be regarded as coinciding with the middle point.

In *esmarkii* the anus is below the second half of the first dorsal fin; this was found to be the case in all the fishes in which these characters had been recorded—viz., 56 in number. In one of these the anus was exactly below the end point of the fin-base. In *esmarkii*, then, the anus is situated below the second half of the first dorsal fin.

The comparative depth of the members of the two species, *luscus* and *minutus*, has been insisted on in a specific description. It is not, however, very easy to reduce this relation to a specific character. In some specimens it is well marked; but while *luscus* is always a deep fish, *minutus* is variable in this respect. Sometimes in a collection of *minutus* it is possible to divide them up into two lots differing markedly in the depth of body, and in the deeper lot simulating in depth *luscus*. It is necessary to know the range of variation in this character as determined by the measurements of various examples. If, therefore, we examine the average dorso-ventral height of each species, as set out in Table XIII, we find the average height at the anus is, for *luscus*, 26 per cent; for *minutus*, 21 per cent.; and for *esmarkii*, 18 per cent. of the length of the fish. In *luscus*, however, the depth ranges from 28 per cent. to 22 per cent., while in *minutus* the limits were 24 per cent. and 18 per cent. The relation between the two species might be summarised thus:—Where the dorso-ventral height reaches one-quarter or more of the length of the fish, we have to deal with *luscus*; where the same character is as small as one-fifth or less of the length, the fish is probably *minutus* or *esmarkii*; but where the relation lies between one-quarter and one-fifth, either of the two first species may be represented. It is evident, then, that a character such as this is only of small importance for specific diagnosis.

The Lengths of the Bases of the Unpaired Fins.

The inter-relations of the sizes of the different fin-bases may be here considered. In the following Table the average size of the fin-base, expressed as a percentage of the length of the fish, and its range of variation is given for each of the three species.

Species.	1 D.				2 D.				3 D.			
	Max.	Av.	*Variants.*	Min.	Max.	Av.	*Variants.*	Min.	Max.	Av.	*Variants.*	Min.
G. luscus	13	**11·6**	10	10	27	**25**	10	24	15	**12·7**	10	11
G. minutus	13	**11·2**	34	10	26	**24·3**	33	22	17	**15·2**	34	13
G. esmarkii	15	**12**	56	9	25	**22**	48	20	18	**16·5**	47	12

Species.	1 A				2 A.			
	Max.	Av.	*Variants*	Min.	Max.	Av.	*Variants.*	Min.
G. luscus	45	**39·8**	40	37	17	**15**	45	12
G. minutus	35	**31**	42	28	18	**15 5**	34	13
G. esmarkii	31	**27·7**	71	25	19	**16·7**	47	14

The base of the first anal fin is measured from the hind edge of the anus to the end of the base of the fin.

Various relationships between the lengths of the fin-bases may be made out by inspection of the averages. Take, for example, the ratio between the lengths of the anal fins:—

In *luscus* the first anal bears to the second anal the ratio of 40 : 15, *i.e.*, 8 : 3.

In *minutus* the corresponding ratio is 31 : 15·5, *i.e.*, 2 : 1.

In *esmarkii* the corresponding ratio is 28 : 17, *i.e.*, 5 : 3.

From these data, then, it might be expected that a specific character could be obtained in the relation between the two anal fins. To test its value from the point of view of specific description it is necessary to find what ratios are found in a number of fish. These are set out below. The various ratios found existing between the anal fins in respect to the length of their bases is set out for each species, and the frequency with which each occurred in the sample of fish is also added.

Ratios of the First Anal to the Second Anal Fin.	Frequency in *G. luscus.*	Frequency in *G. minutus.*	Frequency in *G. esmarkii.*
3·3 : 1	1	..	..
3·2 : 1	..	..	..
3·1 : 1	1	..	..
3 : 1	2	..	..
2·9 : 1	2	..	..
2·8 : 1	4	..	..
2·7 : 1	7	..	..
2·6 : 1	6	..	..
2·5 : 1	12	1	..
2·4 : 1	4	..	..
2·3 : 1	1	1	..
2·2 : 1	3	4	..
2·1 : 1	1	3	..
2 : 1	..	8	1
1·9 : 1	..	6	3
1·8 : 1	..	7	9
1·7 : 1	..	3	7
1·6 : 1	..	..	8
1·5 : 1	..	..	13
1·4 : 1	..	..	4
1·3 : 1	..	..	2
Total	44	33	47

The extensive overlapping between *luscus* and *minutus* and between *minutus* and *esmarkii* renders this character of value only as a distinguishing feature between *luscus* and *esmarkii.* In *luscus* the first anal is always more than twice as long as the second anal; in *esmarkii* it is usually less than twice the length of the second anal.

The above is the most promising relationship between the lengths of the fin-bases in any of the species.

The three species agree fairly closely in the lengths of the dorsal fins, but show wide diversity in the lengths of the anal fins. If we add the bases of the fins of each species together, keeping the dorsal and anal groups separate, the relations will be seen more easily.

Species.	Sum of Bases of Dorsal Fins (Average Sizes).	Sum of Bases of Anal Fins (Average Sizes).
G. luscus, ...	49·3	54·8
G. minutus, .. .	50·7	46·5
G. esmarkii, ..	50·5	44·4

In each species a portion of the dorsal edge equal to half the length of the fish bears fin-rays. On the anal edge the size of the fin-bearing part varies with the species.

The Number of Rays in the Unpaired Fins.

In the accompanying Table are arranged the average, maximum and minimum number of rays found for each fin. A detailed analysis of the numbers of fin-rays in each fish is given in Tables I, II, III. The range of variation in each species is shown in Table V.

Species.	1 D.			2 D.			3 D.			1 A.			2 A.		
	Max.	**Av.**	Min.	Max.	**Av**	Min.	Max.	**Av.**	Min.	Max.	**Av.**	Min.	Max.	**Av.**	Min.
G. luscus	15	**13·5**	12	26	**23**	21	22	**20**	18	36	**34**	31	22	**21**	18
G. minutus.	15	**13**	11	26	**23**	20	23	**21**	19	31	**28**	26	23	**22**	20
G. esmarkii.	18	**15**	14	29	**25**	21	29	**26**	23	32	**29**	24	30	**27**	24

In respect of the first dorsal, *luscus* and *minutus* agree closely both in average, 13, and in the range of variation, 15–11. *Esmarkii* has a larger number of rays, viz., 15 on the average, with a maximum and minimum of 18 and 15 rays respectively.

In the second dorsal the two former species are again almost identical with an average of 23, while *esmarkii* has an average of 25.

The close agreement persists between *luscus* and *minutus* in the third dorsal also, *esmarkii* having in this fin also a higher average.

The first anal, however, brings about a separation between *luscus* and *minutus*; this was, of course, apparent also when the length of the fin-bases were discussed. *Luscus* has 34 fin-rays, and *minutus* 28 rays in the fin, while *esmarkii* approaches the latter closely, having an average of 29.

In the second anal *luscus* and *minutus* are again in close agreement with averages of 21 and 22 respectively, while *esmarkii* shows an average of 27 rays.

Esmarkii has a much larger number of fin-rays than either *luscus* or *minutus*.

The average number of fin-rays in all three dorsals is, for *luscus* 56; *minutus*, 57; and *esmarkii*, 66.

It was noticed above that the extent of the dorsal edge which bore fin-rays was the same in all three species. It therefore follows that in *esmarkii* we have to deal with a rather lighter and less robust ray than in the two others.

The anal rays (first and second) amount to 55 in the case of *luscus*, 50 in *minutus*, and 56 in *esmarkii*. Here *luscus* has a total of 55 rays distributed on a portion of the ventral edge equal to 50 per cent. of the length of the fish, while *minutus* has 50 rays on 46 per cent. of the length, and *esmarkii* has 56 rays on a part equal to 45 per cent. of the length of the fish. In the anal fin-bearing part we have in *esmarkii* a greater number of rays to the unit of length than in *luscus* and *minutus*.

If, now, we divide the average length of the fin-base by the average number of rays we shall get a relative index of the robustness of the fin-rays in the different species, and in the different fins of the same species.

Average Index of Fin-rays for each Fin.

Species.	1 D.	2 D.	3 D.	1 A.	2 A.
G. luscus, ...	·8	1·07	·65	1·17	·71
G. minutus, ...	·84	1·04	·71	1·1	·7
G. esmarkii, ...	·8	·88	·63	·96	·63

The index of the fin-ray of *esmarkii* is smaller than those of *luscus* and *minutus*, in all the fins except the first. There is also to be noticed that in each species the indices of the third dorsal and second anal agree closely, and together differ from the indices of the second dorsal and first anal fins. In the two former fins the rays are set more closely together, which probably means that they are less robust rays than those of the other fins.

The three species agree fairly closely in their respective indices for the first dorsal fin. In all three species the indices for this fin are less than those of the second dorsal and first anal fins.

From the Tables given above it is seen that there is no typical generic number of rays either for the dorsal or anal group. In the two closely related forms, *luscus* and *minutus*, there is an almost identical number of fin-rays for each fin in the dorsal group, but they are both widely separated from *esmarkii* in this comparison. In the matter of the anal fin-rays, *luscus* and *minutus* were separated. Here the anal rays have a specific value. The dorsal fins are together, on the other hand, a sub-generic character. The extent of the dorsal edge of the body furnished with fin-rays is the same in all three species; but the quality of the rays is specific, and involves different numbers.

The Number of Rays in the Paired Fins and Caudal Fin.

Species.	Length of the Fish.	Sex.	Ventral Fin.	Pectoral Fin.	Caudal Fin.
	Cm.				
G. luscus.	24	♂	6	19	...
	26	♂	6	18	38
	27	♂	6	20	40
	27		6	20	...
	Average,		6 (4)	19 (4)	39 (2)
G. minutus.	14	♀	6	19	...
	14	♀	6	19	...
	19	...	6	20	...
	21	♀	6	20	...
	22	♀	6	18	39
	23	♀	6	18	39
	24	♀	6	19	38
	25	...	6	19	...
	Average,		6 (8)	19 (8)	38·6(3)
G. esmarkii.	15	♀	6	20	...
	15	♀	6	19	...
	16	...	6	19	...
	18	♀	6	20	...
	21	♀	6	20	40
	Average,		6 (5)	19·6(5)	...

In all the specimens examined the same number of rays was obtained in the ventral fin, viz., 6. In the case of the pectoral fin there is a fairly similar amount of variation in each species; and the number of caudal rays is apparently very similar in the three species. The absence of variation in the ventral fin is to be expected, from the fact of there being so few rays. That may be one of the factors, but it may also be in part due to the fact that the ventral fin has a well fixed function in the genus—that its function, whatever it may be, is exactly similar in each of the species in which its rays remain the same.

The Lengths of the Ventral and Pectoral Fins.

The authors of "The Scandinavian Fishes" state in their description of *G. minutus* that the tip of the ventral fin reaches past the anus. This is not constant. The ventral fin has a long filamentous tip in the three species.

In *luscus* the ventral fin always extends past the anus, but in *minutus* and *esmarkii* the tip of this fin often fails to reach the level of the anus.

Of 18 examples of *minutus*, in 6 the tip of the ventral fin did not reach the anus; in 3 cases it reached the anus exactly; and in 9 cases it passed the anus.

Fifty-two examples of *esmarkii* were examined for this character. In 20 the tip of the ventral fin did not reach the anus; in 20 it reached the anus; and in 12 specimens it reached past the anus.

The tip of the pectoral fin extended past the anus in all the specimens of each species in which the character was noted, viz., 9 examples of *luscus*, 18 of *minutus*, and 43 of *esmarkii*.

The Vertebræ.

The details regarding the variation in the number of vertebræ in the three species will be found in Tables I., II., III., IV. They are summarised in Table VI.

The average number of vertebræ was :—*Luscus*, 48·4 ; *minutus*, 49·4 ; *esmarkii*, 53·4.

In the matter of the average number of vertebræ, *luscus* and *minutus* come very near each other, the latter exceeding the former by one. *Esmarkii* has the comparatively high average of 53·4. The higher number of vertebræ is accompanied in this species by a higher number of rays in the unpaired fins.

The average number of the vertebra bearing the first hæmal arch was 16 in *luscus*, and the same in *minutus*, while in *esmarkii* the average was 18·6.

The Urinary Bladder and Ureter.

The urinary bladder in *luscus* has no lobe; in *minutus* and *esmarkii* it has usually two lobes.

Luscus.—None of the specimens examined had a lobe to the urinary bladder. The bladder in this form is coloured a silvery white.

Minutus.—In the great majority of cases where this character was noted, two lobes were found attached to the urinary bladder, one on each side. This was the condition in 12 males and 39 females. In 6 specimens (3 males and 3 females) one lobe only was made out. In no case were both lobes absent. They are diverticula of the bladder, and vary in size. Sometimes both are long, narrow processes; one may be a short flap; or both may be small.

In one female 23cm. in length the left lobe had a small secondary lobe attached to it.

In a female 25cm. long, captured in March, both lobes were large; they were well supplied with blood-vessels, and their edges were frilled. Two of the females got at the same time, measuring 23cm., had similar lobes. In another March fish, a male 22cm. long, one lobe only was found, and it was well supplied with blood-vessels. Another male, 22cm., captured in March, had two long lobes which were supplied with blood-vessels, but were not frilled. A ripe female in June had large frilled lobes.

Esmarkii.—In this form there are usually two lobes to the urinary bladder. In four cases, however, no lobe was made out. These fish had been for two or three years in the preservative. In 15 specimens one lobe only was distinguished, but in the remaining 63 examples in which the character was noted both lobes were found. The lobes may be both long, or one may be short.

The *Ureter* varies in position with respect to the swim-bladder. It may come down from the kidney on either side of the swim-bladder Its position has been noted in a number of specimens.

Luscus.—Out of 11 cases the ureter was on the left in 7, and on the right in 4.

Minutus.—Out of 39 cases the ureter was on the left in 14, and on the right in 25.

Esmarkii.—Out of 53 cases the ureter was on the left in 21, and on the right of the swim-bladder in 32.

Reproduction.

G. luscus.—All the specimens of *luscus* examined were mature. The smallest male in the collection measured 16·8cm., and the next in size was 21cm., while the smallest female was 25cm. long. Fifty-three specimens were examined in all.

The reproductive organs ripen early in the spring.

In January, of the males (24 in number), 22 had large testes, and 2 had developing smaller testes ; of 18 females, 17 had large ovaries, and one had a smaller developing ovary.

In February 1 male and 3 females were ripe, and 3 males had large testes. In 1 female there was a developing ovary.

In March 1 female was ripe, and another had a developing ovary.

In May the one specimen examined was a spent female.

A female measuring 24cm. obtained in June had a small ovary.

The ovary is regarded as ripe when it contains transparent eggs. These are to be seen through the skin of the ovary scattered over the ovary, giving the condition known as the "beaded roe." The ovary may thus be labelled ripe before it is actually running. The large ovaries are white "hard roes."

M'Intosh and Masterman give the spawning time of this form as January—February. Fulton found a *luscus* ripe in the Forth in March and another in May. According to Heincke and Ehrenbaum *luscus* spawns at Heligoland from (March ?) April to August.

G. minutus. All the fishes of this species of which the condition of the reproductive organs has been recorded were mature. The smallest male and female measured 15cm., and above that size mature males were obtained at each centimetre up to the length of 22cm. No male larger than that was found. Mature females were found at every centimetre of length from 15cm. up to 29cm., with the exception of 28cm., at which size no *minutus* was obtained. The evidence therefore points to the conclusion that *minutus* becomes mature both in the male and female at or before reaching a size of 15cm. in length.

The reproductive organs of *minutus* ripen about the same time of the year, but a little later than in *luscus.* Ripe females of *minutus* were not met with till March.

In December 5 females had small developing ovaries.

In January 1 male was ripe, 10 males had large testes, while 1 male had a small developing testis. Thirty females had large ovaries, and 22 had small developing ovaries.

In February 16 males had large testes, 73 females had large ovaries, and 5 females had small developing ovaries.

In March 6 males had nearly ripe testes, 2 females were ripe, and 55 females had large ovaries. In this month nearly all the ovaries were large, white "hard roes."

In May 2 males had nearly ripe testes, and 48 females were ripe.

In June 2 females were ripe and 2 males had fairly large testes. Two males from the Firth of Forth were ripe.

The spawning time of this species is, according to M'Intosh and Masterman, March—June.

The ovary of *luscus* and *minutus* is distinctly triangular. The base of the triangle is parallel and close to the swim-bladder, the apex is the attachment by the oviduct to the anal region. The ovary grows forwards into the abdominal cavity and posteriorly into the post-abdominal cavity.

The Ripe Eggs of Luscus and Minutus.

G. luscus.—The ripe eggs of *luscus* were found in a female in February. The transparent eggs measured 1·1 × 1·25 and 1·2 × 1·25mm. The opaque eggs in the same ovary measured about ·7mm. in diameter. The fish had been in formaline solution.

In March the eggs, which were dead, were pressed out by the genital aperture. They were ripe, and measured 1·07 × 1·25; they were in the fresh condition.

Cunningham found the eggs of a ripe *luscus* to measure from 1·05–1·15mm. M'Intosh and Masterman found that the ripe eggs of this form after being preserved in spirit measured 1·14–1·16mm. in diameter.

G. minutus.—In January three-fourths of the eggs in the ovary were yolked.

In February, in one fish the yolked eggs measured ·55mm. in diameter.

On April 1 two of the *minutus* were in a spawning condition. The eggs flowed freely out at the genital pore. They were not fertilised: no ripe male was available. After being in water overnight some of the eggs remained transparent and floating. They were measured, and the sizes of their diameters in millimeters were as follows:—1, 1, 1, 1, 1, 1, ·97, ·97, ·97, ·97, ·97, ·97, ·97, ·97, ·95, ·9, ·9 × ·85, ·9 × ·85, ·87, ·87, ·87, ·87. ·87. Some of the eggs showed a striated zona.

According to M'Intosh the ripe egg of *minutus* measures ·906mm. in diameter.

Maturity of G. esmarkii.

G. esmarkii.—The smallest mature specimens of this form, so far as the development of the reproductive organs bore witness, were a male at 11cm. and a female measuring 9cm. in total length. Both had developing genital organs.

Holt found two ripe females, measuring 4½in. (about 11cm.) in length, in April. Fulton says that spawning probably takes place in February and March.

The ovary of *esmarkii* is like that organ in *luscus* and *minutus*—triangular in shape. It has only a slight attachment to the roof of the abdominal cavity, except for the ureter. It grows forward along the floor of the abdominal cavity, and is in some specimens pushed to one side by the great development of the liver.

The Swim-Bladder.

The swim-bladder in *luscus* and *minutus* is large. It is usually found to be ruptured. In one case an uninjured swim-bladder was noticed.

The Skulls of Luscus, Minutus, and Esmarkii.

The skulls of *luscus* and *minutus* resemble one another much, and both differ distinctly from the skull of *esmarkii*. The main character of difference is the slope of the ethmoid bone. When the three skulls are

examined in side view the ethmoid in *esmarkii* (*E.*, fig. 9, pl. xi.) is seen to slope backwards quickly, whereas in *minutus* (fig. 6, *ib.*) and *luscus* (fig. 3, *ib.*) it is more nearly vertical.

There are few distinguishing features between the skulls of *luscus* and *minutus*, even when they are compared side by side. To convert these differences into characters by which the skull might be recognised apart from the other is well nigh impossible, so closely are they related.

A general contrast will, therefore, be made between the two.

In two fish of the same size the skull of *minutus* was the larger—it was slightly longer and higher.

Seen from above, when the skull is resting on the vomer and the parasphenoid, the calcified base of the ethmoid (E.) is partly hidden by the crest of the bone in *luscus* (fig. 4); in *minutus* the whole of the base is visible (fig. 8).

The processes from the parietals (P. pr.) are large, winglike, in *luscus*; they are narrow in *minutus*. The squamosals (Sq.) project posteriorly farther in *luscus* than in *minutus*. The notch between the frontal (F.) and post-frontal (pt.-F.) which receives the mucous canal passing round the eye, is much smaller in *minutus* than in *luscus*. The frontal in *luscus* contracts a little over the orbits and then expands again into a broadened anterior extremity. In *minutus* it comes to its narrowest over the orbits, and is continued forward with the same breadth.

The breadth of the anterior end of the skull, measured from the outer angle of one pre-frontal (pr.-F.) to the outer angle of the other, is in *luscus* greater than in *minutus*.

Side view.—The occipital spine (Oc. Sp.) of *luscus* (fig. 3) is much higher than that of *minutus* (fig. 6). The part of the spine on the frontal rises more rapidly in the former.

The hind edge of the occipital spine may be straight, or it may be slightly incurved just before reaching the occipital foramen.

The front edge of the ethmoid has less backward slope in *luscus* than in *minutus*.

In *minutus* the pre-frontal rises up to meet the outer corner of the frontal: it raises the latter a little. In *luscus* it does not rise so much.

Seen from below, the pre-frontal is roughly of a quadrant shape in *luscus* (fig. 12), and of a sextant shape in *minutus* (fig. 11).

The parasphenoid (P.s) is more slender in *minutus* than in *luscus*.

The brain-case is more spherical in shape in *minutus* than in *luscus*.

Seen from behind, the squamosal (Sq.) bends outwards and upwards in *luscus* (fig. 5). In *minutus* it projects more in a horizontal direction (fig. 7).

The opisthotic (op. O.) forms in *minutus* a projecting angle where the post-temporal articulates with it; this angle was not noticed in *luscus*.

The par-occipital (par.-Oc.) of *luscus* is continued backwards in a projecting angle (*Ang.*), and in consequence the edge of the ex-occipital (e.-Oc., fig. 3) curves downward in a concave sense to the articulation with the shorter arm of the post-temporal. It is thus contrasted strongly with the blunt termination of the par-occipital in *minutus* (fig. 6).

The skull of *esmarkii* is long when compared with that of *minutus*. An *esmarkii* measuring 15·5cm. in length had a skull equal in length to that of a *minutus* 21cm. long.

The ethmoid slopes back very quickly in *esmarkii* (fig. 9). The frontal is narrow over the eyes, and the pre-frontals stand out prominently laterally, but the breadth across them is small (fig. 10).

The vomer projects further in front of the pre-frontals in *esmarkii* fig. 13) than in *minutus* and *luscus*.

Otoliths.—Generally, the otolith of *minutus* was heavier, more massive than that of *luscus*, in fish of the same length. The bossing or marking on the concave surface of the earstone is more distinct in *luscus*; it tends to become smoothed down in *minutus*. Two *minutus* of one length had very different otoliths; in one they were much more massive than in the other fish.

The otolith of *esmarkii* shows a tendency to transverse ridging in place of, or in addition to, bossing on the concave surface.

The clavicle, &c.—Slight differences are to be seen in the *clavicle, post clavicle,* and *premaxilla* between *minutus* and *luscus*. Thus, in the clavicle the ridge dividing the outer surface of the bone is broader and more prominent in *luscus* than in *minutus*. The post clavicle of *minutus* has a curved expanded superior end; in *luscus* the head of the bone is expanded and bent a little off the straight.

In the premaxilla the only noticeable difference was in the rather longer and narrower shape of the plate expansion on the distal part of the bone in *minutus*.

Teeth.

The teeth are small in *luscus* and *minutus* and minute in *esmarkii*.

A Discussion of the Species.

Gadus luscus and G. minutus.

Only a very brief notice of the literature is necessary. Yarrell gives characteristic figures of *luscus* and *minutus*. The specific characters are treated only briefly. He says with regard to *luscus* that it has the power of inflating a membrane which covers its eyes, and for that reason it is called Pout, Bib, Blens, Blinds. The anus is in a line under the origin of the pectoral fin. The end of the rays of the tail are nearly square. It has a dark spot at the origin of the pectoral fin. The Bib is the deepest gadid. The fin-formula given by Yarrell is—1 D, 11; 2 D, 20; 3 D, 16; 1 A, 33; 2 A, 19; P, 18; V, 6. Vertebræ, 48.

G. minutus has, according to this author, the following fin-formula:—1 D, 12; 2 D, 19; 3 D, 17; 1 A, 25; 2 A, 17; P, 14; V, 6.

At different times the identity of the two species, *G. minutus* and *G. luscus* has been maintained. This is the view which Smitt maintains in the last edition of the "Scandinavian Fishes," although plates showing perfectly characteristic *luscus* and *minutus* are included in the work. According to this author, Steindacher had asserted that the depth of the fish is merely a character of age, and he referred to the same category the character derived from the union of the anals in *luscus* and their separation in *minutus*. The comparative depth of the two species is certainly not a character that can be relied upon. But the deficiency in the second character mentioned I have not been able to find in the adult. Schmidt found this a very reliable character in the very young stages. Further, Smitt remarks that "the size of the eyes has been long since ascertained to undergo a relative diminution with increasing age." The relative size of the eyes in *luscus* and *minutus* is not of much importance.

Smitt has compared 5 *minutus* and 3 *luscus* with respect to a large number of characters. In a considerable proportion of these very close agreement is found between the two species. That is to be expected, since *luscus* and *minutus* resemble one another closely; in fact they form a small group of two fishes very distinct from the other Gadids. The following are the characters which Smitt selected:—Length of the head; distance of the beginning of each of the three dorsal fins from the tip of

the snout; lengths of the ventral and pectoral fins; length of the bases of the third dorsal and first anal fins; the horizontal diameter of the eye; breadth of the hind extremity of the maxilla; distance between the ventral fin and beginning of the first anal fin. All these characters were represented as percentages of the total length of the fish. In most of these characters not only do *luscus* and *minutus* come close together, but they both closely resemble *esmarkii*, as reference to Table XIII. will show. In the characters the length of the bases of the third dorsal, *minutus* and *esmarkii*, come close together, both being separated from *minutus*. In the length of the base of the first anal considerable diversity exists between the three forms. It is not necessary to follow Smitt into the other characters, which are represented as percentages of various standards. It is to be expected that the different species in a genus will show very many points of close resemblance, and that the characters in which they differ may be few. The specific *tout ensemble* may be very characteristic, and still not be easily reduced to a specific description. The specific descriptions of the two fishes in the "Scandinavian Fishes" recite in detail many points in which the two species of *luscus* and *minutus* agree, and do not emphasise the points of difference.

The fin-formulæ and vertebræ given in the "Scandinavian Fishes" are as follows:—

Luscus—1 D, 12–14; 2 D, 20–26; 3 D, 18–20; 1 A, 27–35; 2 A, 17–21; Pect., 19–20; Ventr., 6. Vertebræ, 48.

Minutus—1 D, 12–15; 2 D, 19–25; 3 D, 17–24; 1 A, 25–31; 2 A, 17–23; Pect., 17–19; Ventr., 6. Vertebræ, 50.

The variations in the number of fin-rays found during the present research are arranged in Table V., p. 149, and the variations in the number of vertebræ appear in Table VI., p. 150.

Schmidt discusses Smitt's evidence on the question of the identity of the two species. He shows that in the young stages *luscus* and *minutus* are quite characteristic, and are easily separated by the specific characters that hold good in the adult. He emphasises the position of the anus with reference to the first dorsal fin, and the union of the anal fins which he finds constant in the young stages. He also lays stress on the difference in depth between the two species. He describes and figures a series of both species up to 5cm. in length.

Parnell, in his account of the Brassy (*Morrhua lusca*), mentions that the scales are very deciduous. It is characterised by a dusky spot at the base of each pectoral, by the first anal fin commencing under the middle of the first dorsal. He had examined *Morrhua lusca* up to a size of 17 inches (42cm.). Parnell says that this fish resembles *Morrhua minuta*, but the latter has a shorter anal fin than *Morrhua lusca*. This author does not record *Morrhua minuta* from the Firth of Forth. The fin-formula of a *Morrhua lusca*, measuring 16 inches (40cm.) in length, he gives as follows:—1 D, 13; 2 D, 24; 3 D, 17; 1 A, 31; 2 A, 18; P, 15; V, 6. In the case of the third dorsal he obtained a number (17) which is less than the smallest number found in any of the specimens examined in the present research, viz., 18 rays.

Gadus esmarkii.

This form, which was first recorded for Scottish waters by Günther, was obtained by Sir John Murray in the Clyde and certain lochs on the West Coast of Scotland.

The distinctive characters selected by Günther are the following:—

The lower jaw projects beyond the upper.

The teeth of the outer series in the upper jaw are a little larger than the inner ones.

The snout is almost equal to the length of the diameter of the eye. [This character is preferably expressed as follows :—The diameter of the eye is equal to or exceeds the length of the snout.]

The eye is very large, being a little less than one-third of the length of the head.

The barbel is slender, being about half as long as the eye.

The fin-formulæ were—1 D, 15-16 ; 2 D, 23-25 ; 3 D, 22-25 ; 1 A, 27-29 ; 2 A, 23-25.

In the "Scandinavian Fishes" the fin-formulæ are given as follows :— 1 D, 14-16 ; 2 D, 22-26 ; 3 D, 22-27 ; 1 A, 26-30 ; 2 A, 24-38. Pect., 19. Ventr., 6. Vertebræ, 52.

Attention is called in the latter work to the lateral line which is "dark (though not very distinct) and anteriorly slightly curved."

The numbers of fin-rays and vertebræ found in the *esmarkii* examined for the purpose of this research are set out in Table III., p. 145.

Günther drew attention to the cysts that are found in the eye of *esmarkii*. They are arranged in the iris, may be few in number, or they may occupy almost the whole of the iris, in this way appearing as a ring of white balls. These cysts occur in *minutus* also.

In 1893 Professor M'Intosh described a "peculiar Poor Cod" which is, he informs me, a *Gadus esmarkii*. Professor M'Intosh has kindly permitted me to have a drawing made of this specimen, and it is reproduced in pl. ix.

Since then Dr. Fulton has obtained it in large numbers. Schmidt has described in detail the post-larval and young stages of *G. esmarkii* up to a length of 5·4cm. He remarks that in an example of 19mm. the eyes are but relatively small, their diameter being of the same size or but little larger than the distance from their anterior margin to the end of the snout.

A Specific Description.

For the purpose of determining the specific description a large number of measurements was made on specimens of each species. These show that external measurements made on a single fish may be of little value from the point of view of specific diagnosis, since the variation of each character is large, and, so far as is apparent, independent of, or at least not necessarily correlated with, any other contiguous character. The amount of variation which may occur in the characters, while the general specific identity is retained, is large. Specific identity means identity of function. The specific characters mean a difference in the life and habits of the animal which we may not be able at present to estimate. The correlation between the specific characters and the life of the fish is a field hitherto practically unexplored. Thus there are perplexing similarities and differences between fishes. The former mean that the fishes perform similar functions, but at the same time in certain other functions they occupy different spheres in the economy of the sea.

In working out the specific characters it is well to consider the points in which the species agree, in order that these may form part of the generic or sub-generic description. The object of the specific description is to enable an observer to diagnose a single fish, and for that purpose a chart is required.

The Genus may be divided into certain sub-genera. The species may be arranged into two or more groups, each characterised by some common character. The species in each sub-genus may then be distinguished

from one another. Each species might appear in several sub-genera. For example, the members of the cod family discussed in the previous paper and in this, include *G. callarias*, *G. virens*, *G. pollachius*, *G. luscus*, *G. minutus*, and *G. esmarkii*. Now, these may be divided into two groups, as follows:—(a) Group of large fish, *callarias*, *virens*, and *pollachius*; (b) group of small fish. Thus, if the fish is over 17 inches in length it will probably belong to the first group, if less than that it may belong to either group.

Nothing should appear in a specific description except what can be readily gauged without the aid of any accurate measurements. A measurement shown as a percentage of the length is a poor guide except when its fullest range of variation is taken, for its value. The average is of no value by itself, *i.e.*, as a specific character. It may be used to show broad relationships.

Even in the case where two species are so distinct that a glance is sufficient to separate them, still it is often very difficult to get readily gauged characters sufficient to describe the species. The attempt is made to describe a solid by means of a few characters, which are usually mere distances.

The Diagnosis of a Species.

The simplest mode of diagnosing a species is by means of a key of the genus. Accompanying the key there should be a particular description of the general appearance of each species. The key should be full, so that the species may be determined by different routes. There is hardly a single character which can be absolutely depended on. The specimen which it is desired to diagnose may be affected in such a way as to render a character, even an important one, doubtful. For example, a *G. esmarkii* may be found in which the mouth is fixed wide open, the hyoid and branchiostegal apparatus having become rigid. In such a specimen it could not be determined whether the lower jaw projected in front of the upper or not, and in this way a very valuable character becomes unavailable. In another case a *G. minutus* has been observed in which the lower jaw projected out in line with the upper jaw, if it did not actually pass it slightly. The sum or resultant of the characters has therefore to be relied upon for the sure diagnosis.

General Appearance of the Three Species.

Luscus, fig. 2, pl. viii.; *Minutus*, fig. 1, *ib.*; *Esmarkii*, pl. ix.

They are all three small fishes. The largest size of *luscus* and *minutus* appears to be 17 inches (42cm.), and Fulton gives 10 inches as the length of the largest *esmarkii* recorded so far.

Luscus and *minutus* are deep fishes. While *luscus* is the deeper of the two, still considerable variation exists in *minutus* in this character. In one catch of *minutus* obtained in February it was possible to divide the fishes into two groups, in one of which the members were distinctly deeper than those in the other group. The deep group consisted of 15 females measuring from 21cm. to 24cm., while the narrower specimens numbered 42. Of the latter, 7 were males measuring from 17·5cm. to 22cm., and the remainder, 35 females, measured from 20cm. to 25cm. in length. All the fishes had well-developed reproductive organs, and the only difference appeared to be that in the deeper fish the ovaries were rather larger than in the other lot. In a deep fish variations in depth are readily noticed. Where the character is large the variations are comparatively large. *Esmarkii* is a more slender fish than the preceding.

Colours and Scales.—The three species have silvery snouts, cheeks, and shoulders.

Minutus has large silvery scales that are very easily rubbed off. The exposed part of the scale is covered with dark dots on a ground of silver. The overlapped part of the scale is colourless. The scales of the dorsum above the lateral line have a golden-yellow ground dotted with black. The golden-yellow colour is also seen on the silvery scales on the side.

The scales of *luscus* are smaller than those of *minutus*; they also are very deciduous. On the scale from the side of *luscus* there is a broad edging of black dots. Beneath the scales the skin is thin and somewhat iridescent. When wet the skin of *luscus* has a slight golden sheen, but when dried the black-dotted scales give it a dirty black appearance. In large specimens preserved in formaline the appearance is silvery, but the skin has generally a blackish aspect.

When preserved, *minutus* remains of a brownish-yellow colour, that is when the silvery scales are rubbed off, as usually happens. Where they remain attached the skin becomes of a dark appearance. The skin is of a rougher texture than that of *luscus*. It is slightly pinkish on the dorsum.

In both species the belly is silvery. *Esmarkii* also is silvery on the sides.

The Axillary Mark.—In *luscus* the axillary mark is a large blue-black patch covering the sides of the axilla, and extending out on the clavicle and over the base of the pectoral fin. In *minutus* it is a small dark area on the axilla and the base of the first pectoral fin-ray. It does not extend on to the clavicle much. In *esmarkii* there is a very similar axillary mark to *minutus*: it is a collection of small black dots which spread over the base of the pectoral fin.

The Peritoneum in *esmarkii* is black, and in preserved specimens the black layer shines through the thin abdominal wall.

The Fins.—The anal fins of *luscus* are blue-black; those of *minutus* yellow and black spotted. The first anal of *minutus* is sometimes very dark.

Most of the unpaired fins of *esmarkii* have a black border. Thus the anterior border of the first dorsal is black, while the superior and hind borders of the second and third dorsal fins are likewise black. The black parts of the second anal and caudal fins are the hind border and the hind half of the fin respectively. There are black spots along the bases of the fins, and also on the anterior border of the first anal. The anal fins of preserved specimens are without pigment, except on the anterior part of both fins, where a small area is covered with small dots. This character is more prominent in the larger specimens. The caudal fin is more or less all black.

The second and third dorsals are separate in *minutus* and in *esmarkii*, and are usually separate in *luscus*. In one specimen of *luscus*, however, a male measuring 16·8cm. in length, the second and third dorsals were united.

The first and second anals are separate in *minutus* and *esmarkii*, but are united in *luscus*. There is a thick integument on the unpaired fins in *luscus* and *minutus*. In the former the first anal is a thick flabby fin, the integument being soft and loose. This fin is often inflated with a gas, which can be pressed out at the edge.

There is a characteristic difference between *luscus* and *minutus* in the shape of the third dorsal and second anal fins, as will be seen by reference to Plate VIII. The hind edges of these fins in *luscus* are cut straight across, at right angles to the longitudinal axis of the fish. In *minutus* the hind edges slope away posteriorly. In *esmarkii* the slope is more pronounced and longer than in *minutus* (pl. ix.).

The Caudal Fin of *luscus* has its hind margin slightly concave, that of *minutus* is distinctly concave, and in *esmarkii* the hind margin is deeply cleft.

The ventral fin ends in a filamentous tip in all three species.

The Mandible projects a little in front of the upper jaw in *esmarkii*; in *minutus* and *luscus* the upper jaw projects in front of the lower.

The side and tip of the lower jaw are dark coloured in *esmarkii*. The under-surface of the dentary part of the lower jaw is white in *luscus*; pale, colourless in *minutus*. In consequence, the sensory pits on the under-surface of the dentary show up well in *luscus* and are faint in *minutus*.

The Barbel is long and stout in *luscus* and *minutus*. In *esmarkii* it is thin and short, not being longer than half the diameter of the eye. In the last species the barbel often lies back along the under surface of the lower jaw in the hollow between the two dentaries. The barbel is not so short in *esmarkii* as it is in *Gadus virens*, in which species it is very inconspicuous.

The Lateral Line is curved over the abdomen in all three species. In *luscus* and *esmarkii* the line is dark and more prominent than in *minutus*. The bend rises from the hind straight portion more abruptly in *luscus*; in *minutus* and *esmarkii* the rise is more gradual.

The Anus is beneath the beginning of the first dorsal fin in *luscus*, and beneath the second half of the corresponding fin in *minutus* and *esmarkii*.

The Eye in the three species here discussed is specially large. In *luscus* it is slightly smaller than in *minutus* and *esmarkii*. The diameter of the eye is equal to or greater than the length of the snout, *i.e.*, the distance from the tip of the upper jaw to the anterior edge of the orbit. They all exhibit at times the loose cornea which is sometimes inflated with gas or fluid, giving the eye the well-known bulged appearance. Sometimes cysts are found on the front of the eyeball in the region of the iris.

Two of the larger *esmarkii*, measuring 18·5cm. and 19cm. in length, had eyes which appeared to be larger in proportion than the smaller fishes. The eyes measured in horizontal diameter 7·3 and 7·8 per cent. of the total length of the fish respectively. Four others measuring 19cm., and one of 21cm., had eyes measuring 7 per cent. of the total length of the fish. The small difference in diameter will, of course, entail a considerable difference in the area of the eye, and it is by the area, not the diameter, that the eye of the observer makes the comparison. Any variation towards an increase in the size of an already specially large character will of necessity attract attention.

The barbel in *luscus* is rather bigger and stouter than that of *minutus*. In five specimens of the latter the barbel measured two-thirds or a little more than the horizontal diameter of the orbit.

In the key are introduced the following Gadid species—*G. callarias*, *G. virens*, *G. pollachius*, *G. luscus*, *G. minutus*, and *G. esmarkii*.

KEY.

I. Lower Jaw (Length of)—
- *a.* projects in front of Upper Jaw, . . *virens; pollachius; esmarkii.*
- *b.* of same length as ,, ,, . *virens* (young); *minutus* (sometimes).
- *c.* shorter than ,, ,, . . *callarias; luscus; minutus.*

II. Anus (Position of)—
- *a.* below the beginning of the First Dorsal Fin, . . . *luscus.*
- *b.* ,, ,, first half ,, ,, ,, ,, ,, . *pollachius; minutus.*
- *c.* ,, ,, second ,, ,, ,, ,, ,, ,, *minutus; virens; esmarkii.*
- *d.* ,, ,, first half ,, ,, Second ,, ,, . . *callarias.*

III. Lateral Line—
- *a.* curved, dark, . . . *pollachius; minutus; luscus; esmarkii.*
- *b.* ,, posterior part white, ... *callarias.*
- *c.* straight, white, ... *virens.*

IV. Tail Fin (Hind Edge)—
- *a.* straight or slightly convex, . . . *callarias* (large).
- *b.* very slightly concave, . . . *callarias* (small); *luscus.*
- *c.* slightly concave, ... *minutus.*
- *d.* distinctly forked, ... *pollachius; esmarkii.*
- *e.* deeply cleft, ... *virens.*

V. Snout (The part from tip of upper jaw to anterior edge of the orbit)—
- *a.* sharp, ... *virens; pollachius; esmarkii.*
- *b.* blunt, ... *callarias; luscus; minutus.*

VI. Eye (horizontal diameter of the orbit)—
- *a.* as large as, or larger than, the snout, . *luscus; minutus; esmarkii*
- *b.* not so large as the length of the snout, . *callarias; virens; pollachius.*

VII. Barbel—
- *a.* absent, ... *pollachius.*
- *b.* very minute, ... *virens.*
- *c.* small, slender, about half the diameter of the eye, . *esmarkii.*
- *d.* big, stout, ... *callarias; luscus; minutus.*

VIII. Anal Fins—
- *a.* united, ... *luscus.*
- *b.* separate, . . *callarias; virens; pollachius; minutus; esmarkii.*

IX. Ventral Fin* (length of)—
- *a.* less than two-thirds of the length of the Pectoral Fin, *virens; pollachius.*
- *b.* about five-sixths of the length of Pectoral, . . *callarias.*
- *c.* almost as long as the Pectoral, . . *luscus; minutus; esmarkii.*

X. Second and Third Dorsal Fins—
- *a.* united, ... sometimes in *luscus.*
- *b.* separate, . *callarias; virens; pollachius; luscus; minutus; esmarkii.*

XI. Girth at Pectoral Region—
- *a.* greater than the girth at Anus, ... *callarias.*
- *b.* less than the girth at the Anus, . *virens; pollachius; luscus; minutus; esmarkii.*

XII. Scales—very deciduous, ... *luscus; minutus.*

XIII. Length—
- *a.* not exceeding 10 inches (25 cm.), . *callarias; virens; pollachius; luscus; minutus; esmarkii.*
- *b.* not exceeding 17 inches (42 cm.), . . *callarias; virens; pollachius; luscus; minutus.*
- *c.* exceeding 17 inches (42 cm.), . . *callarias; virens; pollachius.*

LITERATURE.

Cunningham.—"Marketable Marine Fishes." London, 1896. [Short descriptions of *G. luscus* and *G. minutus.*]

Day.—"The Fishes of Great Britain and Ireland." London, 1880–1884.

Fulton.—"The Spawning and Spawning Places of Marine Food-Fishes." *Eighth Annual Report of the Fishery Board for Scotland*, for the year 1889. [Spawning of *G. luscus.*]

——— "On the Comparative Fecundity of Sea-Fishes." *Ninth Annual Report of the Fishery Board for Scotland*, for the year 1890, p. 243. [Eggs of *G. luscus.*]

——— "Ichthyological Notes—*Gadus esmarkii.*" *Nineteenth Annual Report of the Fishery Board for Scotland*, for the year 1902, Pt. III., p. 282. [Distribution of *G. esmarkii.*]

* The slender tip of the ventral fin may be broken sometimes.

FULTON.—"Ichthyological Notes—*Gadus esmarkii.*" *Twentieth Annual Report of the Fishery Board for Scotland*, for the year 1901, Pt. III., p. 539.

——— "The Rate of Growth of Fishes—*Gadus esmarkii.*" *Twenty-second Annual Report of the Fishery Board for Scotland*, for the year 1903, p 195. [Rate of Growth and Distribution.]

GÜNTHER.—"Catalogue of Fishes in the British Museum."

——— "Report on the Fishes obtained by Mr. J. Murray in Deep Water on the North-West Coast of Scotland, between April 1887 and March 1888." *Proceedings Roy. Soc. Edinburgh*, vol. xv., p. 205. 1889. [Specific Description of *Gadus esmarkii.*]

HEINCKE u. EHRENBAUM.—"Eier und Larven von Fischen der deutschen Bucht." II. "Die Bestimmung der Schwimmenden Fischeier und die Methodik der Eimessungen." *Wissen. Untersuch. von der Komm. wissen. Untersuch. der deutschen Meere in Kiel u. Biol. Anstalt auf Helgoland.* N.F. 3er Bd. Abtheil. Helgoland. Hft. 2. 1900. Pp. 131 *et seq.* [Eggs and Spawning of *G. luscus.*]

HOLT.—Royal Dublin Society. Report of Council for 1891. [*Gadus esmarkii.*]

M'INTOSH.—"Report of the St. Andrews Marine Laboratory, No. III." *Fourth Annual Report of the Fishery Board for Scotland*, for the year 1885, p. 201. [*Gadus luscus* and *Gadus minutus.*]

——— "Contributions to the Life-Histories and Development of the Food- and other Fishes." *Eleventh Annual Report of the Fishery Board for Scotland*, for the year 1892. Part III. [Eggs of *Gadus minutus:* On a peculiar "Poor Cod" (*G. esmarkii.*]

M'INTOSH and MASTERMAN.—"The Life-Histories of the British Marine Food-Fishes." London, 1897. [Eggs, larvæ, and post-larval stages of *G. luscus* and *G. minutus.*]

MÖBIUS u. HEINCKE.—"Die Fische der Ostsee." Berlin, 1883. [Specific Description of *G. minutus.*]

PARNELL.—"Fishes of the Firth of Forth." Edinburgh, 1838. [Description of *Morrhua lusca.*]

"SCANDINAVIAN FISHES." (By Fries, Ekström, Sundevall, Wright, and Smitt.) Stockholm, 1893.

SCHMIDT.—"The Pelagic Post-larval Stages of the Atlantic Species of *Gadus.*" 3 Plates and 16 Figures in the Text. Pt. I. *Meddelelser fra Kommissionen for Havundersögelser.* Serie, Fiskeri. Bind I. No. 4. Copenhagen, 1905. [Post-larval stages of *G. luscus*, *G. minutus*, and *G. esmarkii*, with figures.]

WILLIAMSON.—"On the Pelagic Fish-Eggs and Larvæ of Loch Fyne." *Seventeenth Annual Report of the Fishery Board for Scotland*, for the year 1898. Pt. III., p. 79. [Occurrence of the eggs of *G. luscus* and *G. minutus.*]

——— "A Comparison between the Cod (*Gadus callarias*, Linn.), the Saithe (*Gadus virens*, Linn.), ond the Lythe (*Gadus pollachius*, Linn.), in respect to certain external and osteological characters." *Twentieth Annual Report of the Fishery Board for Scotland*, for the year 1901. Pt. III., p. 228.

YARRELL.—"A History of the British Fishes." London, 1861. [Descriptions of *Gadus luscus* and *G. minutus.*]

EXPLANATION OF PLATES.

PLATE VIII.

Fig. 1. *Gadus minutus*, 27 cm. long. ♀, large ovary. *Reduced.*
Fig. 2. *Gadus luscus*, 28 cm. ♀, nearly ripe. *Reduced.*

PLATE IX.

Gadus esmarkii. Nat. size.

PLATE X.

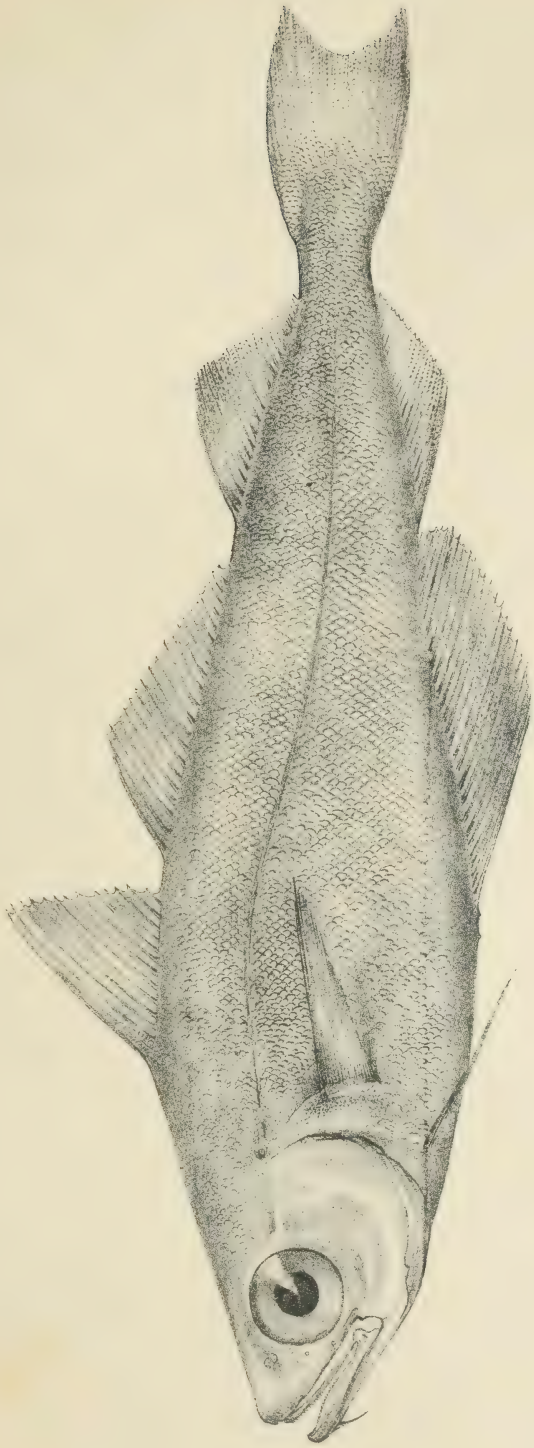
Fig. 3.	Skull of *G. luscus*, ♀, 28·7 cm.,	. . . . .	×	2
Fig. 4.	,, ,, ,, ,,	. . . . .	×	2
Fig. 5.	,, ,, ,, ,,	. . . . .	×	2
Fig. 6.	,, *G. minutus*, 25 cm.,	. . . . .	×	2
Fig. 7.	,, ,, 26 cm.,	. . . . .	×	2
Fig. 8.	,, ,, 25 cm.,	. . . . .	×	2

1.

2.

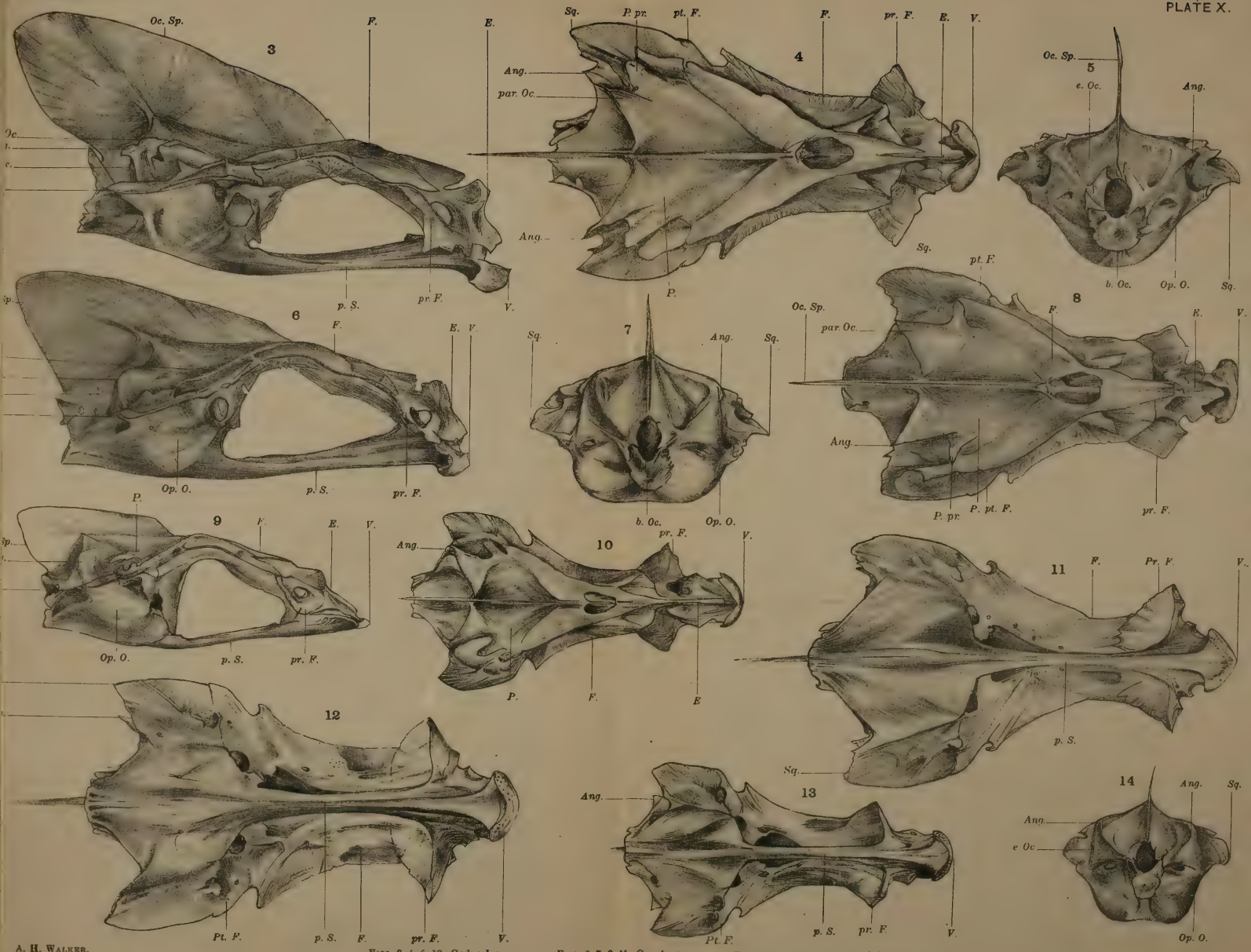
A. H. WALKER, *delt.*

Fig. 1. *Gadus minutus.* Fig. 2. *G. luscus.*



A. H. WALKER. *Gadus esmarkii.*

PLATE X.



A. H. WALKER.

FIGS. 3, 4, 5, 12. *Gadus luscus.* FIGS. 6, 7, 8, 11. *G. minutus.* FIGS. 9, 10, 13, 14. *G. esmarkii.*

Fig. 9. Skull of *G. esmarkii*, ... × 2
Fig. 10. ,, ,, ... × 2
Fig. 11. ,, *G. minutus*, 26 cm., ... × 2
Fig. 12. ,, *G. luscus*, 28 cm., ... × 2
Fig. 13. ,, *G. esmarkii*, ... × 2
Fig. 14. ,, ,, ... × 2

LETTERS USED.

Ang —Angle.
b. Oc.—Basi-occipital.
E.—Ethmoid.
e. Oc.—Ex-occipital.
F.—Frontal.
Oc. Sp.—Occipital Spine.
op. O.—Opisthotic.
P.—Parietal.
P. pr.—Process of Parietal.
par. Oc.—Par-occipital.
p. S.—Parasphenoid.
pr. F.—Pre-frontal.
pt. F.—Post-frontal.
Sq.—Squamosal.
V.—Vomer.

LIST OF TABLES.

PAGE.
Localities near Aberdeen where the examples of *G. luscus* and *G. minutus* were captured, ... 118
Localities where some of the *G. esmarkii* were obtained, . . . 118
Table showing the sex and sizes of the fishes examined, . . . 119
Table showing the average lengths of the bases of the unpaired fins, 124–5
Table showing the ratio of the length of the base of the first anal to that of the second anal, ... 125
Table giving the sum of the lengths of the bases of the dorsal and anal fins, 126
Table showing the average number of rays in the unpaired fins, . . 126
Table of the average index of the fin-rays for each fin, . . . 127
Table of the number of rays in the paired fins and caudal fin, . . 128

TABLE I.—*Gadus luscus.* Number of VERTEBRÆ, the Number of the Vertebra bearing the First HÆMAL ARCH, and the Number of FIN-RAYS, ... 142

,, II.—*Gadus minutus.* Number of VERTEBRÆ, the Number of the Vertebra bearing the First HÆMAL ARCH, and the Number of FIN-RAYS, ... 143–4

,, III.—*Gadus esmarkii.* Number of VERTEBRÆ and FIN-RAYS, 145–7

,, IV.—*Gadus esmarkii.* Number of Vertebra bearing the First HÆMAL ARCH, ... 148

,, V.—*Gadus luscus, G. minutus, G. esmarkii.* The Range of VARIATION in the Number of FIN-RAYS in each Fin. FREQUENCY of each Number, ... 149

,, VI.—*Gadus luscus, G. minutus, G. esmarkii.* The Range of VARIATION in the Number of VERTEBRÆ. Frequency of each Number, ... 150

,, VII. and VIII.—*Gadus luscus.* The BODY-DIMENSIONS represented as *Percentages* of the *Length* of the Fish. AVERAGE at each size (Centimetre groups), ... 151–2

,, IX. and X.—*Gadus minutus.* The BODY-DIMENSIONS represented as *Percentages* of the *Length* of the Fish, AVERAGE at each size (Centimetre groups), ... 153–4

,, XI. and XII.—*Gadus esmarkii.* The BODY-DIMENSIONS represented as *Percentages* of the *Length* of the Fish. AVERAGE at each size (Centimetre groups), ... 155–6

,, XIII.—*Gadus luscus, G. minutus, G. esmarkii,* The Range of VARIATION of the BODY-DIMENSIONS, ... 157

TABLE I.—*Gadus Luscus.*

Number of Vertebræ, Number of Vertebra bearing the First Hæmal Arch, and Number of Fin-rays.

Length. Cm.	Sex.	VERTEBRÆ.		FIN-RAYS.				
		Total Number.	Vertebra bearing first Hæmal Arch.	1 D.	2 D.	3 D.	1 A.	2 A.
16·8	♂	49	16	14	26	22	35	22
21·5	♂	48	16	13	24	20	35	22
24·5	♂	48	16	12	22	20	31	20
25	♂	48	16	15	22	19	32	21
26·2	♂	49	17	15	22	19	33	21
26·4	♂	48	16	13	23	19	32	21
26·6	♂	49	16	14	24	20	36	22
27·4	♂	48	16	14	24	19	34	22
27·8	*	49	16	13	21	18	32	18
28·7	♀	48	16	13	22	21	34	22
30·4	♀	49	16	13	23	18	33	21
32·7	♀	49	16	13	24	21	35	21
40	♀	48	16	14	25	19	36	22
Average, -		**48·4**	**16**	**13·5**	**23·3**	**19·6**	**33·7**	**21**
Variants, -		13	13	13	13	13	13	13

* Sex not recorded.

TABLE II.—*Gadus Minutus.*

Number of Vertebræ, Number of Vertebra bearing the First Hæmal Arch and Number of Fin-rays.

Length. Cm.	Sex.	VERTEBRÆ.		FIN-RAYS.				
		Total Number.	Vertebra bearing first Hæmal Arch.	1 D.	2 D.	3 D.	1 A.	2 A.
11	♀	49	...	13	24	20	27	20
11·3	♀	50	...	13	23	21	28	23
11·4	♀	50	...	13	24	23	28	23
14	♀	49	...	13	23	...	29	21
14·6	♀	50	...	14	22	21	26	22
16·6	♀	49	...	12	24	22	27	21
17·2	♀	49	16	11	23	23	27	22
17·3	♂	49	16	13	22	20	...	21
17·8	♂	49	16	13	26	21	30	23
18	♀	50	17	...	...	...	...	...
18·2	♂	48	16	...	...	...	...	...
18·2	♂	50	16	...	...	...	...	...
18·6	♀	49	17	14	24	23	29	22
19·4	♂	50	16	13	23	21	29	23
19·6	♀	49	16	12	24	20	28	22
19·7	...	...	...	12	22	21	28	22
20	♀	48	16	...	...	...	...	...
20	♀	...	...	13	23	21	28	21
20·5	♀	48	16	13	20	22	29	22
21	♂	51	16	12	24	21	28	21
21	♂	50	17	14	...	21	28	23
21	♀	49	16	...	...	...	...	...
21·2	♀	49	16	12	22	21	28	22
21·3	♀	49	16	12	22	21	29	22
21·4	♂	51	16	14	21	22	...	22
21·5	♂	49	15	13	23	19	28	21
21·6	♀	50	16	...	...	...	...	...
21·7	♀	50	16	...	...	...	...	...
21·7	♂	50	...	13	20	21	27	23
21·8	♀	49	16	12	24	23	29	23
21·8	♀	49	16	13	22	22	27	23

TABLE II.—*continued.*

Length. Cm.	Sex.	VERTEBRÆ.		FIN-RAYS.				
		Total Number.	Vertebra bearing first Hæmal Arch.	1 D.	2 D.	3 D.	1 A.	2 A.
22	♀	...	...	12	22	...	...	...
22	♀	50	16	12	26	22	29	24
22	♀	48	16	...	...	...	...	...
22	♀	51	17	...	...	...	...	...
22	♀	49	16	13	23	23	29	22
22·2	♀	50	16	...	21	21	27	22
22·2	♀	50	16	...	...	...	...	...
22·4	♂	50	17	12	25	21	28	22
22·4	♀	50	16	...	...	...	...	...
22·5	♀	49	15	...	..	...	...	...
22·6	♀	49	16	12	24	23	...	24
23	♀	48	15	12	22	22	27	23
23	♀	49	16	14	21	22	...	23
23	♀	50	...	...	...	...	...	...
23	♀	50	16	12	21	21	29	22
23·3	♀	50	16	15	23	21	29	23
23·3	♀	49	15	...	...	...	...	...
24	♀	49	16	13	23	22	29	21
24·2	♀	49	16	...	...	...	...	...
24·4	♀	49	16	13	21	23	27	22
24·8	♀	50	18	13	24	20	28	21
25·3	♀	50	...	13	24	22	31	24
25·4	...	49	16	12	26	20	29	23
26·4	♀	49	17	13	24	21	30	23
Average, -		**49·4**	**16**	**12·7**	**22·9**	**21·4**	**28·2**	**22·2**
Variants, -		52	43	39	39	38	35	39

TABLE III.—*Gadus Esmarkii.*

Number of Vertebræ and Fin-rays.

Length. Cm.	Sex.	VERTEBRÆ. Total Number.	FIN-RAYS.				
			1 D.	2 D.	3 D.	1 A.	2 A.
8·6	♀	...	15	24	24	29	26
9·5	...	...	16	24	26	29	27
10	♀	...	16	24	28	29	29
10	...	...	15	26	24	29	27
10·6	♂	53	14	25	26	27	28
10·6	...	...	15	24	26	30	26
10·8	...	...	15	27	27	29	27
11	♂	...	15	25	27	29	28
11·3	...	..	15	25	25	27	29
11·3	...	...	15	26	26	30	29
11·3	...	...	15	...	26	29	27
11·5	...	...	16	25	26	27	28
11·8	♂	...	15	25	27	29	29
11·8	♂	...	15	25	25	30	27
11·8	♀	...	16	26	28	30	26
11·8	...	...	14	23	24	27	28
12	♂	...	15	23	23	27	26
12	♂	...	16	27	26	30	26
12	♀	...	16	28	27	31	27
12	...	...	14	28	26	30	27
12	♂	...	16	22	25	28	28
12	♀	...	15	22	26	27	24
12·2	♀	...	14	25	26	29	26
12·2	...	...	16	26	26	32	28
12·4	♀	...	16	26	27	28	27
12·8	♀	...	16	22	24	26	28
12·8	♀	54	17	24	25	31	28
13	♂	54	15	28	25	31	28
13·5	♂	53	15	26	25	30	26
13·6	♀	...	15	26	25	30	...
13·8	♀	53	15	24	25	28	27
14	♀	53	15	22	26	25	28
14·2	♀	54	16	27	27	32	28

TABLE III.—*continued.*

Length. Cm.	Sex.	VERTEBRÆ. Total Number.	FIN-RAYS.				
			1 D.	2 D.	3 D.	1 A.	2 A.
14·3	♂	54	15	25	26	30	27
14·3	♀	55	16	23	26	30	26
14·4	♀	54	15	27	27	30	28
14·5	♀	...	15	26	27	30	29
14·5	...	...	14	27	27	29	29
14·6	♂	...	15	26	...	29	...
14·6	♂	...	16	24	26	28	26
14·6	♀	...	15	27	26	30	26
14·7	♀	53	16	25	25	29	28
14·7	♀	...	15	25	24	29	27
14·7	♀	53	17	26	29	30	28
14·7	♀	53	15	24	26	27	29
14·7	...	54	15	24	26	29	27
14·8	♂	...	15	25	26	28	27
14·8	♀	54	14	27	25	30	25
14·8	♀	52	16		28	29	28
14·8	♀	54	15	28	27	29	28
15	♂	...	16	24	27	30	27
15	♀	...	16	24	25	26	26
15·2	♂	53	16	24	28	30	28
15·2	♀	...	16	26	26	30	27
15·2	♀	55	16	26	26	30	27
15·3	♀	54	15	29	26	29	27
15·4	♀	54	...	...	...	...	..
15·4	♀	...	15	26	28	30	29
15·4	♀	53	14	28	25	28	27
15·5	♂	...	16	25	26	29	28
15·5	♀	52	15	27	27	31	27
15·5	♀	53	...	...	...	...	...
15·5	♀	54	15	25	27	30	28
15·5	♀	52	14	27	24	32	...
15·5	♀	54	18	26	26	27	29
15·5	♀	...	16	27	28	31	29
15·5	♀	54	14	28	25	31	27

TABLE III.—*continued.*

Length. Cm.	Sex.	VERTEBRÆ. Total Number.	FIN-RAYS.				
			1 D.	2 D.	3 D.	1 A.	2 A.
15·6	♀	53	16	26	27	30	28
15·6	♀	53	15	27	26	30	27
15·6	♀	53	16	25	27	29	27
15·6	♀	53	15	24	28	28	27
15·7	♂	53	14	21	23	27	26
15·7	♀	...	16	26	26	29	27
15·7	♀	...	15	25	...	30	26
16	♀	53	15	25	25	29	25
16	♀	54	15	24	26	28	25
16	♀	...	15	...	26	28	27
16	...	53	15	27	26	31	26
16·3	♀	54	16	25	25	27	26
16·3	♀	53	17	24	25	28	26
16·5	♀	54	16	24	26	27	29
16·6	♀	...	15	26	28	30	28
16·6	♀	53	16	25	26	28	26
16·7	♀	...	...	25	27	29	26
16·8	♀	53	15	25	26	27	26
17	♀	53	15	26	25	30	26
17	♀	54	15	25	27	27	26
17	♀	..	15	24	28	28	28
17·2	♂	54	14	24	26	30	27
17·3	♀	53	16	24	28	28	27
17·5	♀	53	15	23	...	28	30
17·6	♀	...	15	27	25	29	27
17·8	♀	54	15	24	26	28	24
18·4	♀	...	...	...	28	24	28
18·6	♀	52	15	25	...	...	...
21	♀	54	16	25	28	30	30
...	♀	54	15	26	28	29	28
Average, -		**53·4**	**15·3**	**25**	**26**	**(28·9) 29**	**27·2**
Variants, -		50	93	92	91	94	91

TABLE IV.—*Gadus Esmarkii.*

Number of the Vertebræ bearing the first Hæmal Arch.

Length. *Cm.*	Sex.	Total Number of VERTEBRÆ.	Number of the Vertebra bearing the first Hæmal Arch.
14·7	♀	53	18
14·7	...	54	19
15·2	♂	53	18
15·5	♀	52	19
17·2	♂	54	18
17·5	♀	53	19
21	♀	54	19

TABLE V.—*The Range of Variation in the Number of Fin-rays in each Fin. Frequency of each Number.*

Species.	Fin.	Number of Fin-rays.																										Number of Variants.
		11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
GADUS LUSCUS.	First Dorsal, - -	...	1	6	4	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13
	Second Dorsal, - -	...	...	...	...	...	...	...	...	...	...	1	4	2	4	1	1	...	...	...	...	...	...	...	...	...	...	13
	Third Dorsal, - -	...	...	...	...	...	...	...	2	5	3	2	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13
	First Anal, - -	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	3	2	2	3	2	13
	Second Anal, - -	...	...	...	...	...	...	...	1	...	1	5	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13
GADUS MINUTUS.	First Dorsal - -	1	14	18	5	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	39
	Second Dorsal, - -	...	...	...	...	...	...	...	...	...	2	5	8	9	11	1	3	...	...	...	...	...	...	...	...	...	...	39
	Third Dorsal, - -	...	...	...	...	...	...	...	...	1	5	16	9	7	...	...	...	...	...	...	...	...	...	...	...	...	...	38
	First Anal, - -	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	8	11	12	2	1	...	...	...	...	...	35
	Second Anal, - -	...	...	...	...	...	...	...	...	...	1	8	14	13	3	...	...	...	...	..	...	...	...	...	...	...	...	39
GADUS ESMARKII.	First Dorsal, - -	..	...	...	11	48	30	3	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	93
	Second Dorsal, - -	...	...	...	...	...	...	...	...	...	...	1	4	4	20	23	20	13	6	1	...	...	...	...	...	...	...	92
	Third Dorsal, - -	...	...	...	...	...	...	...	...	...	...	...	...	2	6	18	34	17	13	1	...	...	...	...	...	...	...	91
	First Anal - -	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	2	13	15	24	28	7	3	...	...	...	...	94
	Second Anal, - -	...	...	...	...	...	...	...	...	...	...	...	...	...	2	3	21	28	24	11	2	...	...	...	...	...	...	91

TABLE VI.

Variations in the Number of Vertebræ—Frequency of each Number.

Species.	Number of Vertebræ.								Number of Variants	Average Number of Vertebræ.
	48	49	50	51	52	53	54	55		
Gadus luscus, .	7	16	...	...	...	...	...	...	13	48·4
Gadus minutus,	5	24	20	3	...	...	...	...	52	49·4
Gadus esmarkii,	...	...	...	...	4	23	21	2	50	53·4

TABLE VII.—*Gadus luscus. The Body-Dimensions represented as Percentages of the Length of the Fish. Average at each Size (Centimetre Groups).*

Length. Cm.	Variants.			Girth.			Dorso-Ventral Height of Body.			Eye. Horiz. Diam.	Inter-orbital Space.	Greatest Length of Fins.			Height of Lat. Line above Lat. Axis.		Rami of Tail.			Greatest Height—Unpaired Fins.				
	♂	♀	Total.	Axil-lary.	At Anus.	Tail.	Pec-toral.	At Anus.	Tail.			Ventr.	Pect.	1 D.	At Anus.	At P.-fin.	*l.* Dorsal	*l.* Ventr.	Sprad.	1 D.	2 D.	3 D.	1 A.	2 A.
16·8	1	...	1	56 (1)	63 (1)	15 (1)	24 (1)	24 (1)	6 (1)	7 (1)	6 (1)	14 (1)	18 (1)	20 (1)	9 (1)	...	...	...	...	...	...	...	...	...
21	1	...	1	55 (1)	55 (1)	13 (1)	20 (1)	22 (1)	5 (1)	6 (1)	6 (1)	15 (1)	16 (1)	19 (1)	7 (1)	6 (1)	...	...	...	...	...	...	...	...
24	2	...	2	...	...	...	...	...	...	6 (2)	5 (2)	15 (1)	17 (1)	19 (1)	7 (1)	6 (1)	18 (1)	18 (1)	8 (1)	...	...	...	...	...
25	3	1	4	60 (1)	63 (1)	14 (1)	25 (1)	26 (1)	5 (1)	6 (2)	6 (2)	15 (1)	17 (1)	...	8 (1)	...	...	...	...	...	...	...	...	...
26	6	2	8	58 (1)	59 (2)	14 (2)	23 (1)	25 (2)	5 (2)	6 (8)	6 (8)	15 (2)	18 (2)	22 (2)	6 (1)	7 (1)	20 (1)	20 (1)	9 (1)	14 (1)	9 (1)	6 (1)	10 (1)	8 (1)
27	7	5	13*	60 (2)	64 (2)	15 (2)	24 (2)	27 (2)	5 (2)	6 (11)	6 (11)	14 (2)	17 (2)	18 (2)	7 (2)	6 (2)	17 (1)	18 (1)	10 (1)	13 (1)	8 (1)	8 (1)	9 (1)	8 (1)
28	1	6	8*	64 (1)	69 (1)	14 (1)	26 (1)	28 (1)	5 (1)	6 (6)	5 (6)	17 (1)	17 (1)	...	7 (1)	...	...	...	...	...	...	...	...	...
29	1	2	3	...	...	...	...	...	...	6 (3)	6 (3)	...	...	...	...	...	...	...	...	...	...	...	...	...
30	3	2	5	...	...	...	...	...	...	6 (5)	6 (5)	...	...	21 (1)	...	...	...	...	...	...	...	...	...	...
31	...	2	2	...	...	...	...	...	...	6 (2)	5 (2)	...	...	...	...	...	...	...	...	...	...	...	...	...
32	...	2	2	...	...	...	...	...	...	6 (2)	6 (2)	...	...	21 (1)	...	...	...	...	...	...	...	...	...	...
33	2	...	2	...	...	...	...	...	...	6 (2)	5 (2)	...	...	...	...	...	...	...	...	...	...	...	...	...
34	2	...	2	...	...	...	...	...	...	6 (2)	5 (2)	...	...	...	...	...	...	...	...	...	...	...	...	...
35	1	2	3	...	...	...	...	...	...	6 (3)	6 (3)	...	...	...	...	...	...	...	...	...	...	...	...	...
40	...	1	1	63 (1)	66 (1)	14 (1)	26 (1)	27 (1)	6 (1)	6 (1)	5 (1)	16 (1)	18 (1)	...	6 (1)	6 (1)	...	...	...	14 (1)	10 (1)	8 (1)	9 (1)	9 (1)
Average, ...				**60**	**62**	**14**	**24**	**26**		**6**	**6**	**15**	**17**	**20**	**7**	**6**	**18**	**19**	**9**	**14**	**9**	**7**	**9**	**8**
Variants, ...				8	9	9	8	9	9	51	51	10	10	9	10	6	3	3	3	3	3	3	3	3

* The total includes one fish of undetermined sex.

TABLE VIII.—*Gadus luscus. The Body-Dimensions represented as Percentages of the Length of the Fish. Average at each Size (Centimetre Groups).*

Length. Cm.	Variants.			Distance from the Tip of the PREMAXILLA.																			
				Eye.	Ventr. Fin.	Operculum.		Pect. Fin.	Anus.	1 D.		2 D.		3 D.		1 A.		2 A.	Base of Tail.		Rami of Tail.		Lateral Line—End of Bend.
	♂	♀	Total.			Cleft.	Hind Edge.			Beginning.	End.	Beginning.	End.	Beginning.	End.	Beginning.	End.	End.	Dorsal	Ventr.	*d.* Tip.	*v.* Tip.	
16·8	1	...	1	5 (1)	18 (1)	21 (1)	23 (1)	23 (1)	24 (1)	26 (1)	37 (1)	40 (1)	65 (1)	65 (1)	78 (1)	27 (1)	65 (1)	79 (1)	81 (1)	81 (1)	101 (1)	100 (1)	58 (1)
21	1	...	1	5 (1)	16 (1)	20 (1)	21 (1)	22 (1)	26 (1)	26 (1)	37 (1)	39 (1)	63 (1)	64 (1)	79 (1)	27 (1)	64 (1)	79 (1)	81 (1)	81 (1)	101 (1)	101 (1)	56 (1)
24	2	...	2	5 (1)	18 (1)	20 (1)	22 (1)	24 (1)	25 (2)	26 (1)	36 (1)	39 (1)	64 (1)	65 (1)	78 (1)	28 (1)	65 (2)	80 (2)	83 (1)	84 (1)	101 (1)	101 (1)	59 (1)
25	3	1	4	5 (1)	17 (1)	20 (1)	22 (1)	23 (1)	26 (2)	26 (1)	38 (1)	40 (1)	64 (1)	65 (1)	78 (1)	28 (1)	65 (2)	80 (2)	81 (1)	82 (1)	101 (1)	101 (1)	55 (1)
26	6	2	8	5 (3)	17 (3)	20 (3)	22 (3)	23 (3)	25 (8)	26 (2)	38 (2)	40 (2)	64 (2)	65 (2)	77 (2)	28 (2)	65 (7)	80 (7)	82 (2)	82 (2)	100 (2)	100 (2)	58 (2)
27	7	5	13*	5 (2)	18 (2)	20 (2)	21 (1)	23 (2)	25 (11)	25 (2)	37 (2)	38 (2)	65 (2)	67 (2)	79 (2)	27 (2)	65 (1)	81 (11)	82 (2)	82 (2)	101 (2)	101 (1)	63 (2)
28	1	6	8*	5 (1)	17 (1)	20 (1)	22 (1)	23 (1)	26 (6)	24 (1)	36 (1)	38 (1)	63 (1)	64 (1)	78 (1)	28 (1)	65 (6)	80 (6)	81 (1)	81 (1)	101 (1)	101 (1)	58 (1)
29	1	2	3	...	...	...	...	...	28 (3)	...	...	...	...	...	...	...	68 (3)	82 (3)	...	...	...	...	...
30	3	2	5	5 (1)	18 (1)	20 (1)	22 (1)	22 (1)	25 (5)	...	...	...	...	...	...	...	65 (4)	81 (4)	...	...	...	...	...
31	...	2	2	...	...	...	...	...	25 (2)	...	...	...	...	...	...	...	66 (1)	82 (1)	...	...	...	...	...
32	...	2	2	6 (1)	18 (1)	21 (1)	23 (1)	24 (1)	26 (2)	...	...	...	...	...	...	..	65 (1)	80 (1)	...	...	...	...	...
33	2	...	2	...	...	...	...	...	25 (2)	...	...	...	...	...	...	...	65 (2)	80 (2)	...	...	...	...	...
34	2	...	2	...	...	...	...	...	26 (2)	...	...	...	...	...	...	...	66 (2)	80 (2)	...	...	...	...	...
35	1	2	3	..	...	...	...	...	27 (3)	...	...	...	...	...	..	..	67 (2)	83 (2)	...	...	...	...	...
40	...	1	1	5 (1)	16 (1)	20 (1)	22 (1)	23 (1)	28 (1)	27 (1)	39 (1)	41 (1)	41 (1)	68 (1)	79 (1)	31 (1)	68 (1)	80 (1)	82 (1)	82 (1)	101 (1)	101 (1)	61 (1)
Average,				**5**	**17**	**20**	**22**	**23**	**26**	**26**	**37**	**39**	**39**	**65**	**78**	**28**	**65**	**81**	**82**	**82**	**101**	**101**	**58**
Variants,				13	13	13	12	13	51	10	10	10	10	10	10	10	46	46	10	10	10	9	10

* The total includes a fish of undetermined sex.

TABLE IX.—*Gadus minutus.* *The Body-Dimensions represented as Percentages of the Length of the Fish. Average of each Size (Centimetre Groups).*

Length.	Variants.			Girth.			Dorso-Ventral Height of Body.			Eye.	Inter-orbital Space.	Greatest Length of Fins.			Height of Lateral Line above Lat. Axis.		Rami of Tail.			Greatest Height—Unpaired Fins.					Length of Barbel.
Cm.	♂	♀	Total.	Pectoral.	At Anus.	Tail.	Pectoral.	At Anus.	Tail.	Horiz. Diam.		Ventr.	Pect.	1 D.	At Anus.	At P.-fin.	*l.* Dorsal	*l.* Ventr.	Spread	1 D.	2 D.	3 D.	1 A.	2 A.	
11	...	1	1	...	...	...	...	...	...	8 (1)	5 (1)	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14	...	2	2	46 (1)	48 (1)	11 (1)	18 (1)	18 (1)	4 (1)	8 (2)	6 (2)	12 (2)	16 (2)	18 (1)	6 (1)	6 (1)	...	...	...	13 (1)	5 (1)	...	6 (1)	5 (1)	...
16	2	1	3	48 (1)	47 (1)	11 (1)	18 (1)	20 (1)	4 (1)	7 (1)	5 (1)	14 (1)	15 (1)	16 (1)	5 (1)	5 (1)	17 (1)	17 (1)	7 (1)	9 (1)	5 (1)	5 (1)	4 (1)	5 (1)	5 (1)
17	3	2	5	49 (2)	52 (2)	13 (2)	20 (2)	21 (2)	5 (2)	7 (2)	5 (2)	...	...	...	...	...	...	...	...	...	...	...	...	...	...
18	2	2	4	51 (4)	52 (4)	13 (4)	20 (4)	21 (4)	4 (4)	7 (4)	5 (4)	...	...	...	...	...	...	...	...	...	...	...	...	...	...
19	2	4	7*	50 (4)	54 (4)	13 (3)	21 (3)	22 (3)	5 (3)	8 (5)	6 (5)	...	17 (1)	18 (1)	...	...	...	...	...	...	...	...	...	...	...
20	1	2	3	49 (1)	52 (1)	13 (1)	...	...	...	7 (2)	5 (2)	...	...	...	...	...	...	...	...	...	...	...	...	...	...
21	5	9	15*	51 (7)	54 (7)	13 (7)	20 (5)	21 (5)	5 (5)	7 (13)	5 (11)	14 (4)	16 (4)	18 (5)	6 (4)	5 (4)	18 (1)	18 (1)	5 (1)	...	...	...	...	...	...
22	1	12	13	53 (5)	55 (5)	15 (5)	20 (5)	23 (5)	5 (5)	7 (12)	5 (12)	14 (5)	16 (5)	19 (2)	6 (4)	5 (4)	18 (1)	18 (1)	5 (1)	...	...	...	...	...	...
23	...	6	6	52 (3)	55 (3)	13 (3)	19 (2)	23 (2)	5 (2)	7 (6)	5 (6)	13 (2)	16 (2)	19 (1)	5 (2)	5 (2)	...	...	...	...	...	...	...	...	...
24	...	6	7*	51 (3)	55 (3)	13 (3)	18 (2)	21 (2)	4 (2)	7 (6)	5 (6)	14 (2)	16 (2)	19 (1)	5 (3)	5 (3)	...	...	...	...	...	...	...	...	...
25	...	4	5*	50 (2)	52 (2)	13 (2)	20 (2)	21 (2)	5 (1)	7 (5)	5 (4)	13 (2)	16 (2)	17 (1)	6 (2)	6 (2)	...	...	...	...	...	...	...	...	...
26	...	2	2	53 (1)	55 (1)	13 (1)	19 (1)	23 (1)	5 (1)	8 (1)	5 (1)	16 (1)	16 (1)	...	5 (1)	5 (1)	...	...	...	...	...	...	...	...	...
Average, - - - -				**52**	**53**	**13**	**20**	**21**	**5**	**7**	**5**	**14**	**16**	**18**	**6**	**5**	**18**	**18**	**6**	**11**	**5**	**5**	**5**	**5**	**5**
Variants, - - - -				34	34	33	28	28	27	60	57	19	20	3	18	18	3	3	3	2	2	1	2	2	1

* The total includes a fish of undetermined sex.

TABLE X.—*Gadus Minutus.* *The Body-Dimensions represented as Average Percentages in the Length of the Fish.*

Length. *Cm.*	Variants.			Distance from Tip of PREMAXILLA.																				
	♂	♀	Total.	Eye.	Ventr. Fin.	Operculum. Cleft.	Operculum. Hind Edge.	Pect. Fin.	Anus.	1 D. Beginning.	1 D. End.	2 D. Beginning.	2 D. End.	3 D. Beginning.	3 D. End.	1 A. Beginning.	1 A. End.	2 A. Beginning.	2 A. End.	Base of Tail. Dorsal	Base of Tail. Ventr.	Rami of Tail. *d.* Tip.	Rami of Tail. *v.* Tip.	Lateral Line—End of Bend.
14	...	2	2	5 (1)	18 (1)	18 (1)	...	24 (1)	33 (1)	26 (1)	37 (1)	38 (1)	61 (1)	63 (1)	79 (1)	35 (1)	62 (1)	65 (1)	81 (1)	83 (1)	...	101 (1)	..	50 (1)
16	2	1	3	4 (1)	23 (1)	20 (1)	...	24 (1)	32 (3)	26 (1)	37 (1)	38 (1)	63 (1)	65 (1)	80 (1)	35 (1)	63 (1)	64 (1)	81 (1)	84 (1)	84 (1)	101 (1)	101 (1)	50 (1)
17	3	2	5	4 (2)	19 (3)	20 (3)	21 (3)	22 (3)	32 (3)	24 (3)	36 (3)	37 (3)	62 (3)	64 (3)	79 (3)	33 (3)	62 (2)	65 (3)	81 (3)	...	...	102 (1)	102 (3)	...
18	2	2	4	4 (4)	19 (4)	19 (4)	20 (4)	22 (4)	31 (4)	25 (4)	36 (4)	38 (4)	62 (4)	64 (4)	80 (4)	33 (4)	63 (4)	64 (4)	81 (4)	...	...	101 (2)	101 (3)	...
19	2	4	7*	5 (4)	19 (3)	21 (3)	22 (3)	23 (3)	32 (7)	26 (3)	37 (3)	38 (3)	63 (3)	65 (3)	80 (3)	35 (3)	64 (3)	66 (3)	81 (3)	...	...	101 (2)	102 (3)	...
20	1	2	3	5 (1)	19 (1)	20 (1)	21 (1)	22 (1)	33 (2)	26 (1)	37 (1)	39 (1)	62 (1)	63 (1)	79 (1)	34 (1)	63 (1)	65 (1)	80 (1)	...	...	...	101 (1)	...
21	5	9	15*	5 (13)	19 (11)	20 (11)	21 (10)	22 (11)	32 (15)	25 (7)	37 (7)	38 (7)	63 (7)	64 (7)	80 (7)	34 (7)	63 (7)	66 (7)	81 (7)	83 (4)	84 (4)	101 (4)	102 (6)	55 (4)
22	1	12	13	4 (10)	19 (6)	20 (6)	21 (6)	22 (6)	32 (13)	25 (5)	36 (5)	38 (5)	63 (5)	65 (5)	80 (5)	35 (5)	64 (7)	65 (5)	81 (7)	83 (5)	84 5	102 (5)	101 (5)	55 (4)
23	...	6	6	5 (4)	18 (3)	20 (3)	22 (3)	22 (6)	32 (6)	25 (3)	36 (3)	39 (3)	62 (3)	64 (3)	79 (3)	35 (3)	64 (5)	65 (3)	81 (5)	84 (3)	83 (3)	101 (3)	101 (3)	51 (3)
24	...	6	7*	5 (3)	18 (3)	20 (3)	22 (3)	22 (3)	33 (7)	26 (3)	37 (3)	38 (3)	...	65 (3)	80 (3)	36 (3)	65 (5)	66 (3)	82 (5)	83 (3)	84 (3)	102 (3)	101 (2)	55 (3)
25	...	4	5*	5 (2)	19 (2)	19 (2)	22 (1)	23 (2)	32 (4)	26 (2)	36 (2)	37 (2)	63 (1)	64 (2)	80 (2)	33 (2)	64 (5)	65 (2)	82 (5)	84 (2)	84 (2)	101 (2)	101 (2)	55 (2)
26	...	2	2	6 (1)	19 (1)	21 (1)	22 (1)	23 (1)	32 (2)	27 (1)	38 (1)	40 (1)	65 (1)	67 (1)	82 (1)	35 (1)	67 (1)	68 (1)	82 (1)	86 (1)	85 (1)	103 (1)	102 (1)	54 (1)
27	...	1	1	...	...	...	...	...	33 (1)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Average, - - - -				**5**	**19**	**20**	**21**	**22**	**32**	**25**	**36**	**38**	**63**	**64**	**80**	**34**	**64**	**65**	**81**	**83**	**84**	**101**	**101**	**54**
Variants, - - - -				46	39	39	35	39	68	34	34	34	30	34	34	34	42	34	43	20	19	25	30	19

* The total includes a fish of undetermined sex.

TABLE XI.—*Gadus Esmarkii. The Body-Dimensions represented as Percentages of the Length of the Fish. Average at Each Size (Centimetre Groups).*

Length. Cm.	Variants.			Girth.			Dorso-Ventral Height of Body.			Eye. Horiz. Diam.	Inter-orbital Space.	Greatest Length of Fins.		Height of Lateral Line above Lat. Axis.		Rami of Tail.			Greatest Height of Unpaired Fins.					Length of Barbel.	Inter-ocular Diameter.		Caudal Peduncle.	Greatest Girth.
	♂	♀	Total	Pectoral.	At Anus.	Tail.	Pectoral.	At Anus.	Tail.			Ventr	Pect.	At Anus.	At P.-fin.	l. Dorsal	l. Ventr.	Spread	1 D.	2 D.	3 D.	1 A.	2 A.		Fore.	Hind.		
8·6	..	1	1	..	..	..	..	..	..	8 (1)	6 (1)	12 (1)	..	..	..	..	..	..	..	..	..	..	..	2 (1)	..	..	..	..
9	..	1	2*	..	..	..	..	..	..	7 (1)	5 (1)	10 (1)	..	..	..	..	..	..	..	..	..	..	..	2 (1)	..	..	..	..
10	1	1	4*	..	..	..	..	..	..	8 (3)	5 (3)	13 (3)	..	..	..	..	..	..	..	..	..	..	..	3 (3)	..	..	..	..
11	2	5	8*	..	..	..	..	..	..	7 (8)	5 (8)	14 (1)	..	..	..	..	..	..	..	..	..	..	..	3 (1)	..	..	..	..
12	..	4		37 (1)	36 (1)	9 (1)	..	..	..	7 (4)	6 (3)	14 (1)	17 (1)	..	..	..	..	..	..	..	..	..	..	3 (1)	..	..	..	..
13	2	2	4	44 (3)	42 (3)	11 (3)	..	..	..	7 (3)	5 (2)	15 (3)	17 (3)	..	..	..	..	..	..	..	..	..	..	..	7 (2)	9 (2)	5 (1)	..
14	3	10	14*	45 (11)	46 (11)	11 (11)	18 (2)	18 (2)	4 (2)	7 (14)	5 (13)	14 (11)	17 (11)	..	..	..	..	..	..	..	..	..	..	2 (11)	8 (3)	9 (3)	4 (11)	..
15	4	17	21	45 (16)	47 (16)	11 (16)	18 (4)	19 (4)	4 (4)	7 (21)	5 (21)	14 (18)	17 (19)	..	..	..	..	12 (1)	10 (1)	8 (1)	5 (1)	..	..	3 (13)	8 (3)	10 (3)	4 (16)	48 (1)
16	..	11	12*	46 (8)	47 (9)	11 (9)	17 (1)	17 (1)	4 (1)	7 (12)	5 (12)	13 (10)	17 (10)	6 (1)	6 (1)	17 (1)	17 (1)	8 (1)	7 (1)	5 (1)	5 (1)	5 (1)	4 (1)	3 (4)	8 (1)	9 (1)	4 (9)	..
17	1	8	9	46 (7)	47 (6)	11 (7)	..	..	..	7 (9)	5 (9)	13 (8)	17 (8)	4 (2)	3 (2)	..	..	..	..	..	..	..	..	3 (5)	7 (1)	10 (1)	4 (8)	..
18	..	5	5	45 (1)	46 (1)	10 (1)	..	..	..	7 (4)	5 (4)	14 (1)	16 (1)	..	.	..	..	..	..	..	..	..	..	3 (1)	..	..	..	..
19	..	3	3	.	..	..	..	..	..	7 (3)	5 (2)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
21	..	1	1	45 (1)	48 (1)	11 (1)	18 (1)	19 (1)	4 (1)	7 (1)	5 (1)	15 (1)	17 (1)	4 (1)	5 (1)	18 (1)	17 (1)	8 (1)	6 (1)	5 (1)	5 (1)	5 (1)	4 (1)	..	..	..	..	..
Average, - - - -				**45**	**46**	**11**	**18**	**18**	**4**	**7**	**5**	**14**	**17**	**4**	**4**	**17**	**17**	**9**	**8**	**6**	**5**	**5**	**4**	**3**	**7**	**9**	**4**	**48**
Variants, - - - -				48	48	49	8	8	8	84	80	59	54	4	4	2	2	3	3	3	3	2	2	41	10	10	41	1

* The total includes a fish of undetermined sex.

TABLE XII.—*Gadus esmarkii. The Body-Dimensions represented as Percentages of the Length of the Fish. Average at each Size (Centimetre Groups).*

Length. *Cm.*	Variants.			Distance from Anterior Point of Fish, viz. :—Tip of MANDIBLE.																	
				Eye.	Ventr. Fin.	Operculum.		Pect. Fin.	Anus.	1 D.		2 D.		3 D.		1 A.	2 A.		Rami of Tail—Dorsal Tip.	Lateral Line—End of Bend.	Tip of Premaxilla.
	♂	♀	Total.			Cleft.	Hind Edge.			Beginning.	End.	Beginning.	End.	Beginning.	End.	End.	Beginning.	End.			
8·6	..	1	1	..	..	..	..	..	38 (1)	28 (1)	38 (1)	..	..	..	..	..	..	..	..	..	1 (1)
9	..	1	2*	..	..	23 (1)	..	..	34 (2)	26 (2)	39 (2)	..	..	..	..	..	..	..	..	..	1 (1)
10	1	1	4*	..	..	..	..	..	34 (4)	25 (2)	38 (2)	..	..	..	..	61 (1)	..	..	103 (2)	..	1 (3)
11	5	5	11*	..	..	..	..	..	34 (11)	26 (1)	38 (1)	..	..	..	..	62 (3)	..	..	..	..	·9 (1)
12	3	8	11	5 (1)	..	..	..	..	34 (11)	27 (1)	37 (1)	..	..	..	..	61 (8)	..	..	103 (1)	..	..
13	2	3	5	5 (2)	21 (1)	19 (2)	21 (1)	22 (1)	34 (2)	26 (2)	38 (2)	37 (1)	60 (1)	64 (1)	80 (1)	62 (1)	64 (1)	81 (1)	102 (3)	49 (1)	·8 (1)
14	3	12	16*	6 (11)	20 (11)	20 (11)	22 (11)	23 (11)	34 (13)	25 (11)	38 (11)	40 (11)	61 (11)	64 (1)	81 (11)	61 (13)	65 (11)	82 (10)	102 (14)	51 (8)	·7 (7)
15	4	17	21	6 (15)	21 (15)	20 (15)	25 (15)	23 (15)	35 (16)	26 (16)	38 (15)	40 (15)	62 (15)	65 (15)	81 (15)	62 (16)	65 (15)	82 (15)	102 (17)	52 (9)	·6 (11)
16	..	11	12*	6 (10)	20 (10)	20 (10)	22 (9)	23 (10)	34 (12)	26 (10)	38 (9)	40 (10)	62 (10)	65 (10)	82 (10)	62 (12)	65 (10)	82 (11)	103 (10)	50 (8)	·6 (3)
17	1	8	9	6 (8)	20 (8)	20 (8)	22 (8)	23 (8)	34 (9)	26 (8)	38 (8)	40 (8)	62 (8)	65 (8)	81 (8)	62 (9)	65 (8)	81 (9)	102 (8)	53 (8)	·7 (3)
18	..	5	5	5 (1)	20 (1)	19 (1)	20 (1)	22 (1)	34 (5)	24 (1)	37 (1)	39 (1)	60 (1)	62 (1)	79 (1)	64 (4)	62 (1)	82 (4)	103 (1)	49 (1)	·5 (1)
19	..	3	3	..	..	15 (1)	..	..	35 (3)	25 (1)	37 (1)	..	..	..	..	64 (2)	..	83 (2)	..	..	..
21	..	1	1	5 (1)	19 (1)	20 (1)	..	22 (1)	35 (1)	25 (1)	38 (1)	39 (1)	61 (1)	64 (1)	81 (1)	63 (1)	65 (1)	82 (1)	102 (1)	51 (1)	..
Average,				**6**	**20**	**20**	**23**	**23**	**34**	**26**	**38**	**40**	**62**	**64**	**81**	**62**	**65**	**82**	**102**	**51**	**·7**
Variants,				49	47	50	45	47	90	57	55	47	47	47	47	70	47	53	57	36	32

* The total includes one or more specimens of undetermined sex.

TABLE XIII.—*The Range of Variation of the Body-Dimensions in the three species, Gadus luscus, Gadus minutus, and Gadus esmarkii.*

Species.	Girth.									Dorso-Ventral Height of Body.									Diameter of Eye.			Interorbital Space.		
	Pectoral.			At Anus.			Tail.			Pectoral.			At Anus.			Tail.								
	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.
Gadus luscus, . . .	63	60	55	69	62	55	15	14	13	27	24	20	28	26	22	6	5	5	7	6	5	6	6	5
Gadus minutus, . .	55	52	46	58	53	48	14	13	11	22	20	18	24	21	18	5	5	4	9	7	6	6	5	5
Gadus esmarkii, . .	50	45	37	52	46	36	12	11	9	19	18	17	21	18	17	5	4	4	9	7	6	7	5	4

Species.	Greatest Length of Fins.									Height of Lateral Line above Lateral Axis.						Rami of Tail.								
	Ventral.			Pectoral.			First Dorsal.			At Anus.			At Pectoral Fin.			*l.* Dorsal.			*l.* Ventral.			Spread.		
	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.
Gadus luscus, . . .	17	15	14	19	17	16	24	20	18	9	7	6	7	6	6	20	18	17	20	19	18	10	9	9
Gadus minutus, . .	16	14	12	18	16	15	19	18	16	7	6	4	7	5	4	18	18	17	18	18	17	8	6	5
Gadus esmarkii, . .	16	14	10	22	17	16	..	..	..	6	4	4	6	4	3	18	17	17	17	17	17	12	9	8

Species.	Greatest Height of Unpaired Fins.															Distance from the Anterior Point of the Fish.								
	1 D.			2 D.			3 D.			1 A.			2 A.			Eye.			Ventral Fin.			Pectoral Fin.		
	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.
Gadus luscus, . .	14	14	13	10	9	8	8	7	6	10	9	9	9	8	8	6	5	5	18	17	16	24	23	21
Gadus minutus, . .	13	11	9	5	5	5	..	5	..	6	5	4	5	5	5	6	5	3	23	19	17	24	22	21
Gadus esmarkii, . .	10	8	6	8	6	5	5	5	5	5	5	..	4	4	..	8	6	5	23	20	18	25	23	21

TABLE XIII.—*continued.*

Species.	Distance from the Anterior Point of the Fish.																							
	Operculum.						1 D.						2 D.						3 D.					
	Cleft.			Hind Edge.			Beginning.			End.			Beginning			End.			Beginning.			End.		
	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.
Gadus luscus, - -	22	20	20	23	22	21	27	26	24	39	37	36	41	39	38	66	64	63	68	65	64	79	78	77
Gadus minutus, - -	21	20	18	23	21	20	27	25	24	38	36	35	40	38	37	65	63	61	67	64	62	82	80	79
Gadus esmarkii, - -	22	20	15	24	23	20	29	26	23	40	38	35	42	40	37	64	62	60	70	64	62	84	81	78

Species.	Distance from the Anterior Point of the Fish.																							
	Anu			1 A:			2 A.						Base of Tail.						Rami of Tail.					
				End.			Beginning.			End.			Dorsal.			Ventral.			Dorsal Tip.			Ventral Tip.		
	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.
Gadus luscus, - -	29	26	22	69	65	61	(End	of 1	A.)	84	81	79	83	82	81	84	82	81	101	101	100	101	101	100
Gadus minutus, - -	35	32	30	69	64	60	68	65	63	86	81	80	86	83	83	85	84	83	103	101	101	106	101	101
Gadus esmarkii, - -	38	34	32	65	62	60	67	65	62	84	82	79	85	84	84	86	85	84	104	102	101	102	102	..

Species.	Distance from the Anterior Point of the Fish.			Caudal Peduncle.		
	Lateral Line.			*Dorsal.*		
	End of Bend.					
	Max.	Av.	Min.	Max.	Av.	Min.
Gadus luscus, . .	69	58	56	5	3	2
Gadus minutus, - -	62	54	46	6	4	3
Gadus esmarkii, - -	58	51	48	6	4	3

VI.—ON THE TAY SPRAT FISHERY, 1905–1906.

By John Fletcher, University College, Dundee.

I regret to report that the Tay sprat fishing has again been a comparative failure. Only 1371 crans of sprats, including young herrings, were taken out of the river this season, as against 1348 crans during last season 1904–1905, and 14,966 crans during the season of 1883–1884.

The 1371 crans consisted of somewhere about 28 million sprats and young herrings, of which some 57 per cent., or 16 million, were sprats measuring from about 4·5 centimetres to 14·5 centimetres in length, and the other 11 million, or 42 per cent., were young herrings measuring from 4·3 centimetres to 17·5 centimetres.

The bulk of the fish were caught during the first half of November, and at that time the sprats were of large size and of first-class quality, and the prospects of a good fishing season, which were afterwards completely disappointed, appeared to be excellent. The large size of these sprats contrasted greatly with the much smaller and younger sprats of last season, and caused a striking difference in the relative numbers of fish per cran during the two seasons.

Last season the average number of fish per cran was 28,800, and this season it was 19,200 during the first half of November, and 24,000 during the rest of the season.

Most of the fish were sent off fresh to the various English markets; a fair proportion, however, were salted and shipped to Germany for sardine purposes, while a small fraction were either sold for manure or thrown into the river, mostly while the men were at the sparling fishing.

The 1371 crans of fresh and salted fish brought to the fishermen a sum of somewhere about £350.

During January and February, while the men were at the sparling fishing, it was often difficult and sometimes impossible to obtain accurate information regarding the quantities of young herrings and sprats captured along with the sparlings. The difficulty was mainly due to the great scarcity of fish, and to the fact that small quantities were being sent off from Newburgh by the fishermen themselves, whilst other small quantities were taken to the Dundee Fish Dock, situated at the extreme east end of the city.

I ascertained, however, that the number of sprat boats engaged at the sparling fishing varied from 1 to 20 during the latter half of December and the whole of January, and from 1 to 7 during February. Each boat during December and January brought in along with the sparlings from 1 bucket to 2 crans of young herrings and sprats per day, while during February the average quantity was only about 2 or 3 buckets per day.

Unlike last season, the Broughty-Ferry fishermen and the sprat fishermen paid no heed to the Board's recommendation of January, 1904, namely:—that both fishermen should observe a line of division drawn

between Broughty-Ferry and Tayport. On several occasions the Broughty-Ferry men drifted for winter herring as far up the estuary as the Tay Bridge, while the sprat men were several times from ¼ to 2 miles below Tayport.

During the course of this season's fishing 40 samples of mixed sprats, young herrings, and other fishes were bought and examined. The samples consisted of :—

Young Herrings,	17,115,	from	4·3cm.	to	17·5cm.
Sprats,	8,539,	,,	4·5 ,,	to	14·6 ,,
Young Sparlings,	600,	,,	4·2 ,,	to	15·0 ,,
,, Whiting,	398,	,,	7·9 ,,	to	19·9 ,,
,, Cod,	215,	,,	7·2 ,,	to	16·0 ,,
,, Plaice,	54,	,,	4·3 ,,	to	15·0 ,,
,, Dabs,	50,	,,	3·8 ,,	to	13·0 ,,
,, Flounders,	19,	,,	5·0 ,,	to	10·0 ,,
,, Saithe,	17,	,,	12·0 ,,	to	16·0 ,,
	27,007				

Agonus cataphractus,	109
Ammodytes tobianus,	70
Liparis montagui,	70
Gobius minutus,	70
Syngnathus, sp.,	9
Cottus scorpius,	7
Gasterosteus spinachia,	4
Centronotus gunnellus,	3
Gasterosteus aculeatus,	1
Petromyzon fluviatilis,	1
	344

The numbers of young cod, whiting, plaice, dabs, flounders, and saithe are somewhat larger than is shown in the above Table, owing to the fact that the daily catches are to some extent picked before and sometimes after being brought into the Dundee Tidal Harbour. Large quantities of leaves, rushes, and weeds of all kinds also enter the nets, and even branches of trees, which sometimes cause great damage to the nets, and the picking and throwing overboard of this rubbish and of the young fish entails a great amount of labour to the men.

During the first half of the month of November, while the fish were abundant and the percentage of sprats remained over 70, the number of other fishes caught along with the sprats was quite insignificant.

A typical unpicked sample of the fish consisting of :—

Sprats,	1057
Young Herring,	86
,, Saithe,	1
Agonus cataphractus,	1
Shrimps,	1
	1146

The above sample represents about one-seventeenth part of a cran.

On the other hand, during December, January, and February, when the fish were very scarce, and the percentage of young herrings very high, a typical unpicked sample of the fish consisted of:—

"Halflin" Herrings,	16
Young Herrings,	2218
Sprats,	54
Young Cod,	38
,, Whiting,	35
,, Sparlings,	416
,, Saithe,	5
,, Plaice,	12
Sand-eels,	25
Gobius minutus,	21
Liparis montagui,	11
Agonus cataphractus,	11
Shrimps *(Crangon vulgaris)*,	600

There were also present in this sample about 200 larval fish, consisting of over 90 per cent. young herring and about 10 per cent. of young sprats, sand-eels, and sparlings.

The whole of the above sample represents about one-twelfth part of a cran. The 40 samples of sprats and young herring examined during this season represented about one-thousandth part of the entire season's catch.

The catch was carefully examined on every day when the fish were landed at the Dundee Tidal Harbour, but on some days no large samples of sprats and herring were bought or examined, a rough estimate only being made of the proportion of sprats and herring which made up the catch.

By these two methods the following Table has been drawn up, showing the approximate composition of the catch throughout the season.

An asterisk denotes the days when the estimate was only a superficial one:—

Date.	No. of Crans.	Estimated No. of Young Herring.	Estimated No. of Sprats.	Estimated Total No. of Fish.
1905. October	1½	25,200	10,800	36,000
November 1	1	16,800	7,200	24,000
,, 2*	1¼	15,000	15,000	30,000
,, 3	8½	61,200	142,800	204,000
,, 6	186¾	250,992	3,334,680	3,585,600
,, 7*	56	107,520	967,680	1,075,200
,, 8	105½	243,072	1,782,528	2,025,600
,, 9	168½	647,040	2,588,160	3,235,200
,, 10	40½	186,624	590,976	777,600
,, 11*	53½	308,160	719,040	1,027,200
,, 13	126½	1,360,128	1,068,672	2,428,800

Date.	No. of Crans.	Estimated No. of Young Herring.	Estimated No. of Sprats.	Estimated Total No. of Fish.
November 14* . .	27½	264,000	264,000	528,000
,, 15 . .	121	998,976	1,324,224	2,323,200
,, 16* . .	57	492,480	601,920	1,094,400
,, 17 . .	20	192,000	192,000	384,000
,, 18* . .	19¾	331,800	142,200	474,000
,, 20* . .	10	192,000	48,000	240,000
,, 21 . .	14¼	331,740	10,260	342,000
,, 22 . .	20	441,600	38,400	480,000
,, 23 . .	¾	8,640	9,340	18.000
,, 24 . .	56¾	404,484	688,716	1,093,200
,, 25 . .	71¼	1,539,000	171,700	1,710,000
,, 27 . .	33¼	454,860	343,140	798,000
,, 28* . .	19¼	277,200	184,800	462,000
,, 29 . .	16	268,800	115,200	384,000
,, 30 . .	17	367,200	40,800	408,000
	1,251¾	9,761,316	15,390,684	25,152,000
December 1* . .	½	10,800	1,200	12,000
,, 4 . .	8	134,400	57,600	192,000
,, 5 . .	6	100,800	43,200	144,000
,, 7* . .	1¾	29,400	12,600	42,000
,, 9 . .	½	8,400	3,600	12,000
,, 11 . .	7¾	130,200	55,800	186,000
,, 12* . .	½	8,400	3,600	12,000
,, 13 . .	10¼	188,800	57,200	246,000
,, 14 . .	19	364,800	91,200	456,000
,, 15 .	4	85,400	10,600	96,000
,, 16 . .	½	10,800	1,200	12,000
,, 18* . .	–	900	100	1,000
,, 19–30 .	24	460,800	115,200	576,000
	82	1,533,900	453,100	1,987,000
1906. January 1–31 . .	30	576,000	144,000	720,000
February 1–24 . .	5	96,000	24,000	120,000

1905–1906.

Months.	Estimated No. of Crans	Estimated No. of Young Herring.	Estimated No. of Sprats.	Estimated Total No. of Fish.	Estimated Percentage of Young Herring.
October, . .	$1\frac{1}{2}$	25,200	10,800	36,000	70·0
November, . .	$1,251\frac{3}{4}$	9,761,316	15,390,684	25,152,000	38·8
December, . .	$82\frac{16}{24}$	1,533,900	453,100	1,987,000	77·6
January, . .	30	576,000	144,000	720,000	80·0
February, . .	5	96,000	24,000	120,000	80·0
	$1,371\frac{1}{24}$	11,992,416	16,022,584	28,015,000	42·4

With regard to the relative percentages of young herrings and sprats, I would point out that there is every indication that when a larger body of fish than usual enter the Tay estuary the percentage of sprats is usually very high; this was certainly the case during the past season 1905–6, but was not quite so noticeable during the previous season of 1904–5. It is also, of course, of equal importance to note that when fish are comparatively scarce in the estuary it is due usually to the falling-off in the numbers of sprats—in other words, whilst young herring are always present in the Tay estuary the larger shoals of sprats are only occasionally present.

The destruction of young herrings and other fishes is, therefore, not so alarmingly great as one would imagine it to be on first looking at the samples and the tables of percentages, and does not, in my opinion, argue for any drastic changes in the mode of fishing.

The fishermen, however, should not persist in fishing when the percentage of sprats falls below 60, and when the fish are of small size and not of much use for purposes of food.

The sale of fish for manure purposes should, I think, also be strictly prohibited, even when the fish are unusually abundant and the percentage of sprats very high.

During the course of the two past winters over 40,000 sprats and young herrings have been carefully measured with the object of ascertaining the probable age groups of both fish and the probable annual rate of growth. These measurements will be dealt with on another occasion.

General Account of the Sprat Fishing, 1905–1906.

This season's sprat fishing was late in beginning, later even than last season, and the lateness was again due to the great scarcity of fish. The regular sprat fishing of this season began on the 6th of November and practically came to an end during the latter half of December; it was taken part in by the same number of boats, and by practically the same number of men as last year.

The two main features of this season's fishing were (1) the excellent quality of the sprats whilst they remained plentiful in the estuary, and (2) the great scarcity of both sprats and young herring during the latter half of December and the whole of January and February.

The quality of the sprats was the best seen in Dundee for some years, the catches during the first week of the regular fishing consisting of over

70 per cent. of first-class sprats, the number of young food fishes other than young herring forming only an insignificant fraction.

The sprats were mostly of large size, their average sizes varying from 9·8cm. to 12·5cm., and contrasted greatly with the much smaller and younger sprats of last season.

Unlike last season, there was a keen demand for sprats throughout almost the whole of this season, and the usually brisk competition amongst the buyers kept the prices generally at a high standard.

In consequence of the good prices which the fishermen obtained for their fish, there was less dissatisfaction amongst them than last year, but there still remained great discontent amongst the buyers, owing to what they consider the excessive railway rates charged for the carriage of the fish to the various English markets.

The complaints of the fishermen gradually increased, however, as the fish became scarcer, and much real distress prevailed again during January and February.

With regard to the great scarcity of fish during December, January, and February, some of the men thought it was because of the want of south-easterly gales, and others because of the weak tides, heavy spates, and frosty weather. I also interviewed a few old fishermen, some of whom had been all their days taking part in the various fishings on the River Tay, and one and all complained bitterly of the great scarcity of all kinds of fish in the River Tay at the present day. They attribute this great scarcity of fish to the general increase in the numbers of bleaching works, dye works, ink factories, paper mills, and tanneries, and to the gradually increased sewerage from Perth downwards. They declare that 20 and 25 years ago fish of many different kinds were very plentiful in all parts of the river; salmon and trout were exceedingly plentiful, and great numbers of large black flounders were got all the way from Newburgh to Broughty-Ferry, and were particularly plentiful on the north side of the Middle-Bank, where they are now scarce and of a much smaller size. Large cod were also very plentiful in various parts of the estuary, and were occasionally captured in considerable numbers as far up the estuary as Invergowrie Bay. Plaice, dabs, brill, and other fishes were also in much greater numbers than at the present day. During that time—20 and 25 years ago—the sprat boats only numbered some half-dozen, but they quickly increased until they numbered somewhere about 30, and have remained at about that number for many years.

Here I must mention, in connection with the general scarcity of fish in the river, the bitter complaints of the sprat fishermen and the Broughty-Ferry fishermen, who allege that the barge and dredger men in the employment of the Dundee Harbour Trustees deposit large quantities of mud and filth in the vicinity of Monifieth Bay, and have thus completely destroyed excellent spawning grounds of the winter herring. The barges containing mud dredged from the Dundee and Tayport harbours are supposed to be towed out to the mouth of the river, but the fishermen assert that on the approach of darkness, or if there be the least sign of a storm outside, the mud is at once dumped down in the vicinity of Monifieth Bay. I advised the fishermen to communicate with the Fishery Board in connection with the matter, but found later that the Broughty-Ferry Town Council had been in communication with the Dundee Harbour Trustees, and that the latter had, in consequence, instructed their employees to convey all mud to the mouth of the river.

During the course of this season's fishing, I pointed out to several fishermen and buyers that the Fishery Board regretted the destruction of so many young herring and sprats in the Tay estuary, and I suggested

the general use of the drift-net instead of the usual bag-net; but both fishermen and buyers were unanimously of opinion that drift-net fishing for sprats in the Tay estuary was impracticable; the currents, they maintained, were far too strong, and the drift net would not capture nearly enough fish to enable both fishermen and buyers to earn a fair living.

I further pointed out to the buyers the possibility of the drift-nets capturing more sprats than young herring, because of the deeper, rounder, and more serrated bodies of the sprats, but one of the buyers assured me that he had seen, on several occasions, as many young herring as sprats captured in the drift-nets at other sprat fishing stations. I also, in the course of my visits to the harbour, pointed out to the buyers that the barrels they were using in conveying the fish to the various English markets were generally of too large a size, and that the fish before they reached their destination must be in a very pulpy condition, and many of them not of much use for cooking purposes.

I suggested as an alternative the general use of smaller flat boxes. The buyers admitted the barrels were far too large, but argued that smaller flat boxes would have to be made of much stronger wood, and this would only add to the weight and subsequent cost of the carriage of the fish.

I discussed also the question of the preservation and tinning of the sprats for sardine purposes, and one of the buyers—Mr. William Hopkins, a noted Anstruther herring curer and exporter—was of opinion that the question was worthy of every consideration, but pointed out that a business of this kind would require a large sum of money to set it agoing, and it would not very likely pay for a year or two, because practically the whole trade is at present in the hands of foreigners.

I learned also that some of the fishermen had bought preserving and tinning apparatus several years ago, but they only met with fair success, owing chiefly to the high prices of sprats during some seasons, and their poor quality and small size during other seasons. If sprats are to be used for sardine purposes they must be bought at or below 5s. or 6s. per cran, and they must be of a fair size and comparatively free from young herrings. Young herrings can, however, be sardined like the sprats, but they require more labour and expense, and are not nearly so palatable as the sprats themselves.

Further Notes on the Natural History of the Sprat and the Young of the Herring.

Fairly large numbers of young herrings and comparatively small numbers of sprats appear to be present in the Tay estuary at all times of the year, but the larger shoals of full-grown sprats only occasionally.

The Tay estuary would therefore appear to be more of a natural nursery ground for young herrings than for sprats, but its usefulness as such is very much diminished by the enormous amount of impurities poured into the river.

Here, then, arise the two most interesting points in connection with the natural history of both fish, namely:—"Why do they enter our estuaries at all during the winter months, and what are the causes of the constant fluctuations in their numbers."

As I pointed out in last year's report, the question of food may safely be left out of account altogether, principally because of the ill-success which attended the examination of the estuarine waters for food material, and the almost complete absence of food material in the stomachs of both the sprat and the young herring.

Again, with regard to the tides, I am still of opinion that spring tides have no more influence in bringing the fish into the estuary than neap tides have. This opinion is against that of many of the fishermen, but I found that in 1904–1905 as many large catches of fish were made during neap tides as during spring tides, and that during the past winter, 1905–1906, the largest catches of the season were made during the lowest phases of the neap tides. Here we must bear in mind, however, that the greater strength of the spring tides undoubtedly adds to the capturing power of the bag-net.

Slight variations in the temperature of the air, I also find, have no marked influence on the movements of the fish, but prolonged frosts and subsequent colder waters of spates may drive at least the younger forms out into the sea again. Neither of these, however, account for the principal fluctuations in the number of fish in our estuaries.

Spawning may, of course, be left out of account altogether, as the sprats do not spawn in the estuary proper, and spawning does not take place until the spring and early summer months.

Storms, and especially south-easterly gales, on the other hand, are undoubtedly important factors to be taken into account; but that south-easterly gales do not always drive the fish into the Tay estuary may be easily seen by referring to the weather statistics of the two past sprat fishing seasons. I may point out, however, that a series of westerly gales sometimes drive many of the fish from the upper parts of the estuary, and may give rise to large catches of young herring.

It was after a week of storms and south-easterly gales when the largest shoal of sprats of the past season made its appearance in the Tay estuary; but a greater storm of wind and rain a few days afterwards made little or no difference in the numbers of fish in the estuary. The same remarks hold good for the sprat-fishing season of 1904–1905.

There only remains now the question of the constant persecution by numerous and varied enemies and the consequent inherent restlessness and timidity of both fish. As is well known, large shoals of cod, ling, whiting, dogfishes, mackerel, and other fishes feed upon the sprat and herring, and shoals of haddock devour the spawn of the herring in large quantities. Seals, porpoises, and dolphins and many sea birds are also well known to be formidable enemies; add to all these, then, the cannibalistic habits of the two fish themselves, and the great destruction made upon them by the sprat fishermen, and one cannot wonder at the great and constant fluctuations in the numbers of both fish in our estuaries.

A sudden shoal of cod, whiting, or dogfish, or an increase in the numbers of seals and porpoises, or even the occasional presence of a whale in the vincity, will doubtless drive large shoals of sprats into our estuaries. Here I may mention that only a few years ago a large whale made its appearance in the Tay estuary, and during the same time the water was simply teeming with sprats, young herring, and young whiting. I may also mention that both porpoises and dolphins are not uncommon just outside the river, and seals are sometimes very plentiful even in the estuary.

This incessant persecution, then, by numerous and varied enemies, may well explain the presence of the sprat, at any rate in such large and varying numbers, in our estuaries.

From the preceding remarks one could naturally conclude that a diminution in the number of enemies would result in an increase in the numbers of sprats and herring, and that both fish, especially the sprat, would in consequence remain further and longer away from our estuaries.

Again, during other seasons, when perhaps cod, whiting, dogfishes, and

so on, are very abundant, the numbers of sprats and young herring in our estuaries would very likely be much greater, although the actual total number of both fish in the sea would rapidly grow less. In this way, then, we may find a possible explanation of the occurrence of fat and lean fishing seasons in the various sprat fisheries round our coasts.

In connection with the above ideas I interviewed several fishermen and buyers belonging to Dundee, Broughty-Ferry, and St. Andrews, and obtained information from them which went to support my theories.

I found that very few sprats and young herring had been present in St. Andrews Bay during the autumn months of 1905, and that little or no cod were caught there during the same time. After, however, a week of storms in the North Sea, a large shoal of sprats, unmixed with young herring, made its appearance in St. Andrews Bay on the 2nd or 3rd of November, 1905, and large numbers of cod and whiting were being caught there at the same time.

All the cod, the fishermen informed me, were simply gorged with sprats, and many of the cod were vomiting up the sprats whilst being hauled on board.

This large shoal of sprats made its appearance in the Tay estuary about the same time as it did in St. Andrews Bay, and on the 6th of November the largest catch of the season—namely, 186¾ crans—was made by the Tay sprat fishermen.

Another, if not greater, storm of easterly gales and rain took place on the 13th November, 1905, and caused great loss and damage to fishing apparatus in St. Andrews Bay. It also completely cleared out all the cod and codling as well as the sprats in the bay, and since that date, and until the close of the sprat fishing season towards the end of the following February, the fishing in St. Andrews Bay was a complete failure.

This great storm caused little or no increase in the numbers of sprats in the Tay estuary, so that the bulk of the St. Andrews Bay sprats must have sought shelter elsewhere.

Following closely upon the disappearance of the cod and codling from St. Andrews Bay, or in the course of the next two or three days after the storm, the Tay sprat fishing almost suddenly fell away and became a complete failure, and, further, it remained a failure along with the St. Andrews Bay fishing until the close of the Tay sprat fishing season.

I also found, upon further inquiry, that the season of 1904–1905 was a poor cod and codling fishing season in St. Andrews Bay, and this, of course, entirely coincides with the poor and unproductive sprat fishing in the Tay estuary at the same time.

With regard to the difference in the quality of the sprats during the two past seasons, it may be that owing to the mildness and exceptional dryness of the season 1904–1905 the younger forms of the sprat were enabled to remain much longer and much more constantly in the Tay estuary than usual, and that the cold and heavy spates of the past season 1905–1906 drove the younger and smaller forms of sprats out into the sea. These and like questions, however, can only be answered by observations and experiments extending over a period of several years, and require very careful scientific study.

Note on the External Differences between the Sprat and the Young of the Herring.

There is generally not much difficulty in distinguishing a sprat from a young herring, even when the external features are only taken into account and the internal structure left entirely alone.

The external differences, however, between the two fish appear so slight to a beginner that it takes him some considerable time to separate even small quantities of one from the other; and it is only after he has handled several thousands of fish, or has otherwise had long experience of them, that he is able to separate the one from the other with any degree of comfort and rapidity.

The proper method is, therefore, to first of all accustom the eye to the differences in the general shape and colour of the two fish; but to make sure, the thumb or forefinger must be drawn along the throats of the fish, when the sharp spines in the case of the sprat at once distinguish it from the comparatively smooth-throated young herring.

If in doubt about the general shape, colour, and spines, the position of the pelvic fins in relation to the first ray of the dorsal fin must be noted, and if still in doubt the number of rays in the pelvic fins themselves have to be counted.

In very small and semi-transparent fish the number of vertebræ have to be counted.

The following Table shows the general external differences between the two fish:—

	Sprat.	Young Herring.
General shape. .	Deeper and narrower in the body. Belly curved from head to tail.	Relatively not so deep in the body, and much less curved in the belly; whole body usually more tapering towards tail.
Colour. . . .	Narrow strip of slaty blue colour on back. Sides of body relatively more silvery.	Broader strip of greenish blue colour on back.
Head. . . .	Short from snout to occipital region.	Relatively longer.
Spines. . . .	Well developed on throat and belly.	Weak on throat and not so well developed on belly.
Eyes. . . .	Small.	Relatively large.
Position of Pelvic Fins.	In nearly all fish above, but sometimes below, 5 cms. in front of first dorsal fin ray.	In nearly all fish above, but sometimes below, 5 cms. behind first dorsal fin ray.
Number of Rays in Pelvic Fins.	7, usually.	9, usually.
Tail. . .	Greyish in colour and usually ragged.	Darker fringe and more uniform in shape.
Vertebræ, . .	Not more than 48.	Not less than 54.

VII.—ON THE SPAWNING OF THE LUMPSUCKER (*Cyclopterus lumpus*) AND THE PATERNAL GUARDIANSHIP OF THE EGGS. By Dr. T. Wemyss Fulton, F.R.S.E., Superintendent of Scientific Investigations.

(PLATE XI.)

The lumpsucker is a common fish on our shores in spring, when it comes close in among the rocks to deposit its spawn, the spawning-season extending from February to nearly the end of May. Its food consists of marine worms, cœlenterates, crustacea, and small fishes; Dr. Murie has taken 100 whitebait (young herrings and sprats) from the stomach of a specimen.* It is stated by several authors that the stomachs of females, especially, often contains nothing save a quantity of fluid; this is no doubt owing to their being mostly caught during the breeding season, when food is usually not taken by fishes.

The males are much smaller than the females and somewhat more numerous; they are brightly-coloured red on the fins and lower surface during the spawning time, while the females are dark leaden blue or slatey-coloured. The mass of eggs produced by a female is large, and may reach as much as 35 per cent. of the total weight; the average for three specimens examined by me was 27 per cent. In a female, 14½ inches in length and weighing 6 lbs. 12 ounces, caught on 16th May, and included in the following table, the eggs weighed 2 lbs., while 150cc. of ovarian fluid escaped from the ovaries.

The eggs measure about 2·2mm.–2·6mm., and have a volume of 4·18cc.; I found them to number from 79,758 to 136,764 in females a little over 18 inches long. The fecundity of the lumpsucker is therefore high. When examined in the ripe female before extrusion they are usually reddish or salmon-tinted, but may be lilac, pale violet, pale brown, or pink. On extrusion they are pink, but this tint fades on exposure to light, and gives way to a faint greenish or yellowish hue; later they become dark, owing to the development of pigment in the embryos.

The whole of the eggs are laid at one time, or at all events this appears to be the usual occurrence, but an examination of the ovaries of the females included in the Table below tends to show that it does not always happen, as several of them were found to be only partly spent. One of the females referred to in this paper, moreover, deposited her eggs in two lots after an interval of thirteen days. The eggs in the ovary, just before extrusion, are bathed in a plentiful fluid, but they are not adherent; when the fingers are passed through the mass, the feeling conveyed resembles that of contact with a mass of half-boiled sago. Around the eggs the secretion is syrupy, and on separating them glutinous threads pass between them. This substance hardens in sea water and binds the eggs into a large compact spongy mass, leaving narrow channels between by which water enters. It is doubtful, as we shall see, whether this arrangement would not be fatal to many of the eggs were it not for the constant attention of the male fish; and perhaps the same attention is given by the parents of other shore forms whose eggs are laid in adherent masses.

* M'Intosh mentions annelids (*Nereis*), *Third Annual Report*, p. 60; Parnell says it feeds on worms and small fish, *Fishes of the Firth of Forth*, p. 382; Scott found cœlenterates (*Beröe*, *Pleurobrachia*) annelids, and crustacea, in their stomachs, *Twentieth Annual Report*, p. 467; Murie's observations are given in *Report on the Sea Fisheries of the Thames Estuary, Part I.*, p. 139.

These masses of eggs may be found attached to rocks, &c., about low water mark.

In the following Table I give the measurements and other particulars of 69 lumpsuckers taken from a salmon stake-net in the Bay of Nigg in spring a few years ago, between 2nd May and 24th July.

Date.	Females.				Males.			
	Length.	Weight		Sexual Condition.	Length.	Weight.		Sexual Condition.
	Inches.	Lbs.	oz.		Inches.	Lbs.	oz.	
May 2	18	7	1	Ripe	10	1	4	Ripe
,, 3	14	5	4	,,	10	1	5	,,
,, 7	18	8	1½	Nearly spent	14½	3	6¾	,,
,, –	14½	5	6	Ripe	12	2	5¾	,,
,, –	17¾	7	9¾	Nearly spent	11½	2	0¾	,,
,, –	18¼	10	7¾	,,	12	2	4¾	,,
,, –	17	6	14½	Spawning	11½	2	4	,,
,, –	17¾	7	1½	Spent	9	...	15¼	,,
,, 8	16	7	4	Spawning	...	...	...	...
,, 10	17	6	6	,,	12	2	9¼	Nearly spent
,, –	16	5	14½	,,	...	...	...	...
,, 12	15	6	15¾	Ripe	11½	2	2¾	Ripe
,, –	14¾	4	3	Spent	10½	1	7½	Nearly ripe
,, 14	...	...	...	...	13½	2	7	Ripe
,, –	...	...	...	...	10¼	1	7¾	,,
,, –	...	...	...	...	7⅞	...	11¼	Nearly ripe
,, 15	19	9	12	Spawning	...	...	...	...
,, –	14¾	5	6	,,	...	...	...	...
,, 16	18½	9	8	,,	...	...	...	...
,, –	14½	6	12½	,,	...	...	...	..
,, 17	15¼	5	10¾	Ripe	...	...	...	...
,, –	14½	4	1½	Spent	...	...	...	...
,, –	14	3	12½	Nearly spent	...	...	...	...
,, 18	17	7	7½	Ripe	...	...	...	...
,, –	15¼	4	1	Spent	...	...	...	...
,, –	15½	5	7½	,,	...	..	...	...
,, –	14½	5	13½	Ripe	...	...	...	..
,, –	18	8	12	,,	...	...	...	...
,, –	15	6	14½	,,	...	...	...	...
,, 19	15	6	2	Spawning	11¼	2	3¼	Ripe
,, –	...	...	...	...	12	2	2½	,,
,, 20	14½	5	14¾	Ripe	13	2	13½	Nearly spent
,, –	16½	6	4½	Spent	10½	1	12	Ripe
,, –	17¼	10	12	Ripe	...	...	...	...
,, –	14½	6	0½	,,	...	...	...	...
,, 21	16½	9	2	,,	15	4	6	Ripe
,, –	16	7	0½	Nearly spent	8⅛	...	10¼	Nearly ripe
,, –	14	4	1½	,,	...	...	...	...
,, –	14¾	4	1¾	,,	...	...	...	...
June 7	16	5	...	Spent	...	...	...	...
,, 8	14½	5	9¼	Nearly spent	...	...	...	...
,, 11	15½	5	1	,,	10¾	1	12½	Immature
,, 13	11	2	2¾	Quite Im'ture	7½	...	11¾	,,
July 3	...	...	...	...	10¼	1	5	,,
,, –	...	...	...	...	9¾	1	7	,,
,, –	...	...	..	...	11	1	11½	,,
,, 11	...	...	...	...	12½	2	7	,,
,, –	..	...	...	...	11	1	13	,,
,, –	...	...	...	...	10	1	7	,,
,, –	...	...	...	...	10¼	1	2½	,,
,, 24	...	...	...	...	10¾	2	4	,,
Average, –	15·8	6	6	...	11	1	14	...

There were 39 females and 30 males. The females ranged in length from 19 to 11 inches, but the latter specimen was immature, the smallest female which was mature measuring 14 inches (35·5 cm.) and the weight of the mature females ranged from 10 lbs. 12 oz. (4871 grammes) to 3 lbs. 12½ ounces (2113 grammes), but this specimen had got rid of most of its eggs. The average length of the 39 females was 15·8 inches (about 39cm.) and the average weight 6 lbs. 6 oz. (2889 grammes).

The length of the males varied from 15 inches to 7½ inches, the smallest ripe being 9 inches (23cm.); the weights ranged from 10¼ oz. (290 grammes) to 4 lbs. 6 oz. (1982 grammes); the former was not quite mature, the minimum weight of the males that were certainly spawning being 15¼ oz. (432 grammes). The average length of the 30 males was 11 inches (28cm.) and the average weight 1 lb. 14 oz. (822 grammes.) The difference in the size of the males and females is thus striking.

In June all the fish were spent or nearly so, and in July they were all immature, No female was obtained after 13th June, no doubt because they withdraw probably to deeper water, and the last male was got on 11th July, though the net was examined up to the middle of August.

One of the habits of the lumpsucker well known to fishermen is the guardianship by the male of the mass of eggs after they are deposited. The habit was long ago accurately described by Fabricius in his description of the fishes of Greenland, and it has been referred to since by most writers, though often with scepticism. Couch, for example,* is of opinion that the description of Lacépède to this effect is exaggerated, and that the presence of the male near the eggs is accidental. M'Intosh has given a graphic and pathetic picture of the male remaining on the beach guarding the eggs in a mere runlet of water after the tide had withdrawn from them.†

The authors of "Scandinavian Fishes,"‡ quoting from Malm, state that a fisherman of Bohuslän, named Johan Persson, had observed the spawning of this fish for three years in succession in the same cleft of the rocks at a depth of three or four fathoms; that the male posted himself a couple of feet away and "blew on the roe," besides defending it from enemies, defeating the attacks even of the crab. This habit of "blowing" upon the roe seems to have escaped the notice of naturalists; but from what follows it will be seen that the observation of the Swedish fisherman was quite accurate, and that an important part of the duty of the male taking charge of the eggs is to spout currents of water from his mouth on them.

I should think there are few better instances among fishes of parental devotion to the progeny than what is shown by the male lumpsucker. For weeks and months he devotes himself to the nursing of the eggs with the most remarkable assiduity, refusing to be driven or seduced from his post; fasting and rejecting food until almost the end of his long and trying vigil: "blowing" upon them and fanning them with his fins all the time to keep them well aërated and clean; removing anything that might injure them, and defending them with courage and even ferocity from the attacks of foes great and small. When his task is ended and the eggs are hatched it is not wonderful that he is worn-out, thin, and exhausted with his zealous labours.

Last spring four living lumpsuckers were obtained from the local salmon stake-nets and brought to the Laboratory, and as two were males

* "British Fishes," II., p. 187.

† *Ann. and Mag. Nat. Hist.*, XVIII., 5th Series, p. 81; *Ann. Rep. Fishery Board for Scotland*, Part III., p. 174; M'Intosh and Masterman, "British Marine Food Fishes," 183.

‡ Vol. I., p. 297.

and two were females, and the latter were evidently full of eggs, the opportunity was taken to make some detailed observations as to the spawning and the guardianship of the eggs by the male. The two females were first procured, and a few days afterwards the two males, and they were all put together in a tank, in which were also a number of small flounders, a few small plaice, and a lobster which had been there for a long time and dwelt by day in a hole under a stone at the back.

The concrete tank measures 5½ feet long by 4 feet 4 inches wide, and is 3½ feet high; it is provided with plate glass in front and back, and during the observations the height of water was maintained at 27½ inches, so that the quantity of water was about 336 gallons (1663 litres). The flow amounted approximately to 80 gallons per hour. Since light is admitted to the back of the tank by a window narrower than the tank, and partly under the level of the ground, the back corners are not so well illuminated. The outflow from the tank was so arranged at first that the water had to pass first through a layer of sand around the lower end of a large fireclay pipe standing erect on the bottom, and high enough to reach above the surface, then up the inside of this pipe till it reached a lateral hole in the iron outflow pipe, which passes through the concrete bottom of the tank and is enclosed by the fireclay pipe.

On the morning of 24th March it was found that both the female lumpsuckers had spawned. Two large masses of eggs had been deposited during the night, in close contact with one another, in the left-hand corner of the tank, in front, against the glass, and between the side of the tank and a stone, on the top of which a large sea anemone was fixed (*see* figure on plate XI.). It was thus in a good position for observation. So closely were these masses applied to one another that they appeared at first to form a single mass, distinguishable only by a difference in tint. Later, when the eggs were nearly ready to hatch, they were separated throughout by an interval or gap of about half-an-inch, showing that the masses had in reality not been adherent to one another. It may therefore be surmised that though both females spawned during the night, 23rd–24th March, an interval of time elapsed between the layings; and, further, that the adhesiveness of the eggs is soon lost in sea water.

Both clumps of eggs were pink at first, but one lot was much paler than the other, and thereby readily distinguished.

After the females had shed their eggs they retired to the shadiest spots at the back of the tank, and passed the time in clinging to or lying on large stones which were there. They were sluggish and quiescent, scarcely moving, and at this time they took no food. Their system was no doubt much upset by the sudden ejection of so large a mass of eggs, which they had carried for some months.

The two males, on the other hand, occupied very different positions, both as regards their place in the tank and as regards their place in the social or domestic polity of the lumpsuckers present. One of them lay close to the masses of eggs; the other was as far from them and his fellow male as he was able to get, clinging to the wall of the tank in quite the opposite corner, and near the surface of the water, from which he often pushed his snout.

The former was guarding both masses of eggs. He was lying behind them, with his snout against them, and obviously keenly attentive to his surroundings as well as to the responsible duties of his office. The movement of another fish in the water, or of a person standing in front of the glass plate of the tank was sharply watched. If the hand or face or a handkerchief was approached towards the glass, the little lumpsucker came up over the eggs with eagerness and celerity, and remained there in

an attitude of watchfulness. If the hand was placed on the glass near the eggs, he made a furious charge at it; with so much force, indeed, in the early days of his long guard, that he obviously hurt his snout.

This was repeated again and again, and day after day. If anyone entered the tank-house and came within five or six yards of the tank, he was observed by the alert little sentinel, who rose up and watched him. When the attendant bared his arm and plunged it into the water to place a flat stone behind the eggs (so that the actions of the fish might be better observed as he rested upon it at a higher level), his arm was charged with such fury that it was forcibly driven against the front of the tank. The guarding male showed the courage, ferocity, and tenacity of a bulldog, which, indeed, he somewhat resembled, with his ugly visage, heavy jaws, and restlessly moving eyes, the whites of which were often exposed and conspicuous against the dark colour of his cheeks. His capacity as a defender of the eggs lay more in his power of butting than of biting, for which his mouth is not well adapted. All attempts to drive him off were futile. When a stick was pushed down into the water towards him he shoved it away with his snout, or charged at it.

During the two months that the eggs were under his care, the patient and devoted parent never left them, except for a moment now and again to pursue the other male. He could neither be driven away by menace nor enticed away by guile. The most savoury mussels, which were greedily swallowed by the other lumpsuckers, did not tempt him. On the contrary, if one were allowed to sink near him or the precious eggs, he took it in his mouth, swam rapidly towards the middle of the tank, and promptly ejected it there, returning immediately to his post. Until almost the close of his vigil he ate nothing.

His conduct towards the other occupants of the tank was very interesting. Occasionally a flounder would swim lazily and aimlessly round the tank. The moment it approached the eggs, the lumpsucker turned swiftly towards it, and, if necessary, headed it off. Now and then he would make a sudden dash at the trespasser, who precipitately retreated. The flounders soon came to understand the position, and avoided the corner where the eggs were lying; they chose to occupy the other side of the tank, preferring the company of the old lobster, though he was in the habit of catching one of them by stealth occasionally and devouring it. His quiet, sly, diplomatic ways, though really more dangerous, were less alarming to them than the furious but harmless assaults of the lumpsucker.

Of special interest was the conduct of the two males towards one another. By rights, it may be supposed, and under ordinary circumstances, each mass of eggs would have been guarded by a male fish, and probably fertilised by him alone. But owing to the two females having laid their eggs in the same corner—for whatever reason—a conjoined guardianship was only possible if friendly feelings existed between the two males. This was far from the case. The male which had obtained possession of the eggs showed throughout the whole period the most rancourous and persistent animosity to the unattached one. The latter, on the other hand, displayed the greatest fear of his successsful rival.

It may be supposed that in the night when the females were spawning, or about to spawn, the two males engaged in a combat or contest for the privilege of fertilising the eggs and guarding them. The one which was worsted in the nuptial fight never regained courage to attempt further contest for his rights, but displayed a most craven spirit from first to last, lurking in the darkest part of the tank as far from his rival as he could get.

It was sometimes possible, but always difficult, to drive or push him in the direction of the other male by means of a stick. He was more

readily enticed by holding mussels in front of him under the surface of the water, when he would swim after them as they were slowly withdrawn; but, though very fond of mussels, his fear of the other male usually subdued his appetite before he had gone very far, and he turned back.

Whenever the guarding male saw his late opponent moving, even a comparatively little way from his retreat, he rushed at him with the utmost fury—I was not previously aware that so clumsy aud usually sluggish a fish could swim so fast—and the other male made off with equal speed, and often attempted to jump out of the water, or was partly knocked out. On such occasions so much commotion was made that waves were created in the tank and the other fishes were alarmed. These were the only occasions that the guardian left the eggs for a few moments. The animosity was kept up during the whole period of the experiment, a fact which is of some interest.

The females took no part at all at any time in looking after the eggs, as some authors have supposed them to do. They lay indolent and quiet at the back of the tank for some days. On the 2nd April, one of them began to swim about and come to the surface. She took not the least notice of the eggs or of the males, nor the males of her. Even when she came so close to the eggs as to brush them with her fins, the male merely looked at her, or moved a little aside to let her pass.

On the 5th April, a second deposit of eggs, comparatively small in quantity, was observed, laid over the top of one of the other clumps. It had been deposited during the night by one of the females. Three of the usual dimples or cup-like depressions were noticed on the surface of them, caused no doubt by the fondling snout of the male.

On the 15th April, attempts were again made to induce the sentinel male to eat mussels. He took no notice of those dropped at some distance; if they came near, or fell on the eggs, he seized them, swam a foot or two away, and ejected them. Very different was one of the females, who devoured them in great numbers, as did also the other male, if within what may be called his safety-zone, all his actions being dominated by fear of the guarding male. The second female, perhaps the one which had recently deposited the eggs referred to, still lay quiescent at the back of the tank, and did not attempt to seize mussels. The active female showed the greatest indifference to the lobster, and when by accident she touched his open claws he merely withdrew a little further into his hole.

From the first, the guarding male was observed to fan gently the mass of eggs with his breast fins, clearly for the aëration of the eggs, but for some time the action was leisurely performed and was by no means so striking as it became later. It is certain that the duties of the male is not confined to guarding the spawn from foes, but that an important part of them include the aëration of the eggs by creating currents through the mass, and the keeping of them clean. It is indeed a little surprising how a sufficient supply of oxygenated water can reach the interior of the compact mass by the narrow and tortuous channels which exist between the adhering eggs. The mass may be six or seven or more inches in diameter. It is probable that under natural circumstances the surging movement of the tides is the most influential agent in effecting this. At all events, from the early part of April onwards, the male lumpsucker kept fanning the spawn with more zest than at first. And on the 10th April another action was for the first time observed. Placing his mouth about an inch or so from the spawn he spouted water out upon it, the action of the gill-apparatus being thus reversed, as I have observed also in plaice with their snout above the level of the water.*

* *Twenty-second Annual Report*, Part III., p. 287.

This curious action was most purposive and effective. The current created was so strong as to sway the algæ growing on the side of the tank in the neighbourhood as well as the tentacles of the anemone, and even to cause the whole mass of eggs to rock visibly backwards and forwards. This action was done at brief intervals and from this time onwards. Later, when the eggs were hatching it was redoubled, and great activity was shown with the fins. The movement thus created in the water very probably helped the escape of the larval fishes from the eggs. At this time the "pumping" or "blowing" action was at the rate of fifteen or sixteen in ten seconds, and in the pauses the fins were kept vigorously at work.

On April 17th, I tried an experiment. I removed the devoted lumpsucker in a dip-net and placed him in an adjoining tank of the same dimensions, in which were a few dabs (which were greatly alarmed). After turning round once or twice, as if to get his bearings, he swam towards the corner where he expected the eggs to be and paused about a foot away. He then swam up to a stone at the back of the tank and paused again; he next moved restlessly all round the tank, and came back once more to what appeared to be the familiar corner; then he moved slowly towards the other corner and lay quietly on the bottom, having apparently abandoned the quest.

Meantime, I endeavoured to get the other male to undertake the guardianship of the eggs. He was driven gradually to the corner where they lay, and paused a moment, but rather, it may be conjectured, with surprise at the absence of his foe than from any impulse to attend to them. The experiment was repeated with a like result, no inclination being shown by this male to assume the duty. Whether he would have done so later may only be conjectured. Finally, I placed this male in the other tank beside the proper guardian in order to see whether the latter would attack him in the absence of the eggs. He did not. He merely looked at him, without making any attempt to approach or pursue him. On the other hand, the newcomer recognised his enemy, and rushed off as before, but finding that he was not pursued, he soon settled down and approached the other male, who took not the least notice of his presence.

Both males were then put back into the tank containing the eggs. The guardian at once sought for them and resumed his duty, and with it also his animosity to the other male, and the old relationship was re-established.

Towards the end of April the conditions were the same as before, the sentinel lumpsucker "blowing" and fanning the eggs, refusing mussels, removing them from near the eggs if dropped there, chasing away wandering flat-fishes and relentlessly pursuing the other male, and coming up angrily and aggressively when one approached the front of the tank.

By this time the egg masses had become very dark, owing to the development of black pigment in the now well-advanced embryos. The masses at first, as stated, were pink; this tint faded and they appeared pale green, whitish, then dirty amber-coloured, and then dark, for the reason mentioned.

The colours of the males were also different. The one that was guarding the eggs, and had probably fertilised them, had lost his brightness and was dingy, while the other, who most likely had not spawned, possessed the red colour on his fins and lower part as vividly as at first.

More than a month had elapsed since the guarding male assumed duty, and during that time he had eaten nothing. He was looking thin and and was infested with ecto-parisites (*Caligi*), and appeared sometimes

exhausted by his onerous task and prolonged fast. That this was not entirely due to these causes was shown when the supply of water to the tank was increased, and when it was directed to his corner. After a refreshment of this kind he moved round about with vigour, energetically spouting water on the eggs and fanning them with his fins.

Towards the end of the month he took a mussel occasionally and swallowed it. This was first noticed on the 26th, and on some days he ate as many as five; any excess he carried off and ejected, as before; and at the beginning of May he was as alert, active, and pugnacious as ever.

On one day at this time I dropped on the top of the egg-mass a little common swimming-crab, about $1\frac{1}{4}$ inches in breadth, which, apprehending danger, clung tightly in one of the snout-depressions on the surface of the eggs. It was amusing to watch the lumpsucker ineffectually trying to rout him from the hollow in which he had taken refuge, the blunt snout of the fish preventing a hold being got on the crab. He tried again and again to dislodge or seize the crab. At last the crab turned partly on its side, and extended its widely-opened chelæ as if to defend itself, which gave the fish its opportunity. It seized the crab in its mouth and swam off with it to the furthest corner of the tank, where it dropped it.

Early in the experiment the outer fire-clay pipe was removed and an apparatus fitted up to the overflow, so that all the water leaving the tank passed through two boxes with fine silk-gauze bottoms. This was to retain the larval lumpsuckers when they issued from the eggs. The first of these was got on 5th May, 43 days after the eggs were deposited and fertilized. The daily temperature of the water during this period may be seen by reference to the tables on pages 113 and 284. When the eggs were spawned it was 42·5°F; in April it varied from 41·5° to 46°; and at the end of the month was 43·7°F. and 45°F., rising to 44·6° and 47°F. in the first week of May.

For the first few days after the 5th, the tadpole-like larval lumpsuckers were found in small numbers in the overflow-filter every morning, and they slowly increased in numbers. They were very active, swimming with great rapidity by a lashing movement of the tail, a large yolk containing an oil globule at the right side being conspicuous.

At this time, as I have mentioned, the male parent was most assiduous in his attention to the egg-masses, redoubling his activities both in fanning and "blowing" upon the eggs. He ate mussels sparingly, sometimes fasting for a few days, and carrying off and ejecting the proffered food. He also continued to chase the other male and drive off intruders.

Up to the 22nd May, or almost exactly two months from the time the eggs had been spawned, and seventeeen days after they had begun to hatch, the conditions described continued. The young lumpsuckers were appearing in greater numbers, but still not in such abundance as one might have expected. The largest number was about two or three hundred in a day. They were also to be seen adhering to the glass front of the tank, and numbers were thus accounted for. None were observed on the back of the male, a habit sometimes attributed to them.

It was now noticed, however, that many of the larval lumpsuckers were dead and white, and these were also seen floating in the water. On examination, it was found that the condition of the tank was unsatisfactory; it was obviously rather dirty from an accumulation of weed and refuse, and had probably too many occupants for the experiment, and when the egg-masses were examined their lower parts were found to be black and fetid, a circumstance that explained the presence of the dead and whitened young lumpsuckers. Clearly the aëration had not been sufficient for the interior of the egg-masses. The supply of water to the

tank was increased, but it was judged that that would not suffice, and the blackened parts of the spawn were torn off, the portions that seemed in good condition being replaced in their old position. The spell, however, was broken. The male did not resume his attention to the eggs, the mass of which was indeed much broken up and diminished in size. He pushed some of the pieces about the tank and withdrew. Both he and the eggs were placed in another tank, without any better result. He pushed the pieces about a little and left them. And when the other male was introduced, he seemed oblivious to its presence; his animosity, at first associated no doubt with reproduction and fertilisation, and then with the care of the eggs, had quite departed.

On examining the portions of the egg masses that remained, the surface was found to be flocculent from the empty egg-shells from which the young fishes had escaped, most of which were still attached to it. On the other hand, the interior of the mass was solid, the eggs all containing embryos, some of which had died, but many were subsequently hatched out in jars. From an early period some of the eggs, but not many, next the glass in front of the tank, were observed to be white and opaque (dead), but they did not decay.

The difficulty of hatching the eggs of the lumpsucker was pointed out previously by M'Intosh, who stated that in tanks they speedily acquire a fetid odour, that the death of a few causes putrefaction of the whole, and that they had not yet been hatched out in tanks.* He does not give any particulars as to the dimensions of the tanks or the flow of water, but probably the chief difference between his experiments and that described here was that the male in the latter case was constantly engaged in tending the eggs, which shows how efficient that attention may be.

The hatching of the eggs, so far as it was accomplished in the tank under the care of the male, extended from the 5th to the 22nd of May, or seventeen days. The greater number were still unhatched on the latter date. It seems a long period, considering that the eggs were deposited, and no doubt fertilised, at practically the same time. Under natural circumstances, it is probable that the time taken for the hatching of all the eggs is prolonged, for it is difficult to understand how the larvæ could make their way from the interior of the mass by the narrow channels between the eggs if the eggs there were hatched as soon as those on the exterior. The condition of the masses shows that this does not occur, and that hatching proceeds from the outer surface inwards, a process which must take a considerable time. It seems very likely that the development of the eggs towards the centre of the mass is retarded, owing to defective or inferior aëration there, compared with the eggs on the surface and near it; and that this is related to the gradual disintegration of the outer surface as the eggs hatch there, and a pathway of escape is opened to the larvæ.

One could not fail to be impressed with the advantage to the species of this guardianship of the eggs by the male fish. Numerous foes must be driven off and the eggs preserved, and I do not think the story of Fabricius, that the lumpsucker under such circumstances will attack the wolf-fish, need be doubted. The courage and pugnacity of this usually docile and inoffensive fish seem boundless when it is protecting its eggs, and in contests of this kind it not infrequently happens that courage and determination count for as much as strength and the power of inflicting real injury.

The conclusions from the experiment may be thus summarised:—

(1) The male alone defends the eggs, the female taking no part whatever in protecting them.

**Annual Reports Fishery Board for Scotland*, 3rd, p. 60; 14th, p. 272.

(2) The guardianship is prolonged till the eggs hatch, probably till all are hatched, a period exceeding two months in duration.
(3) The male not only protects the eggs from enemies, but is constantly engaged in cleansing and aërating them, both by the movement of his fins and by spouting currents of water upon them from his mouth.
(4) He removes from them or their immediate neighbourhood foreign bodies which might injure them, and carries them to a distance.
(5) The male fasts during at least the greater part of his long vigil, but begins to feed towards its close.
(6) He drives away other males, and displays great animosity to them throughout the whole period.
(7) This animosity is shown only when the eggs are present.
(8) The period of incubation may extend over 40 days.
(9) The hatching of the eggs is also prolonged and gradual, those at the surface of the mass hatching first, and those at the centre last; and this difference in the rate of development is probably correlated with a difference in the degree of aëration or oxygenation of the eggs, the better oxygenated hatching first.

The figure is a reproduction of a photograph taken by Dr. Williamson through the glass front of the tank, and shows the eggs and male *in situ*. The male lump-sucker (*a*) occupies a position which he often took up, adhering to the side of the tank above the eggs. His outline is somewhat blurred, owing to movement while the photograph was being taken. Very often he sat on the stone behind the eggs, part of which is shown at *b*. The egg-masses which he is guarding and attending to are shown at *c*, *c*. The anemone, which was his constant companion, is represented at *d*.

VIII.—ON THE RATE OF GROWTH OF FISHES. By T. W. Wemyss Fulton, M.D., F.R.S.E., Superintendent of Scientific Investigations.

(Plates XII., XIII.)

Contents.

	Page.
Introduction.	
Species Dealt With,	179
Methods,	180
Comparison Between Different Species,	180
Influence of External Conditions,	181
A Law of Growth,	182
Plaice (*Pleuronectes platessa*),	184
Common Dab (*P. limanda*),	189
Flounder (*P. flesus*)	191
Lemon Dab (*P. microcephalus*),	192
Long Rough Dab (*Drepanopsetta platessoides*),	196
Turbot (*Rhombus* (*Bothus*) *maximus*),	199
Brill (*Rhombus lævis*),	203
Cod (*Gadus callarias*),	209
Haddock (*G. æglefinus*)	225
Whiting (*G. merlangus*),	227
Grey Gurnard (*Trigla gurnardus*),	229
Tables of Measurements, I.–XXV.,	234

Introduction.

For a considerable number of years special attention has been devoted to the study of the growth of fishes by the scientific department of the Board. In 1889, I began observations on this subject by two methods, (1) by marking fishes (plaice, dabs, lemon dabs, brill, turbot, cod, &c.) by attaching to them brass labels bearing a number, the method which is now so largely used in connection with the international investigations, and then returning them alive to the sea; in the case of the herring, by removing a portion of the caudal fin; (2) by keeping the fishes in tanks, and noting the changes that occurred from time to time in their length and weight.*

Since then very many fishes have been dealt with by another method—viz., by collating the measurements of large numbers of each species, by which the earlier series or generations can be separated from one another and the rate of growth ascertained, the measurements grouping themselves into curves or waves. This method was used to a limited extent by Miescher Ruesch in his classic studies on the salmon of the Rhine, and by other observers, as Ljungman, in studying the growth of the herring. These observers, however, did not classify the measurements in a scientific manner, which was first done by Dr. C. G. J. Petersen, who thus placed an important method at the service of investigators.

Species Dealt With.

In the course of my investigation on growth during recent years, a large number of fishes have been dealt with—viz., nearly 209,000, belonging to 21 species. The results in regard to many of them have been given in a

* "An Experimental Investigation on the Migrations and Rate of Growth of the Food-Fishes," *Eleventh Annual Report*, Part III., p. 117.

series of papers in the Annual Reports of the Board.* The numbers of the various species measured for this work, and already dealt with, are as follows :—

Plaice,	17,950	Gurnard,	5,495
Common Dab.	26,230	Norway Pout,	7,192
Flounder,	231	Hake,	571
Lemon Dab,	2,201	Herring,	19,806
Witch,	3,422	Sprat,	6,473
Long Rough Dab,	20,261	Grey Skate,	432
Turbot,	212	Angler,	722
Brill,	807	Armed Bullhead,	1,312
Cod,	7,176	Lesser Weever,	417
Haddock,	28,760	Lumpenus	738
Whiting,	58,164		

Numerous measurements of other forms, as halibut, megrim, ling, pollack, coalfish, tusk, catfish, have also been made, and will be dealt with later.

Most of the fish were measured on board commercial steam-trawlers, engaged either in trawling investigations in territorial waters or in commercial fishing in the North Sea.

Methods.

In a previous paper† I gave a full account, with illustrations, of the method adopted in collecting and measuring the fishes. Besides this method, there is no doubt that much may be learned by keeping fishes in confinement, and measuring and weighing them from time to time, for comparison with those obtained on the fishing grounds, and this has been done. Another method, referred to above—viz., labelling the fish—has also in certain cases given good results, most, perhaps, with flat-fishes. Recently a fourth method has been employed, especially in Germany, by the examination of the markings on the scales, otoliths or ear-stones, and bones. It has also been used in the international investigations in this country by Garstang and Wallace, with reference particularly to the growth of the plaice, and the results agree with those obtained by a study of the measurements.‡

Comparison Between Different Species.

While one general result of the investigations on the rate of growth of fishes has been to show that they do not grow so fast as was generally believed, it has been made clear that different species may increase at different rates, apart from differences in size. In fishes which undergo a marked metamorphosis, growth is sometimes, and perhaps always, slow, especially at early periods. It is thus with the plaice and other flat-fishes, with the eels, and with the herring and sprat. Among round-fishes, as the cod, the haddock, and the whiting, on the contrary, growth is comparatively rapid. A young haddock grows many times faster than a plaice.

With regard to the age at which fishes attain mature size and begin to reproduce, similar differences exist. So far as the investigation has gone,

* 19th, 20th, 21st, 22nd.

† *Twentieth Annual Report*, Part III., pp. 226-334.

‡ North Sea Fisheries Investigation Committee. *Report (No. 2, Southern Area) on Fishery and Hydrographical Investigations in the North Sea and Adjacent Waters.*

no sea fish has been found to attain the mature condition in the first year of its life, or before the close of its second year. Some spawn for the first time at the end of their second year, *i.e.*, when two complete years of age. These, as a rule, are the smaller species, as the sprat, the armed bullhead, the Norway pout, and the lesser weever; but this class includes also the whiting, which reaches maturity with comparative rapidity.

Among those which spawn for the first time at the end of their third year must be included the haddock, though some of these may reach maturity at the close of two years, the common dab and the long rough dab. Amongst the latter two species, indeed, the male comes to maturity a year earlier than the female, when two years of age, a phenomenon common to most flat-fishes.

Thus, with the witch, the male matures at three years and the female at four years; among plaice the male matures at four years and the female at five. Among round fishes, on the other hand, the two sexes reach maturity at the same age.

The cod does not attain its mature condition before the completion of its fourth year, while such large flat-fishes as the turbot, halibut, and brill take a longer time—the turbot probably not before it is seven years old, and the brill not before it is five or six. The approximate age at which the angler first spawns is, as the minimum, four years for the male and five years for the female.

How many years fish live after they reach sexual maturity it would be difficult to decide; but it is certain that in most cases the duration of reproductive life greatly exceeds the immature period. The method of determining the age by a study of the measurements is not well suited to solve the question, owing to the fusion of the groups from the variations in the rate of growth, and it is here that the method of estimating the age by the markings or number of zones on the hard structures may be of special advantage. Fishes of a size above the normal limit for the species are very old. When dealing with the plaice in a previous report* I remarked that the largest specimens I then described must be sixteen years old, but Professor Heincke, from an examination of the bones of the gill-cover, concludes that such individuals are twenty years old and more.

Influence of External Conditions.

Among the conditions which influence growth the most important, apart from quantity of food, appears to be temperature. Direct experiments on this point, by keeping fishes in water of different temperature, are described in the *Twenty-second Annual Report*, where it is shown that those in the water that was warmest grew much faster than those in colder water. Previous experiments in tanks,† in which the fish were retained over winter and supplied with water from the beach at the ordinary temperatures, proved that the growth of plaice of 13 and 14 inches and of dabs is almost or quite arrested in January and February. It has also been shown that the growth of small plaice and dabs on the beaches ceases in winter, and that among such round fishes as the haddock and whiting the retardation of growth is marked in the early months of the year, when the temperature is low, the growth of these fishes taking place mostly in a few months in summer.

With regard to the whiting, I have been struck with the attenuation shown by many individuals examined in the early part of the year, and I think it is not improbable that the storage of fat in the muscles and the liver of fishes during summer and autumn is not merely for supplying

* *Twentieth Annual Report*, Part III., p 357.
† *Eleventh Annual Report*, Part III., p. 193.

material for the growth of the reproductive organs, as is commonly supposed, but is also connected with maintaining their nutrition over the colder portion of the year. Fat is often got in immature fishes in quantities, as in the herring and Norway pout, for example.*

There are reasons for the belief† that growth is modified with respect to period and amount in the deeper waters of the northern part of the North Sea, compared with the waters near the coast, but to what extent the growth of fishes in the sea in deep and moderately deep water, as on the fishing banks in the North Sea, is affected by the changes in the temperature of the water is not yet clear, there being a want of sufficient observations as to the changes in the temperature that actually occur there.

It is clear that a knowledge of the changes in temperature that take place is necessary to understand not only the growth of fishes and its variation, but their biology generally. All the other observations ought to be correlated with the temperature changes, just as the biological changes on land are, and what is wanted is a calendar of physical conditions throughout the year to which the biological observations may be referred, whether they relate to plankton, food of fishes, spawning periods, development, growth, or migrations.

The salinity of the water is another condition which probably modifies growth to a considerable extent, and it is not unlikely that it is one of the causes which produce a change in the range of size and the average size in species in certain localities. Some fishes, as the plaice, the dab, and the lesser weever, I have found to be of smaller dimensions, and of slower growth, in the Solway Firth, where the salinity is reduced, than on the East Coast, and the same cause probably acts on other forms. The subject is one which has not yet been much investigated.

A Law of Growth.

During the researches on the growth of fishes, it has become apparent to me that there exists a relationship between the size at which sexual maturity occurrs in the various species and the general maximum size to which they attain. It may be expressed in one way by saying that *fishes approximately double their size and increase their weight about eight times after they have reached sexual maturity*; or that *fishes attain sexual maturity when they reach about half their maximum length and about one-eight of their maximum weight.*

It cannot be said at present that the law is more than approximately correct, for our knowledge of the precise average size at which the males and females of many fishes first spawn is as yet meagre—it is not well determined even for the cod—and the same is true as to the general maximum size to which many fishes attain; a limit, moreover, which, in some instances at least, may have been modified by the action of man. For example, the maximum size of most fishes at Iceland is larger than in the North Sea at present, though there is no reason to suppose that growth is quicker there; and it is known that when the Dogger Bank was first worked by trawlers the general maximum size for plaice was higher than it is now.

* A research on this subject is at present being made for the Board by Dr. Noël Paton, whose investigation of the changes in the salmon are well-known, as well as one on the rate of digestion in fishes. † *Twentieth Annual Report*, Part III., p. 394.

But the facts are sufficient to justify the statement in its broad sense, and doubtless the extensive investigations now being carried on will ere long show how far it may be incorrect. It is to be noted that it applies to the fish in a region in which growth is naturally modified; if plaice, for example, reach maturity in one region at a size less than in another, then the maximum size is also less. It is the same with the males and females among flat-fishes; the males, as a rule, attain the mature condition at a less size than the females, and their maximum growth is correspondingly curtailed. As the maximum size of a species of flat-fish is approached, the proportion of males diminishes and the proportion of females increases; and all the very large individuals are females.

I give in the following Table the information such as it exists for a number of species, the sizes being in inches:—

Species.	Approximate Size at Maturity.		Approximate Age at Maturity.		Approximate Maximum Size.		Exceptional Records of Size.	
	Female.	Male	Female.	Male.	Fema	Male.	Female.	Male.
Plaice, . .	16-17	13-14	5	4	32	...	38½	...
Com. Dab, .	7½	6	3	2	15	13	17	...
Flounder, .	8-9	...	...	...	...	...	18	...
Lemon Dab, .	10	8	4(?)	...	20	..	...	...
Witch, . .	11-12	10-11	4	3	23	...	24½	...
Halibut, .	48	30	...	...	84	...	.	
Megrim, .	12	9½	...	...	24	...	...	...
L. R. Dab, .	6½-7	...	3	2	13-14	12	16½	...
Turbot, . .	17-18	...	7	...	32	...	(70 lbs.)	
Brill, . .	15	...	6	...	26	...	...	...
Cod, . .	26-27	...	4-5	...	55-58	...	68	...
Haddock, .	11	11	3	3	25	...	33	..
Whiting, .	8½-9	...	2	2	18	...	...	...
Norway Pout,	4½	...	2	...	8-8½	...	9¾	...
Gurnard, .	9	...	3	...	17-18	...	..	...
Angler, . .	30	27	5(?)	4(?)	...	...	...	...

The approximate maximum size is as far as possible derived either from market measurements or from fish which have been measured on trawlers.

PLAICE *(Pleuronectes platessa).*

A considerable number of collections of plaice were measured, partly from Aberdeen Bay and the Moray Firth, as well as from the Solway Firth and Lochfyne; special attention being given to the small forms. The total number of plaice dealt with in this paper, whose measurements are given in the Tables appended is 11,385, making with those described in the previous paper an aggregate of 17,950.

LOCHFYNE.

The small plaice taken in Lochfyne were obtained by the push-net on the beaches at low water, that is to say, in two or three feet of water at that period of the tide. Those dealt with here were got in July and August, 1901, and in June and July, 1903, the aggregate numbers being 4751 fish. They were taken at several different places in the loch, as shown in Tables I.–III. (p. 243), most being got at Inveraray, Strachur, Big Harbour, and Salen. They all belonged to the same series, the fry of the year, and consideration of their measurements gives an indication of the rate of growth at this stage in Lochfyne. Taking first of all the catches in July and August, 1901, it will be seen from the Tables that the push-nettings in July, which were made between the 1st and 6th of the month, resulted in the capture of a total of 3529 small plaice. The sizes ranged from 12mm. to 58mm., a difference of 46mm. The maximum numbers were ranged about 2·5cm. to 3cm., and the average length was computed to be 30·3mm. (Plate XII.).

The period in August when the collections were made was from the 28th to the 31st. The numbers were smaller, viz., 556 fish. They ranged in size from 34mm. to 88mm., a difference of 54mm. The greater numbers were ranged about 50mm., or more than 20mm. higher than in July, and the average size was calculated to be 55·9mm., or an increase of 25·6mm. (as near as possible, 1 inch) in the period, which may be placed at 58 days from the middle of the one series of collections to the middle of the other (Plate XII.).

It is noteworthy that in some of the collections, most noticeably in July, the plaice of one locality were sensibly larger than those of others, a fact that was pointed out at the time by Mr. Dannevig. Taking the four chief places at which collections were made in that month, the range and averages in millimetres are as follows:—

	Number of Fish.	Smallest.	Largest.	Average.
Inveraray, ...	1,163	19	58	35·9
Strachur, ...	668	16	51	28·9
Big Harbour, ...	822	12	51	27·0
Salen, ...	806	14	51	26·1

[TABLE.

The contrast between two of the places may be brought out in the following manner by comparing the sizes at Inveraray and Strachur, reduced to percentages, the number of fish being in the former case 1163 and in the latter 668, and both series collected on the same days (*see* fig. 3, pl. xii.):—

Cm.	Strachur.	Inveraray.
1	–	–
·5	0·15	–
2	8·50	0·08
·5	37·90	2·90
3	35·90	25·50
·5	11·80	37·40
4	4·20	20·40
·5	1·00	8·80
5	0·40	3·60
·5	–	1·10
6	–	0·08

It may be said that in August the average size and the minimum size were also larger at Inveraray than at Strachur, the average at the former place being 66·5mm. and at the latter 52·0mm., while the minimum sizes were 48mm. and 34mm. In the collections in June and July, 1903, the same feature is repeated, thus:—

	Date.	Number of Fish.	Smallest.	Largest.	Average.
Inveraray, . .	June 22	86	17	47	27·7
Strachur, . .	,, 24	94	15	29	19·94
Inveraray, . .	July 10, 11	105	17	50	30·4
Strachur, . .	,, 13	50	19	57	26·8

The explanation put forward by Mr. Dannevig to account for this difference was the probability that the temperature at Inveraray is higher than at Strachur, owing to the former locality being less affected by the deep-water tidal currents, and he pointed out that the size of the small plaice at the top or upper parts of the loch appears to be slightly greater than at the lower parts near the mouth. So far as the somewhat limited observations on the temperature are available they seem to show a rather higher temperature at Inveraray, as a rule, but not always.

The other collections referred to in the Tables were made in June and July, 1903. The period in June extended from the 22nd to the 26th, and the small plaice caught numbered 218. They ranged in size from 15mm. to 47mm., a difference of 32mm., and the average length was computed to be 23·9mm. The greater number ranged about 20mm., but it would appear from the curve (fig. 2, plate XII.) that the smaller sizes were not fully represented.

In July the collections were made from the 10th to the 13th. The number of plaice taken was 448, ranging in size from 17mm. to 57mm., the average being 29·0mm., or only about 5mm. higher than in June. The interval may be placed at about 18 days.

The measurements of the plaice in these four series of collections, reduced to percentages, are as follows :—

Cm.	1903.		1901.	
	June.	July	July.	August.
1	–	–	·1	–
·5	13·3	·2	1·3	–
2	35·3	8·9	7·3	–
·5	25·7	32·8	30·2	–
3	17·3	37·1	29·3	–
·5	4·6	14·5	17·4	1·8
4	1·8	3·3	8·7	9·0
·5	1·4	1·8	3·6	12·6
5	–	1·1	1·7	20·1
·5	–	·2	·4	16·9
6	–	–	·03	13·1
·5	–	–	–	10·2
7	–	–	–	7·3
·5	–	–	–	4·7
8	–	–	–	2·5
·5	–	–	–	1·4
9	–	–	–	·18

The features are also shown in the curves. It is probable from an examination of the individual collections that the larger forms are not sufficiently represented. They no doubt move out into somewhat deeper water even at this early stage, and in part get beyond the depth at which a man wades in using the push-net at low tide.

Aberdeen Bay.

A number of collections were made in Aberdeen Bay by means of a small fine-meshed shrimp net, used from a yawl, in depths usually ranging from 3 to 6 or 7 fathoms. The measurements of these are grouped in ·5 centimetres in Table IV., and it is apparent that, though the numbers of fish are in no case large, three annual series or generations are at least indicated. Thus, there is represented a series ranging from 2cm. to 9cm. or 10cm. or a little more ; another from 15cm. or 16cm. to 24cm. or 25cm., and a third from about 27cm. to 34cm. These are best seen in the aggregates for March, April, and May, which, with those for September and November, as grouped in centimetres measure as follows :—

[Table.

Cm.	March.	April.	May.	September.	November.
1	–	–	–	–	–
2	–	–	2037	–	–
3	–	–	–	–	–
4	2	–	1	1	1
5	7	2	15	1	–
6	2	6	16	–	1
7	2	6	8	–	1
8	–	3	6	2	1
9	1	4	6	–	–
10	–	–	–	–	–
11	–	1	2	–	1
12	–	1	–	–	2
13	–	–	–	–	1
14	–	–	–	–	–
15	–	–	1	–	–
16	–	1	1	1	–
17	–	1	1	–	1
18	–	1	–	–	1
19	–	1	–	–	–
20	–	–	1	–	–
21	–	2	1	–	–
22	–	2	–	–	–
23	–	2	–	–	–
24	–	1	–	–	–
25	–	–	1	–	1
26	–	–	–	–	–
27	–	3	–	1	1
28	–	3	–	–	1
29	–	7	–	–	3
30	–	2	–	–	1
31	–	6	–	–	–
32	–	1	–	–	1
33	–	4	–	–	
34	–	1	–	–	–
35	–	–	–	–	–

It is clear that the small plaice ranging from about 4cm. to 9cm. in spring belong to the previous year, and are one year old or a little more. The plaice of the year appear on the sands in May in great swarms. On 12th May, 1904, a collection of 717, measuring from 12mm. to 18mm., was taken on the sandy bottom in Aberdeen Bay in a fine-meshed net in hauls made in from 4 to 7 fathoms. On 18th May a collection of 1320 was taken in the same way in from 3 to 5 fathoms; they measured up to 19mm. and 20mm. In both cases several of the specimens were incompletely metamorphosed. Some of those caught on 12th May were kept alive in a tank, and on July 7—56 days afterwards—seven of them measured 26mm., 24mm., 24mm., 23mm., 21mm., 19mm., and 17mm.

From these records it appears that the first group in spring, the sizes of which range mostly about 5cm. to 7cm. or 8cm., is about one year of age; the second group, with a size mostly from 17cm. to possibly 22cm., represents two-year-olds; and the third group, ranging mostly about 29mm. to 32mm., is at least a year older. The numbers of fish are not large in any of these collections, and the precise limit between one series and another is uncertain. In a collection made on 9th May, 1902, in Aberdeen Bay, in from 4 to 10 fathoms, there were 126 plaice, of which the first series, over one year old, comprised 98 specimens, ranging in size from 57mm. to 126mm., the arithmetical average being 92·2mm., and the maximum ordinate on the base-line in the curve 92·5mm. The second series, which was imperfect, comprised 28 specimens from 140mm. to 227mm., the average of this lot being 190·8mm., and the maximum ordinate 185mm., or 7¼ inches.*

* *Twentieth Annual Report*, Part III., p. 353.

Dornoch Firth.

In the Dornoch Firth some collections of small plaice were also obtained, the particulars of the measurements being given in Tables IV. and VI. On 7th December, 1904, a haul in from 4 to 9 fathoms yielded 182 plaice. The smallest ranged from 59mm. to 98mm.; there were 19 between these sizes. There were also 13 measuring from 125mm. to 145mm. The remainder measured from 173mm. to 472mm. The first group is evidently the fish of the year; the limits of the other series are not certain. On 9th February, 1905, another haul with the fine-meshed net, in from $5\frac{1}{2}$ to 10 fathoms, yielded 355 plaice, ranging in length from 5cm. to 16cm., and distinguished into two well-marked groups. The first included 283 specimens, measuring from 52mm. to 99mm. ($2\frac{1}{16}$–$3\frac{7}{8}$ inches), or it might possibly be 108mm. ($4\frac{1}{4}$ inches), the maximum number being around 7cm. (*see* fig. 4A, pl. XII.). The average length was computed, on the former limit, at 74mm., or very nearly 3 inches. If at the larger limit, the average size would be 74·5mm.

Grouped in centimetres, the measurements are as follows:—

5	6	7	8	9	10	11	12	13	14	15	16
8	59	115	78	19	6	7	14	21	19	8	1

The smaller series are obviously fish of the previous spawning, and about 10 or 11 months old.

In the second, older series, comprising 72 plaice nearing the end of their second year, the greater number are grouped about 13cm. to 14cm. ($5\frac{1}{8}$–$5\frac{1}{2}$ inches), the mean size being about 13·3cm., or $5\frac{1}{4}$ inches, and the apparent growth from the previous series amounts to about 6·5cm. ($2\frac{5}{8}$ inches); but the representation of the larger fishes may not be perfect.

In another haul on the 31st of March, or about 52 days later, but in a different year, viz., 1904, the second series is represented by 29 specimens, ranging from 112mm. to 196mm. ($4\frac{3}{8}$–$7\frac{3}{4}$ inches), as follows, in centimetre grouping, the mean size being about 14·5cm. ($5\frac{3}{4}$ inches):—

9	10	11	12	13	14	15	16	17	18	19	20
1	–	1	1	7	3	6	8	1	1	1	–

These may be regarded as two years of age (fig. 4B, pl. XII.).

The same group is represented in other collections, as given in Table VI., but only by a few fishes, viz., in October, November, and December.

In a haul taken on the 22nd October, 1903, in from 8 to 13 fathoms of water, the 363 plaice which were caught were measured. Though the small-meshed net was employed, the smallest plaice caught was 164mm.; the great bulk of them formed a group between 20cm. and 29cm., with the maximum from 23cm. to 26cm. These fish were approaching their fourth year.

Annan.

A few collections of small plaice in April, 1904, were sent to me by Mr. George Bryson, Annan, which had been taken by shrimp-net in the Solway, on the ordinary shrimping grounds. It will be seen from Table IV. that an early series of fish, about one year of age, is represented, most distinctly in the collection on the 23rd of the month, and also a second series, less distinctly marked off from the third, and again best shown in the collection on the 23rd. They indicate the same feature as shown in the previous paper dealing with the growth of the plaice, that the rate of increase in the Solway is slow.

Burghead Bay.

The plaice taken in several of the hauls in this locality were measured, and the measurements are given in Tables V., VI., at the end of this paper. On 20th October, 1903, a collection of 233 was taken in from 8 to 12 fathoms, the small-meshed net being around the cod-end. The smallest plaice caught was 175mm., and, with another specimen measuring 193mm., probably represented the second group. The next smallest was 216mm., and the bulk of the plaice came between this and 30cm., the majority measuring from 24cm. to 26cm., and representing the third series. The haul in the Dornoch Firth two days later, in which 363 plaice were taken, corresponded pretty closely, as above indicated.

At the beginning of December (6th and 7th), 1904, a considerable number of plaice taken in from $4\frac{1}{2}$ to 16 fathoms, in Burghead Bay, were measured, the sexes being first determined and dealt with separately. The number so treated in three hauls was 1737. These measurements are given in the appended Table V. The separation of the groups is not so well seen in these cases as one might expect. The great bulk of the fish measured between 25cm. and 42cm., and in the case of the females it was not difficult to see that they were separated into two groups, at 34cm. to 35cm. The curve formed by the measurements of the males is much less regular.

The plaice in some other ordinary hauls, taken in from 5 to 21 fathoms on 7th February, 1905, were kindly measured for me by Dr. Williamson, the sexes being distinguished, and also the condition of the reproductive organs (Table VII.). The range in size was from 20–68cm., but the separation of the groups is not very clear; females seem to show maxima about 30–31cm. and 34–35cm. The size at maturity, it will be observed, is about 41cm. for males and 42–43cm. for females; but the number of mature or nearly mature plaice was very small.

COMMON DAB *(Pleuronectes limanda).*

The number of common dabs whose measurements are dealt with here is 8094, belonging to 28 collections from the Moray Firth and Aberdeen Bay. With those included in the previous paper, the total number of common dabs, mostly measured on board commercial trawlers, is 26,230. In many of the recent collections the first, or youngest, series is specially well represented, and the facts show that this fish grows slowly.

Aberdeen Bay.

The collections of young dabs made here were taken in fine-meshed nets, mostly from a fishing yawl, in comparatively shallow water, the depths ranging as a rule from 3 to 6 or 7 fathoms. There are 11, viz., 1 in January, 1 in February, 1 in March, 3 in April, 2 in May, 1 in September, and 2 in November. In Table VIII. appended, the measurements of the fish in each collection are given in ·5 centimetre groups. Few of them show well in any series but the first.

On the 3rd January, 1906, a collection of 323 was obtained in 8 fathoms of water. The smallest measured 27mm., or slightly over 1 inch, and the largest was 63mm., or $2\frac{1}{2}$ inches; the majority ranged in size from 35mm. to 41mm. ($1\frac{3}{8}$–$1\frac{5}{8}$ inches), and the average size computed is 39·2mm., or slightly over $1\frac{1}{2}$ inches.

The next collection, on 11th February, 1905, was taken in somewhat deeper water, viz., 8–12 fathoms, and comprised only 16 small dabs. The smallest measured 32mm., and the largest of the series 67mm., most ranging from 3·5cm. to 4·5cm.

The third collection, on 27th March, 1905, was in from 5 to 10 fathoms, and the small dabs obtained numbered 154, measuring from 32mm. to 78mm. ($1\frac{1}{4}$–$3\frac{1}{16}$ inches), the majority ranging from 4·5cm. to 6cm.

Three collections were obtained in April, 1904, in from 3 or 4 to 6 fathoms of water. In the first, on the 8th, 282 small dabs were secured, the smallest measuring 23mm. and the largest 67mm. ($\frac{15}{16}$–$2\frac{5}{8}$ inches), while in this case the majority ranged from 3cm. to 4cm. in length. In the second, on 16th, the small dabs numbered 308, ranging in size from 24mm. to 82mm. ($\frac{15}{16}$–$3\frac{1}{4}$ inches), and the majority measured from 3·5cm. to 5cm., most being about 4cm. On the 26th the number secured was 178, measuring from 25mm. to 83mm., the majority being from 3·5cm. to 4·5cm. The curve for the collection on the 16th is the most symmetrical. These fish were very nearly, or quite, one year old.

Two collections were obtained in May, 1904. In the first, on the 4th, in from 3 to 7 fathoms, 37 small dabs were taken; they measured from 30mm. to 51mm., the majority being from 3·5cm. to 4·5cm. ($1\frac{3}{16}$–$1\frac{3}{4}$ inches). In the second, in the middle of the month, 70 were taken in the same place and depth; they measured from 31mm. to 58mm., the majority ranging from 4cm. to 5cm. The fish in these collections may be considered to be about one year old.

In the next collection, on 1st September, 1904, in from 4 to 9 fathoms, the small dabs numbered 279, and they ranged in length from 20mm. to 59mm. ($\frac{3}{4}$–$2\frac{3}{8}$ inches), most measuring 3·5cm., and 4cm., or nearly as much as in May. Two collections were obtained in November, 1903. In one, on the 13th, in 6 to 9 fathoms, 114 small dabs, measuring from 20mm. to 82mm. ($\frac{3}{4}$ to $3\frac{1}{4}$ inches), were taken; the curve is not very regular, but the largest numbers are grouped under 5cm. to 6·5cm. In the second collection, got on the 19th, in from 2 to 10 fathoms, 108 small dabs ranged from 33mm. to 72mm. ($1\frac{5}{16}$–$2\frac{7}{8}$ inches), the greater number measuring 4·5cm. to 5·5cm. The dabs of the year appear for the first time in the September collection; but no collection was made between May and that month.

The measurements of these dabs may be arranged in centimetre groups, as follows, from January to November, according to the dates.

Cm.	3/1/06.	11/2/05.	27/3/05.	8/4/04.	16/4/04.	26/4/04.	4/5/04.	12, 18/5/04.	1/9/04.	13/11.	19/11/03.
1	–	–	–	–	–	–	–	–	–	–	–
2	7	–	–	18	5	3	–	–	11	6	–
3	171	5	11	164	72	67	13	10	118	9	6
4	120	9	35	83	142	90	20	41	128	23	35
5	24	1	56	16	71	14	4	18	21	35	49
6	1	1	47	1	14	–	–	1	1	32	17
7	–	–	7	–	2	3	–	–	–	7	1
8	–	–	–	–	2	1	–	–	–	2	–
9	–	–	–	–	–	–	–	–	3	–	–
10	–	1	–	–	–	–	–	–	10	–	1
11	–	–	–	–	–	3	–	–	16	–	–
12	–	–	–	–	–	11	–	–	10	–	1
13	–	–	–	–	–	16	–	–	9	–	–
14	–	–	–	–	–	11	–	–	7	–	–
15	–	–	–	–	1	5	–	–	5	–	–
16	–	–	–	–	–	4	–	–	2	–	–
17	–	–	–	–	–	1	–	–	2	–	–
18	–	–	–	1	–	–	–	–	5	–	–
19	–	–	–	–	–	–	–	–	12	–	–
20	–	–	–	–	–	–	–	–	1	–	–
21	–	–	–	–	–	–	–	–	1	–	–

In one or two of the collections a second group is fairly well indicated. Thus, in that of 26th April, we have a series extending from 112mm. to 164mm. ($4\frac{3}{8}$–$6\frac{1}{2}$ inches), most being aggregated at 12cm. to 14cm. This group is apparently approaching two years of age. Then, in the collection taken on 1st September, the second group begins at 89mm. and apparently ends at 153mm., and it represents fish at nearly the end of their second summer's growth. A comparison of the Tables and dates will show that the very small dabs grow slowly, and like the small plaice, grow very little in winter.

Moray Firth.

In some collections from the Moray Firth the small dabs are also well shown (Tables IX–X.). On 9th February, of a collection got in the Dornoch Firth, in from $6\frac{1}{2}$ to 10 fathoms of water, 377 ranged in size from 31mm. to 78mm., the greater number being aggregated from 4cm. to 5cm. These fish, of course, belonged to the spawning of the previous year, and were about nine months old. On the 7th December, in another collection from the Dornoch Firth, in from 4 to 9 fathoms, 219 specimens measured from 24mm. to 65mm. (the next largest being 92mm.); they were mostly aggregated from 32mm. to 42mm., and chiefly at 36mm., or barely $1\frac{1}{2}$ inches. In a large collection made at Smith Bank on the 27th December, 1903, 66 small dabs measured from 25mm. to 72mm. (the next largest being 84mm.), and in this case the greater number were aggregated between 25mm. and 35mm.

In the Tables the measurements of a large number of older dabs are given, but the division between the annual series is not always very clear. In the Dornoch Firth, in the hauls in December, a group with the majority of the specimens aggregated between 10cm. and 12cm. (about $4\frac{1}{2}$ inches) may be noted; while in the collections from Smith Bank in the same month the group has the aggregate between 10cm. and 14cm. In the haul from the Witch ground at the end of January the aggregate is at 14·5cm. to 15·5cm. ($5\frac{3}{4}$–$6\frac{1}{8}$ inches), and these fish are approaching their third year.

FLOUNDER *(Pleuronectes flesus).*

The information afforded by the collections as to the rate of growth of the flounder is rather scanty, small specimens of this species coming only rarely under observation in the course of the investigations. The young flounders prefer the shallows, especially at the mouths of streams, and where the water is brackish, and even the adult is uncommon in water of moderate depth, except at certain times of the year. The number measured was 231.

In the course of the push-nettings in Lochfyne specimens of flounders were occasionally secured, though usually in very small numbers. A series obtained on 5th July, 31 in all, measured from 16mm. to 53mm. ($\frac{5}{8}$–$2\frac{1}{8}$ inches), the greater part being grouped at 3cm., or scarcely $1\frac{1}{4}$ inches, the arithmetical average being 31·9mm., or $1\frac{3}{4}$ inches. This is rather more than with the little plaice collected at the same time, in which case the majority ranged from 24mm. to 32mm., and the computed average size was 30·3mm. The spawning period of the flounder in Lochfyne, according to Williamson, is a little later than that of the plaice.* It is not unlikely that at this period the habitat of the young flounder leads to an exceptionally rapid growth, viz., in the very shallow and mostly brackish waters, where the temperature in the summer months is highest; and probably also its growth in winter is arrested.

**Seventeenth Annual Report of the Fishery Board for Scotland*, Part III.

Another collection, on 10th September, in Lochfyne, yielded 17 young flounders, the smallest measuring 44mm. and the largest 78mm. ($1\frac{3}{4}$–$3\frac{1}{16}$ inches). It is not clear, however, that the last, and another at 77mm., belong to the same series, since none were taken between 61mm, and the sizes stated. They were mostly aggregated about 5cm., or 2 inches. The other collections of little flounders were small, and serve to indicate only a few points. Thus, some taken in spring, and therefore not belonging to the year's spawning, were rather small in certain cases. On 27th March 2 were got in Lochfyne, measuring 63mm. and 99mm. On 25th May 2 were taken in the Dornoch Firth, one measuring 60mm. and the other 70mm. At Annan, in April, two, measuring 82mm. and 90mm. were taken. These represented fish of the preceding year, and there are few of the second series in the collections; but it is probable that while those mentioned, and a few others of the same kind in the Table, belong to the second group, or those a little over one year old, those in the Tables at 17cm. to 19·5cm. are at least a year older.

A large collection of flounders was obtained in the Dornoch Firth on the 30th March, 1904, in from 5 to 16 fathoms, in the otter trawl, and as they were either actually spawning or nearly ripe, the sexes were separated and measurements made. They numbered 158, namely, 136 males and 22 females, the males in this species preponderating in numbers over the females. It is unfortunate that the small-meshed net was not used on this occasion, but, at the same time, it is not probable that many more small flounders would have been taken, as the smaller fish do not migrate to the depths referred to. The smallest male flounder in the collection measured 202mm., or just 8 inches, and the smallest female was 252mm. The measurements are not sufficient to enable the fish to be separated into definite annual series with any certainty, but they in all probability represent flounders of at least three years and over.

LEMON DAB *(Pleuronectes microcephalus).*

The growth of the lemon dab has not been made out so well as that of most of the flat-fishes. This is owing to several circumstances. The spawning period is of exceptional length, extending from the middle of April to well on in September and even into October. Of a number of large lemon dabs examined at a fish-yard at Aberdeen on the 21st and 22nd September, all the males—129 in number—yielded more or less spermatic fluid on pressure, and of 168 females, 44, or 26 per cent., contained ripe eggs, and were, in point of fact, spawning. On 10th November all were found to be spent. Eggs of the lemon dab were also obtained in tow-nets on 8th October. Owing to this circumstance of the extended spawning period, the various annual groups soon coalesce to such an extent as regards length that it is difficult to separate them. Another difficulty is the scarcity of small specimens. For a long time lemon dabs under three or four inches were unknown, though now specimens under that size have been recorded by Holt, Cunningham, and myself. Still another reason is the fact that large individual collections of lemon dabs are not very often obtained by the trawl. They are scattered, and it would appear that collections from different parts may show a different rate of growth. The number dealt with in this paper is 2201.

I ascertained that in the Solway the boats that carry on prawn-fishing by means of trawl nets often take considerable numbers of small lemon dabs, and I arranged for collections to be made from the boats and the fish forwarded to me. Such collections were obtained in April, May, and

September, and the measurements, in ·5cm. groups, are given in Table XII. (p. 256). The fish are caught on rough ground off the Cumberland coast, in about 4 fathoms of water, and are rather localised in their distribution.

In dealing with them the sexes were first carefully determined, microscopical examination being resorted to when necessary; the proportions of the sexes in these collections were thus made precise and certain. Most of the series were also weighed and the condition of the reproductive organs made clear, and some remarks on this head may be of interest. In the collection in September it is noted that the females had small ovaries, weighing less than one gramme, and usually only a fifth or a tenth of a gramme. The eggs were small and unyolked, the largest measuring up to ·106 and ·134mm. In May the great majority had also small unyolked eggs, but some of them had large eggs and would have spawned in the ensuing summer. This was the case with one measuring 201mm., in which the eggs measured ·72mm., and also in others from 164mm. to 188mm., where the eggs were of the same size. In one of 188mm., weighing 75 grammes, the roe weighed 5·9 grammes and the eggs were ·73mm. in diameter. Another of 182mm. long weighed 66 grammes, the roe weighing 4·0 grammes, and the eggs were of the same diameter as those mentioned. I previously recorded instances of still smaller lemon dabs being quite mature.*

These lemon dabs from the Solway Firth varied in length from 5·5cm. to 20cm., the smallest obtained was 57mm. ($2\frac{1}{4}$ inches) taken in April, and the largest was 202mm. (8 inches). The smallest were got in April (22nd), and the Table shows that in all probability a group terminates about 10cm. No males were got between 98mm. and 114mm., and no females between 89mm. and 111mm. Two females were taken at 57mm. and 59mm., the next being 80mm.; while the smallest male was 71mm. There is thus a suggestion that the two females represent the larger specimens of a younger group.

In the May collections three groups appear to be represented, when curves are drawn of the measurements; the first and third are only partly present, the bulk of the collection consisting of fish from 10cm. to 16cm. and aggregated around 13cm. and 14cm. ($5\frac{1}{4}$ inches). The figures for the totals for the 6th and 15th May, grouped into centimetres are as follows:—

8	9	10	11	12	13	14	15	16	17	18	19	20	21
2	7	3	13	16	21	23	12	8	20	9	2	2	–

The measurements of the separate collections similarly arranged are:—

Cm.	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
April 22, .	1	1	2	7	3	1	3	3	3	3	3	3	1	2	–	–	–
May 6, .	–	–	–	1	3	1	8	11	15	19	12	8	14	11	4	2	–
,, 15, .	–	–	–	–	9	1	3	4	6	5	3	3	5	1	–	–	–
,, 24, .	–	–	–	1	2	–	1	1	–	1	1	1	4	–	–	–	–

Obviously none of the specimens belong to the year; the smallest must be approaching one year of age, or are over it.

In the collections made in September the extreme range of the sizes is very much the same, and the curve of the total shows that a division

* *Twenty-first Annual Report of the Fishery Board for Scotland*, Part III., p. 48.

between two groups is about 13cm. to 14cm., the fish being aggregated at about 12cm. and 16cm. to 17cm. respectively. The figures of the total measurements arranged in centimetres are as follows:—

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	3	10	9	22	49	64	50	51	67	62	62	27	9	2	–

The corresponding figures for the individual collections are:—

Cm.	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Sept. 2 .	–	–	–	–	6	2	3	2	2	2	3	2	–	1	–	–
,, 9 .	–	–	1	3	4	21	32	19	14	21	23	29	4	1	–	–
,, 15 .	–	–	4	3	11	22	21	27	34	43	35	31	23	7	2	–
,, 25 .	1	3	5	3	1	4	8	2	1	1	1	–	–	–	–	–

Small lemon dabs, though not quite so small, were also obtained in various hauls in the Firth of Forth and in the Clyde, the particulars of the measurements of which, arranged in ·5cm. groups, are given in Tables XIV., XV. In May, in the Forth, a collection of 68 ranged in length from 10cm. to 30cm., four groups being probably, but unequally, represented. In the most outstanding the majority of the fishes are grouped around 15cm. to 17cm., and they are thus a little larger than the corresponding May collection from the Solway, where, as was previously shown, plaice and dabs at all events grow more slowly than on the east coast. It would appear that these fish are entering their third year, the two-year-old fish being represented by the few of a smaller size. There is a second aggregation of lemon dabs between 23cm. and 30cm., but they not improbably represent at least two series. The figures, as arranged in centimetre groups, are these:—

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	1	1	1	6	8	11	2	1	1	1	2	1	2	6	4	4	4	6	4	1

A small collection was also obtained in August, but the number was scarcely sufficient to give a reliable clue to the growth. Arranged in centimetres, the measurements are these:—

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	3	–	2	2	2	1	3	1	3	5	3	6	1	–	1	–	–	–	1

The collections in the Clyde (Table XV.) were obtained in somewhat deep water in the neighbourhood of Ailsa Craig. In September, those taken numbered 79, and a curve of the measurements shows them mainly aggregated between 12cm. and 18cm., with a deeply-indented apex, the maxima being at 13cm. and 16cm., thus corresponding fairly closely to the collection from the Solway in the same month of the year. On the 5th October a number measured from 8cm. to 25cm., the mass being aggregated between 13cm. and 19cm., there also being an indentation in the curve at 15cm. The figures grouped in centimetres are these:—

8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	2	–	–	3	7	9	3	9	4	7	4	1	1	–	1	2	1	–	–

The collections from Aberdeen Bay were more numerous (Tables XIII., XIV). The largest was obtained on 21st August at the "Doghole," a

few miles off, in 58 fathoms of water, the specimens numbering 118. The measurements, arranged in centimetres, are as follows :—

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
2	3	2	2	2	1	1	6	7	5	10	13	3	3	5	4	6

27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
11	7	3	1	4	5	1	4	3	–	2	–	1	–	–	1	–

The curve shows at least five groups, though the lines are not very regular. The first comprises the fish up to about 15cm. The middle of the base is about 12cm. or 12·5cm. The next extends from 16cm. to to 22cm. or 23cm., the maximum number are at 21cm., and the middle of the base about 19cm. to 20cm. The third extends from 22cm. or 23cm. to 30cm., the greater numbers are at 27cm., and the middle of the base is about 26cm. or 26·5cm.

In hauls in July, on the 31st and 30th, that is about three weeks earlier, the same order of grouping can be made out, the measurements being as follows :—

11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	1	2	1	1	–	1	1	2	4	–	3	–	2	–	3	2	–

29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
6	4	7	6	3	5	4	3	5	7	5	4	6	4	1	2	–	1

In collections made in October, the first and second of the above indicated series are best shown. The following are the figures of the measurements, arranged in centimetres:—

	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
8th .	–	–	–	3	–	3	–	–	1	1	1	–	1	–	–	–	–	1	–	–	–	1	–
23rd .	–	–	–	4	2	1	3	3	1	–	5	1	2	3	–	3	–	–	–	–	–	–	2
31st .	1	–	2	2	2	1	3	2	4	1	–	–	–	–	–	–	–	–	–	–	–	1	2

There are also given in Table XIII. the measurements from a large number of hauls taken in the Moray Firth and Aberdeen Bay on two occasions, the first from 8th to 13th October, 1900, and the second from 31st October to 9th November in the same year. The curve formed by the former series shows two great aggregations, the first extending from about 15cm. or 16cm. to 27cm. or 28cm., and the second from the latter point to 41cm. In the former the maximum number are aggregated at 23cm. (9 inches), and in the latter they are aggregated at 36cm. ($14\frac{1}{4}$ inches), a difference of 13cm., or a little over 5 inches. It seems tolerably certain, however, that one or other of these, and probably both, aggregations comprise more than one annual series, though the very deep depression between the two cones is marked, and very distinct. The measurements at the beginning of November are less satisfactory, the curve formed being irregular. The second aggregation is poorly represented, but the first is well marked, but begins at 14cm., and the maximum number are at 18cm.; there is a well-marked depression at 27cm., much as in the curve of the measurements taken some weeks earlier. The figures arranged in centimetres for the two series of measurements are as follows:—

	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
(1) .	–	–	2	1	1	3	17	12	17	25	15	18	12	7	7	6	4	6	9
(2) .	1	4	3	11	16	21	25	14	12	14	13	11	10	10	8	2	7	7	10

	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
(1) .	11	9	20	31	31	47	27	20	22	15	4	11	1	1	–	–
(2) .	2	3	2	2	2	7	4	1	1	2	–	1	1	1	–	–

Larval and post-larval lemon dabs have been obtained at periods which correspond with the long spawning season. Thus, Cunningham records specimens of 10mm. and over taken in April, and specimens of this size are taken in May, while at the end of October they have been secured in considerable numbers measuring from 8mm. to 18mm. It is obvious that in the succeeding year, say in spring, the young lemon dabs derived from these would vary much in size. The early ones would have the full benefit of the favourable temperature throughout the whole year, while those of October would meet with the colder water in winter and have their growth retarded. Thus, a specimen caught by the "Garland" on 7th May, which measured 25mm., was no doubt derived from the preceding year, while specimens measuring 27mm. taken in August belonged to the same year.

Young lemon dabs in some number were got by Holt at the Humber in October and November, measuring from 2 to $3\frac{1}{2}$ inches, which might possibly have been derived from the spawning of that year, but the larger, at least, were more probably from that of the year before.

Cunningham, at the beginning of June, took small lemon dabs on the Essex coast from 3 to 5 inches long, and these were clearly at least one year old.

The evidence seems to me to justify the belief that the growth of the lemon dab is slow, and probably does not much, if at all, exceed 5cm. to 6cm. (2 to $2\frac{1}{2}$ inches) in a year. It is probable that the female does not spawn before the fourth year, though the prematurely mature specimens occasionally got* probably spawn at an earlier age, and may form a distinct variety.

LONG ROUGH DAB (*Drepanopsetta platessoides*, Fabr.).

Various collections of long rough dabs were measured, the total number being 3529, part of them being from the Moray Firth and part from Aberdeen Bay (Table XVI.). Including those dealt with in the previous paper, the aggregate number measured amounts to 20,261.

Several of the collections contained the very small series which are always in this species well separated from the older series, contrasting with the case of the lemon dab. The spawning period of the long rough dab extends from the end of January well into May, and is chiefly marked at the end of March and the beginning of April. Each year's brood have therefore the summer following for growth, and not, as in the lemon dab, part of them the summer and part of them the winter.

In three collections made in the Moray Firth the early group is well shown. The first was taken on 28th December in 30 fathoms, on the so-called witch ground off Burghead; the second on 23rd January, but somewhat further east off Kinnaird Head, in 50 fathoms; and the third on 1st April, in the neighbourhood of the place where the first haul was made, in from 30 to 32 fathoms.

In the December collection 73 fish belonged to this group; they ranged in length from 46mm. to 65mm. ($1\frac{13}{16}$–$2\frac{9}{16}$ inches) (the next largest in the collection being 85mm.), and the average length was 56·8mm., or $2\frac{1}{4}$ inches. In the January collection there were 57 specimens, ranging from 47mm. to 68mm. ($1\frac{7}{8}$–$2\frac{11}{16}$ inches) (the next largest being 86mm.), and the average computed size was 57·4mm., or $2\frac{1}{4}$ inches. The third collection contained 84 specimens of the class, varying in length from 47mm. to 70mm. ($1\frac{7}{8}$–$2\frac{3}{4}$ inches), and the average was 56·2mm., or almost $2\frac{1}{4}$ inches, the next largest in the collection being 89mm.

* See *Twenty-first Annual Report*, Part III., p. 48.

	Number of Fish.	Range in Length.	Average Size.
28th December 1903 .	73	46–65mm.	56·8mm.
23rd January 1904 . .	57	47–68mm.	57·4mm.
1st April 1904	84	47–70mm.	56·2mm.

As already stated, the locality of the collections in December and April were the same, and the facts show how much retarded the growth of this fish may be during winter.

In previous collections, described in my paper in the *Twentieth Annual Report*, numbers of these small long rough dabs were secured, and the average length in some cases may be referred to. The facts show that the growth of this somewhat deep-water fish does not materially differ in the north-eastern parts of the North Sea as compared with the Moray Firth. In the deep water off the Shetlands, on 31st August and 4th September, the average size was 48·3mm. and 48·4mm. On 16th–19th October it was 53·3mm.; on 11th December it was 54·4mm., and on 19th May 68·4mm. Off Aberdeen Bay, on 21st August, 11 specimens had an average length of 53mm.; on 16th December the average length of 116 specimens was 65·5mm. On 4th July, in from 83–85 fathoms, off Kinnaird Head, 146 had an average length of 98·3mm. ($3\frac{7}{8}$ inches). It is thus clear that the growth of this fish, as formerly remarked, is slow, and that when one year old its average length does not greatly exceed two inches.

In some of the collections the older groups are well indicated. In that of 28th December, off Burghead, the sexes were not completely separated, but in the lot of 23rd January they were. The females in the second series in this collection range in length from 92mm. to about 129mm. ($3\frac{5}{8}$–$5\frac{1}{16}$ inches), the average being about 112mm., or 11cm. ($4\frac{1}{4}$ inches). The males vary in size from 89mm. to 118mm. or thereabout, and the average size is a little over 10cm. (or 4 inches). The increase in length from the previous annual series is thus about 5·5cm., or $2\frac{1}{4}$ inches; in other words, the females at this stage grow about that more in the course of a year. The difference in the case of the males is less, viz., from 57mm. to about 103mm., or 4·5cm., a little over $1\frac{3}{4}$ inches.

The curve in this case shows a somewhat more rapid growth of the females than the males, the latter lagging behind, and the fact suggests that the males are approaching reproductive activity. I have shown before that males may be sexually mature when scarcely 5 inches (127mm.) long, and may show testes half developed when only $3\frac{1}{2}$ inches (89mm.) long. The date of this collection about coincides with the beginning of the spawning season, and is more than three months distant from its close, and thus probably some of the males would reach reproductive length during the spawning season. It is much more likely that the third series represented in the collection is the chief reproductive series. In it the males extend in length from 11·5cm. ($4\frac{1}{2}$ inches) to 16cm. or over ($6\frac{1}{2}$ inches), the average size being about 13·5cm. ($5\frac{1}{4}$ inches). This group is very nearly three years of age.

The females in the third series are widely separated from the second, so that, in the curve, the curve of measurements of the males of the third series is intercalcated in the gap between the curve for the second and third series of females—a usual circumstance among flatfishes at the

period when maturity is reached. The third series of females, which comprises the greater number of fishes, begins about 12·5cm. and appears to extend to 20cm. The cone in the curve is a wide one, and the apex, or point where the fish are chiefly aggregated, is at 16·5cm. ($6\frac{1}{2}$ inches).

The results may be stated in tabular form as follows :—

Group.	Sex.	Probable Age.	Range in Size.	Average Size.	Apparent Growth in Year.
I.	—	10 months.	47–68mm.	57·4mm.	57mm.
II.	♀	1 year and 10 months.	9–13cm.	11cm.	5·5cm.
	♂	,, ,,	9-12cm.	10cm.	4·5cm.
III.	♀	2 years and 10 months.	12·5–20cm.	16·5cm.	5·5cm.
	♂	,, ,,	11·5–16cm.	13·5cm.	3·5cm.

In the collection obtained on 1st April the sexes were also separated and measured in the older groups. In the second series, or those about two years old, the females extended in length from 89mm. to 126mm. ($3\frac{1}{2}$–$4\frac{15}{16}$ inches), the average being about 10·5cm., or $4\frac{1}{8}$ inches. This shows a rate of growth of about 5cm. (2 inches) from the previous year's fish. The males extended from about 9cm. to 11cm., ($3\frac{1}{2}$–$4\frac{3}{8}$ inches), the average length being about 10cm., or a little less, indicating a growth from the previous year's series of about 4·5cm. ($1\frac{3}{4}$ inches).

In the third group represented the females extend from 131mm. to apparently 210mm. ($5\frac{1}{8}$–$8\frac{1}{4}$ inches), the fish being mostly aggregated between 15cm. and 17cm., the apex of the curve being at 17cm. If the latter be taken as the mean size of the group, the growth from the previous series would be on the average about 6·5cm., or $2\frac{1}{2}$ inches, which is too large for this series. The presence of a small cusp at 15cm. leads one to suspect that this group is made up of two series.

The males of the third series are not numerous, and their size extends from about 11cm. to 15cm., the average length being approximately 13cm., or $5\frac{1}{8}$ inches; the amount of growth indicated in the year from the previous series being 3cm., or barely an inch and a quarter. In tabular form the particulars are these :—

Group.	Sex.	Probable Age.	Range in Size.	Average Size.	Apparent Growth in Year.
I.	—	1 year.	47–70mm.	56·2mm.	5·5cm.
II.	♀	2 years.	9–13cm.	10·5cm.	5·0cm.
	♂	,,	9–11cm.	10cm.	4·5cm.
III.	♀	3 years.	(13–21cm.)	(17)	(6·5cm.)
	♂	,,	11–15cm.	13	3cm.

Of the other collections whose measurements are given in the Tables, it may be said that in that taken on 13th May at the "Doghole," off Aberdeen, in 55 fathoms, in which case the sexes were separately dealt with, the younger series is imperfectly represented. A group beginning as to the females about 12cm. or 13cm. shows an aggregation at 14cm. and 14·5cm., the apex in the curve of the measurements being at 14·5cm., after which there is a drop to 15·5cm. and a subsequent rise, indicating that the third series in the collection of 1st April contains two series. This is rather confirmed by the position of the aggregation of the males, the apex of the curve being in the gap between, viz., at 15·5cm. The numbers, however, are not very large.

TURBOT (*Rhombus* (*Bothus*) *maximus*).

Observations as to the rate of growth of this important flat-fish leave much to be desired. The number measured by me, the measurements of which are given in Table XVII., was 212, but comparatively few of these refer to young fishes.

The spawning period is in summer, from about the middle of April to the early part of August, and is at its height in June. The larval turbot measures 2·2mm. to 2·8mm.; after the absorption of the yolk, in about a week, it measures 3·2mm. to 4·8mm., and metamorphosis is usually completed at about 27mm.*

The pelagic metamorphosing forms are got in August and September, and partly in July, and the young forms on the sands in September and later. Thus Cunningham notes the pelagic forms from early in August till 8th September, measuring from 15mm. to 37mm., and which he thought were about one month old, but are probably older.

M'Intosh refers to specimens of 21mm. to 28mm. in July and August, and of 41mm. to 62mm. on 7th September; on 18th September, three, respectively, 44mm., 48mm., and 55mm., were got by me at the mouth of the Don. M'Intosh records them 3 inches long (about 7·5cm.) in the middle of December, and this is the largest for the year of which I have noted a definite record.

From this time on to about the end of March it is almost certain the turbot grows little or not at all, as with other small flat-fishes in the same habitat.

In the spring of the next year the recorded sizes are as follows:—23rd May, $2\frac{3}{8}$ inches (60mm.), by M'Intosh; April 25th, 79mm.; May 16th, three at 68mm., 73mm., and 85mm., by Cunningham, who also says that from April to June, at Cleethorpes, they measure from 75mm. to 105mm. (3–$4\frac{1}{8}$ inches). I received one from the Solway Firth, taken on 23rd April, which measured 95mm., while another from the same locality, caught on 27th November, was 119mm. ($4\frac{3}{4}$ inches), and had no doubt passed through the second summer of its life.

The young turbot at or approaching one year of age is thus a very little fish, and probably ranges in size from about 70mm. ($2\frac{3}{4}$ inches) or less to about 105mm. ($4\frac{1}{8}$ inches).

A tank experiment of Cunningham's may be mentioned. In June he put into a tank a number of young turbot in the pelagic transforming stage; on the 19th October three, whose measurements are given, were 65mm., 95mm., and 99mm. respectively; on 4th April, in the next year, the one which survived was 108mm.

* Ehrenbaum, Nordisches Plankton, Vierte Lieferung, I. Eier und Larven von Fischen. Theil I., p. 199, Kiel und Leipzig, 1905.

I append a Table showing the occurrence of the small turbots in the various months of the year. The bracket shows the spawning period.

Cm.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	X	X	–	–	–	–
2	–	–	–	–	–	–	–	X	X	–	–	–
·5	–	–	–	–	–	–	–	X	X	–	–	–
3	–	–	–	–	–	–	–	X	X	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–	–	X	–	–	–
·5	–	–	–	–	–	–	–	–	XX	–	–	–
5	–	–	–	–	–	–	–	–	XX	B	–	–
·5	–	–	–	–	–	–	–	–	XX	–	–	–
6	–	–	–	–	X	–	–	–	XX	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	B	B	B	–	–	–	–	–	X
8	–	–	–	B	B	B	–	–	–	–	–	–
·5	–	–	–	B	B	B	–	–	–	–	–	–
9	–	–	–	B	B	B	–	–	–	–	–	–
·5	–	–	–	XB	B	B	–	–	–	–	–	–
10	–	–	–	B	XXX	B	–	–	–	–	–	–
·5	–	–	–	B	B	B	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	XXX	X	–	–	–	–	–	–
12	–	–	–	–	X	X	–	–	–	–	X	–
·5	–	B	B	B	XXX	X	–	–	–	–	–	–
13	–	B	B	B	XXX	X	–	–	–	–	–	–
·5	–	B	B	B	–	–	–	–	–	–	–	–
14	–	B	B	XB	XXX	XX	–	–	–	–	–	–
·5	–	XB	B	B	XX	–	–	–	–	–	–	–
15	–	B	B	B	XXXX	–	X	–	–	–	–	–
·5	–	–	–	–	XXX	X	–	–	–	–	–	–
16	–	–	–	–	X	XX	–	–	–	–	–	–
·5	–	–	–	–	–	XX	–	–	–	–	–	–
17	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	X	–	–	–	–	–	–
18	–	–	–	–	–	XX	–	–	–	–	–	–
·5	–	–	–	–	–	–	X	–	–	–	–	–
19	–	–	–	–	XX	–	XX	–	–	–	–	–
·5	–	–	–	–	–	X	–	–	–	–	–	–
20	–	–	–	–	XX	X	X	–	–	–	–	–
·5	–	–	–	–	–	X	–	–	–	–	–	–

In the salmon stake-nets at Montrose 52 young turbots were taken in May, June, and July, the measurements of which are given in inches in the Table subjoined (2), and as near as possible in centimetres in Table XVII.

The greater number were obtained in May, viz., 30, while 17 were got in June and 5 in July; perhaps an indication that the young turbot move further out with the rise in temperature.

From what has been stated above, it is probable that the smallest at 4 inches (101mm.) are turbot of the preceding year and are approaching their first year of age. Whether those at $4\frac{1}{2}$ to $4\frac{3}{4}$ inches (115mm. to 120mm.) in May are also fish of the preceding year, under one year of age, is not so clear. The curve formed by the May measurements appears to show the presence of four groups, and the first is separated from the second by a deep division at 13cm ($5\frac{1}{8}$ inches), and the second from the third at 17cm. to 18cm. (7 inches) The figures, in centimetres, are as follows:—

10	11	12	13	14	15	16	17		19	20	21	22	23	24	25	26	27	28
3	3	6	1	5	7	1	–	–	2	2	–	–	2	–	1	–	1	–

It does not appear to me altogether probable, judging from the facts given above, and those that follow from the older groups, that all the turbot up to 13cm. ($5\frac{1}{8}$ inches) are under one year of age. It will be observed that the young turbot are rather smaller than the young brill, and it must be borne in mind that the addition of a unit of length to a turbot means a much greater increase in growth than to any other fiat fish, owing to its breadth and thickness and its consequent greater proportional weight.*

If regarded provisionally as approaching their second year, then the next group, from 13cm. to 17cm. or 18cm. ($5\frac{1}{8}$ to 7 inches), must be looked upon as nearing their third year; the fourth group, from 17cm. or 18cm. to 22cm. (7 to $8\frac{3}{4}$ inches), as nearing their fourth year; and those from 22cm. to 26cm. ($8\frac{3}{4}$ to $10\frac{1}{4}$ inches) as approaching their fifth year.

TABLE 2.

Inches.	May.	June.	July.
4	3	–	–
¼	–	–	–
½	3	1	–
¾	1	1	–
5	5	2	–
¼	1	–	–
½	3	2	–
¾	2	–	–
6	7	–	1
¼	1	1	–
½	–	4	–
¾	–	–	–
7	–	3	–
¼	–	–	1
½	2	–	2
¾	–	1	–
8	2	2	1
¼	–	–	–
½	–	–	–
¾	–	–	–
9	1	–	–
¼	1	–	–
½	–	–	–
¾	–	–	–
10	1	–	–
¼	–	–	–
½	–	–	–
¾	–	–	–
11	1	–	–
¼	–	–	–

The possibility of each of these groups being a year younger must not be lost sight of; in any event, those of the latter size can scarcely be less than four years of age or near it.

Turning now to the collections which contain the larger fishes, we have some in October, November, December, and February, which are of interest. The measurements are given in Table XVII.

Although the numbers are not large in any instance, the arrangement and order of the figures are such as to lead to the supposition that the groups are of small dimensions.

The group above referred to, from the stake-nets, as extending from about 22cm. to 26cm., is represented by only a single specimen, at 23cm., taken in December at Burghead Bay. It is at the end of either its fourth or fifth summer.

*See *Twenty-second Annual Report*, Part III., pp. 144, 216.

The next series is represented in a collection from Aberdeen Bay in October, and in it there are ten turbot from 27·5cm. to 30cm. ($10\frac{3}{4}$–$11\frac{3}{4}$ inches), which are a year older.

The other series are shown in the Moray Firth collections in November, December, and February, the sizes ranging from 33cm. to 80cm. From Table XVII. it will be seen that a division appears to exist at 34–35cm., and it is probable that this group extends back at least to 30·5cm., as indicated in the October series.

The arrangement of the measurements in one-centimetre groups may be shown in the subjoined Table, in which column 4 summarises the figures for the three months, October, November, and December, and column 6 summarises them all:—

Cm.	1	2	3	4	5	6
	Oct.	Nov.	Dec.	Sum. of 1, 2, 3.	Feb.	Sum. of 1–5.
23	–	–	1	*1*	–	*1*
24	–	–	...	–	–	–
25	–	–	–	–	–	–
26	–	–		–	–	–
27	2	–	–	*2*	–	*2*
28	2	–	–	*2*	–	*2*
29	4	–	–	*4*	–	*4*
30	2	–	–	*2*	–	*2*
31	1	–	–	*1*	–	*1*
32	–	–	–	–	–	–
33	–	2	2	*4*	–	*4*
34	–	2	1	*3*	–	*3*
35	–	1	–	*1*	–	*1*
36	–	5	5	*10*	–	*10*
37	–	5	2	*7*	2	*9*
38	–	5	3	*8*	1	*9*
39	–	4	–	*4*	2	*6*
40	–	2	–	*2*	2	*4*
41	–	1	1	*2*	2	*4*
42	–	–	–	–	2	*2*
43	–	2	–	*2*		*2*
44	–	4	2	*6*	–	*6*
45	–	4	3	*7*	4	*11*
46	–	–	–	–	2	*2*
47	–	1	–	*1*	1	*2*
48	–	1	–	*1*	–	*1*
49	–	2	–	*2*	–	*2*
50	–	1	–	*1*	2	*3*
51	–	–	–	–	–	–
52	–	–	1	*1*	–	1

There appears to be evidence in this Table of the existence of at least five groups, and possibly six, if those turbot under 34cm. in November and December are regarded as separate from the October group. The points of probable separation of the groups, as shown in the ·5cm. grouping, are 34-35·5cm., 46cm., and 50cm., or 52cm.

The age of these turbot is considerable in any way the figures may be regarded. It is possible that they represent fish of $4\frac{1}{2}$, $5\frac{1}{2}$, $6\frac{1}{2}$, $7\frac{1}{2}$, $8\frac{1}{2}$, and $9\frac{1}{2}$ years of age; but they may be a year less, and, if the October group is looked upon as terminating at about 34cm. in November and December, the fishes above that size may be a year less still.

It, however, seems certain that turbot ranging from 35cm. to 41cm.

($13\frac{3}{4}$-$16\frac{1}{8}$ inches) are not under $5\frac{1}{2}$ years old, and that those about 50cm. (20 inches) are not under $7\frac{1}{2}$ years of age, while those between 40cm. and 46cm. (16-18 inches), when reproduction is supposed to commence, are at least $6\frac{1}{2}$ years old at the season of the year referred to, and may be a year, or possibly two years, older still.

It seems to me probable that the turbot does not spawn until it is at least seven years of age.

With reference to the slow rate of increase in length of the turbot, as thus indicated, the relatively great increment in weight must not be lost sight of. Thus a turbot of 44cm. ($17\frac{1}{4}$ inches) weighs about 1830 grammes, and one of 50cm. ($19\frac{3}{4}$ inches) weighs about 2700 grammes, while plaice of the same lengths weigh just about half—viz., about 950 and 1430 grammes respectively—and a female plaice of 44cm. is at least five years of age, and may be six. On the other hand, one would expect that the rate of increase of weight in the turbot would be greater than in the plaice, owing to its piscivorous habit and feeding.

BRILL *(Rhombus lævis).*

As with the turbot, so with this fish, the observations in respect to the rate of growth are not as complete as they might be. A considerable number of specimens were, however, measured, viz., 1182, and they appear to be satisfactory as regards certain groups (Table XVIII.).

The spawning period of the brill is about a month or so earlier than that of the turbot, extending from the end of March into July, the chief spawning taking place in May. The egg is larger than that of the turbot, varying according to Heincke and Ehrenbaum, from 1·24mm. to 1·46mm., and hatching occurs in twelve or thirteen days.

The smallest specimens in my collections were procured from Aberdeen Bay on 18th September, being taken on the beach at low tide by means of a push-net; they numbered six, and measured as follows:—38mm., 40mm., 47mm., 49mm., 51mm., and 54mm., or $1\frac{1}{8}$ to $2\frac{1}{8}$ inches. At the mouth of the Forth, on the 17th September, four specimens measuring 41mm., 54mm., 57mm., and 58mm., and another of 78mm., or a trifle over three inches, were obtained in another year. Other small specimens taken were as follows:—One at 41mm. ($1\frac{5}{8}$ inches), by the push-net in Lochfyne on 27th July; one measuring 51mm., on 27th July, by shrimp-net at Annan, and another in the same locality on 30th April which measured 80mm. ($3\frac{1}{8}$ inches). M'Intosh mentions specimens measuring from 22mm. to 29mm. in August, one of 24mm. on 25th July, and others from 50mm.-61mm. in September. Cunningham records 34 specimens measuring from 22mm. to 25mm., between 21st May and 11th June.

All the above, with the exception of the specimen taken in the Solway, measuring 82mm. ($3\frac{1}{4}$ inches), on 30th April, were no doubt derived from the spawning in the same year.

Other specimens which have been described, and which apparently belong to the spawning of the previous year, are as follows:—That referred to above, which was 82mm. long, on 30th April; one of 74mm. ($2\frac{13}{16}$ inches) taken on 4th May; one of 91mm. and another of 96mm. ($3\frac{3}{4}$ inches) taken on 25th April; one of 104mm. taken on 28th April; two on 15th June, measuring 89mm. and 104mm.; and two on 14th May, measuring 98mm. and 108mm. ($4\frac{1}{4}$ inches)—all of which are referred to by Cunningham. These specimens, together with some of the smaller individuals got in salmon stake-nets and referred to below, may be included in the following Table; the latter are represented by a small (x), the former by a large (X):—

Cm.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–
2	–	–	–	XXXXXX			–	XX	–	–	–	–
·5	–	–	–	XXXXXX			X	–	–	–	–	–
3	–	–	–	–	–	x	–	X	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	X	–	X X X	–	–	–
·5	–	–	–	–	–	–	–	–	X	–	–	–
5	–	–	–	–	–	–	X	–	XXX	–	–	–
·5	–	–	–	–	–	–	–	–	XXX	–	–	–
6	–	–	–	–	–	–	–	–	XX	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	X	–	–	–	–	–	–	–
8	–	–	–	X	–	–	–	–	X	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	X	–	X	–	–	–	–	–	–
·5	–	–	–	X	X	–	–	–	–	–	–	–
10	–	–	–	–	–	X xx	–	–	–	–	–	–
·5	–	–	–	X	–	X	–	–	–	–	–	–
11	–	–	–	–	X x	–	–	–	–	–	–	–
·5	–	–	–	–	x	xx	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	Xxxx	x	x	–	–	–	–	–
13	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–
14	–	–	–	–	x	x	X	–	–	–	–	–
·5	–	–	–	–	–	x	–	–	–	–	–	–
15	–	–	–	–	xxxx	xxxx	x	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–
16	–	–	–	–	x	x	–	–	–	–	–	–
·5	–	–	–	–	x	x	–	–	–	–	–	–
17	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–
18	–	–	–	–	x	x	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	x	–	–	–

The outstanding feature of the above Table is that a line drawn diagonally from the top left-hand corner (at January) to the bottom right-hand corner divides the small brill into two groups, an upper and a lower; and the inference is that those below the line in April, May, and June are a full year or more in age.

Before considering this Table further, reference may be made to some experiments by Cunningham in rearing young brill in tanks. He placed the 34 specimens, measuring from 22mm. to 25mm., taken between 21st May and 11th June, and above mentioned, in an aquarium. He computed their age to be about three weeks or a month. On 18th October following four of them were measured, and their length was found to be from 70mm. to 98mm. ($2\frac{3}{4}$-$3\frac{7}{8}$ inches), the growth of these four, in the 140 days or so that elapsed, amounting to about 60mm.—or, to give the extremes, to from 45mm. to 76mm. The author does not state anything as to the sizes of the others, except that on 4th October one measured 85mm.; nor is the temperature given, but it is obvious that the period comprised the chief season of growth. Other two of these brill were measured on 3rd April in the following year, and their lengths were respectively 84mm. and 88mm. ($3\frac{1}{4}$–$3\frac{1}{2}$ inches), giving an approximate increase from the beginning of June in the previous year, or in about 307 days, of only 6cm., or $2\frac{3}{8}$ inches. These fish were nearly one year old.

Cunningham suggests as a reason for the slow growth, which he thinks had been abnormally checked, that they were fed on marine worms and not on living fish; but it is much more likely that it was chiefly owing to the lowered temperature of the water in winter. I have already shown that small plaice at the same stage, which frequent the same habitat on

the beach, do not grow between October and April,* and that this is true also of larger plaice kept in tanks and supplied with water from the beach.

It is probable that the young brill, living on the margin of the sea, does not increase in length from November till the latter part of March.

In a subsequent year Cunningham records having placed some young brill in the pelagic transformation stage in tanks in June. On 19th October following three measured 80mm., 85mm., and 104mm., and on 4th April in the next year one was 113mm.†

Looking to the Table above given, it will be seen that under natural conditions the young brill in September may reach a length of 6cm. and even 8cm., while those taken in April of the following year may measure from 80mm. to 105mm.; in May they may be as small as 74mm., 96mm., and 98mm., and in June as small as 89mm., that is, when fully one year old.

Some years ago a record was kept at Montrose of small brill and turbot taken in May, June, and July in stake-nets, as previously mentioned. They were measured to fractions of an inch. The total number of brill was 53, and 30 of them were taken in May, 16 in June, and 7 in July. The particulars are set forth in the appended Table.

Inches.	May.	June.	July.
1	-	–	–
¼	–	1	–
½	–	–	–
¾	–	–	–
2	–	–	–
¼	–	–	–
½	–	–	–
¾	–	–	–
3	–	–	–
¼	–	–	–
½	–	–	–
¾	–	–	–
4	2	–	–
¼	–	–	–
½	2	2	–
¾	–	–	–
5	4	1	1
¼	–	–	–
½	2	1	–
¾	–	1	–
6	6	4	1
¼	–	1	–
½	2	1	–
¾	-	–	–
7	2	1	–
¼	–	–	–
½	1	–	–
¾	–	–	–
8	1	–	3
¼	–	–	1
½	–	–	–
¾	1	–	–
9	2	2	–
¼	2	–	–
½	2	1	1
¾	–	–	–
10	–	–	–
¼	–	–	–
½	–	–	–
¾	–	–	–
11	–	–	–
¼	1	–	–
½	–	–	–

* *Twentieth Annual Report*, Part III., p. 342.
† *Jour. M.B.A.*, II., p. 106; III., p. 272.

The smallest one was got on 19th June in St. Cyrus Bay; it measured $1\frac{1}{4}$ inches, or about 3cm., and belonged no doubt to the brood of the year. The next smallest were 4 inches, or about 10cm., and brill of this size were procured on 8th and 12th May, and doubtless represent the fish of the previous year, and would therefore be about one year old. At $4\frac{1}{2}$ inches (114mm.) four were taken, two on 4th and 5th May, and two on 5th and 6th June. The next size was five inches (127mm.), of which six were taken—four in May, one in June, and one in July (8th). At 6 inches (152mm.) there were eleven, six of which were obtained in May, four in June, and one in July. The largest brill secured was $11\frac{1}{4}$ inches, in May.

Looking down the column for May, the place where the first striking interval occurs is between 8 inches and $8\frac{3}{4}$ inches, or about 20cm. to 22cm.; but it is pretty certain that fish of this length, or even of $7\frac{3}{4}$ inches (19·5cm.) do not belong to the same series, which, as we saw, has individuals measuring as low as 74mm. in May.

The nature of the net by which the brill were taken must be borne in mind, practically all the very small fish and many of those of the sizes included in the Table no doubt escaping. It seems to me, considering the Table, the rate of growth of other flat-fishes, the much greater increase in weight or volume in the case of the brill than with the plaice, dab, &c., that the one-year-old group is represented in May by those at 4 inches (10·2cm.) and probably at $4\frac{1}{2}$ inches (11·5cm.); that those from 5 to 7 inches (12·7cm. to 17·8cm.), or perhaps to $7\frac{1}{2}$ inches (19·0cm.) are two years of age; those from 8 to $9\frac{1}{2}$ inches (20cm. to 24cm.)—and the group is obviously only partially present—are three years of age; while the brill at $11\frac{1}{4}$ inches (28·5cm.) is probably four years old.

It seems to me likely that the range of size of the one-year-old brill is from about 70mm. to about 115mm. ($2\frac{3}{4}$ to $4\frac{1}{2}$ inches), or perhaps a little less, with an average size of about 90mm. to 95mm. ($3\frac{1}{2}$ to $3\frac{3}{4}$ inches).

Attention may now be given to the catches made on board trawlers in the Moray Firth, the particulars in regard to which are given in Table XVIII. These hauls were limited to November, December, and February, and the collection in the latter month was a small one. In none of the cases were the sexes separated, the fish being too valuable to be opened for the purpose, and the collections under the various dates represent a series of hauls, all the brill taken having been measured. Some groups come out with distinctness, and the measurements may be grouped here in centimetres.

Cm.	November.			December.			All November Hauls.	All December Hauls.	Both Combined.	Burghead, 6th, 7th February.
	Dornoch, 9th–11th.	Burghead, 9th, 10th.	Combined.	Burghead, 25th, 26th.	Dornoch, 25th, 26th.	Combined.				
21	-	-	-	-	-	-	1	2	3	-
22	-	-	-	-	-	-	1	2	3	1
23	2	-	2	-	-	-	4	4	8	1
24	-	-	-	-	-	-	1	-	1	-
25	1	-	-	-	-	-	2	-	2	1
26	1	1	2	1	-	1	3	2	5	-
27	2	2	4	-	2	2	5	3	8	-
28	-	6	6	1	3	4	8	6	14	1
29	-	7	7	1	2	3	8	5	13	1
30	2	6	8	2	4	6	9	9	18	1
31	2	11	13	1	7	8	16	9	25	3
32	2	10	12	1	8	9	16	12	28	5
33	3	4	7	3	4	7	7	8	15	1
34	2	1	3	1	2	3	5	6	11	-
35	1	1	2	1	1	2	7	6	13	2
36	4	7	11	-	2	2	23	8	31	2
37	4	4	8	-	1	1	37	16	53	10
38	3	4	7	-	1	1	39	18	57	25
39	2	6	8	-	1	1	35	25	60	22
40	3	4	7	1	-	1	36	23	59	24
41	-	3	3	1	1	2	25	16	41	27
42	-	4	4	2	1	3	11	11	22	14
43	3	3	6	1	1	2	12	8	20	13
44	-	-	-	-	1	1	4	7	11	6
45	-	-	-	1	-	1	3	3	6	4
46	-	-	-	-	2	2	5	4	9	-
47	-	1	1	-	-	-	2	3	5	2
48	-	-	-	-	1	1	1	2	3	1
49	1	-	1	-	1	1	5	1	6	-
50	-	-	-	2	-	2	1	2	3	2
51	-	-	-	-	-	-	-	1	1	-
52	-	-	-	-	1	1	-	-	-	-
53	-	-	-	-	-	-	1	-	1	1
54	-	-	-	-	-	-	-	-	-	-
55	-	-	-	-	-	-	-	-	-	-
56	-	-	-	-	-	-	-	-	-	1
57	-	-	-	-	-	-	-	-	-	-
58	-	-	-	-	-	-	-	-	-	-
59	-	-	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	1	-	1	-
61	-	-	-	-	-	-	-	-	-	-
62	-	-	-	-	-	-	1	-	1	-

The curves formed by these figures combined indicate a great group, which includes the greater proportion of the brill between about 34cm. ($13\frac{1}{2}$ inches), where a division between groups is most distinct, and 42cm. or 43cm. (17 inches). Taking the larger combined series first, for all hauls in November and December, the group extends from 34cm. to 45cm., but the lower part of the descending line of the curve and its form indicate the probability that two groups are combined, the probable division being at 41cm. to 42cm. The great majority of the fishes are aggregated at 37cm. to 40cm., the largest number being at 39cm. and the next at 40cm. ($15\frac{1}{2}$–$15\frac{3}{4}$ inches).

In the November series the curve and its limits are much the same, the group beginning at 34cm., and it appears to terminate at 44cm. or 45cm.,

but more probably at 42cm. The fish are aggregated between the same limits, 37cm.–40cm., but the greatest number is at 38cm. (15 inches).

In the December series the lower limit is at 34·5cm.; the greater number of the fishes are at 39cm. and 40cm., most being at 39cm.; but the end of the group is not clear, the line falling gradually from 42cm. to 49cm.

The curve for the measurements of brill taken on 9th–11th November shows plainly a group beginning about 35cm., but the greater numbers of fish are at 36cm., after which the line of the curve falls more or less regularly to 41cm., then rising to 43cm., and falling thereafter; there are none between 43cm. and 47cm., but the numbers are not large.

The fish taken in the Dornoch on 9th–11th November show a group beginning about 35cm., and there is a similar fall at 41cm. to 42cm., and a rise to 43cm. In the hauls on 25th and 26th December this fall at 41cm. is also present. The curve of the measurements of the brill taken at Burghead on 21st–27th November show the group beginning at 33·5cm. or 34cm. and ending at 42cm., but there is a depression at 39·5cm. to 40cm.; most of the fish are aggregated between 37·5cm. and 40·5cm. In the brill taken in the early part of February the limits of the great mass are from about 34cm. or 35cm. to 44cm. or 45cm., but there are depressions at 39·5cm. and 42cm.; the greater number of the fishes are aggregated between 38cm. and 41cm., mostly at the latter (16 inches).

Comparison of the upper part of the cone of the curves, that is to say, the "modal" sizes, or the sizes at which the brill are most numerous, in the different periods, is indicated in the following Table:—

	Greatest Number Between.	Maximum.	Mean.
Burghead, November 9, 10 .	36–39	36	37·5
,, ,, 21–27 .	37–41	38	39
,, December 6–12 .	37–41	39	38·5
February 6–7 .	38–41	41	39·5
All November . . .	37–40	38	38·5
All December . . .	37–41	39	39·5

The next smallest series of brill shown in these collections ends where the last one begins, about 34cm. to 35cm. In all cases the measurements and curves indicate that the smaller fishes in the group are not fully represented. The fish are aggregated in greatest numbers at 31cm. to 32cm., which is larger than it ought to be by the limits of the group. The distances from the actual apex in the curves of the two groups, or the sizes of greatest frequency, are as follows, in centimetres:—

	Smaller Group.	Larger Group.	Apparent Annual Growth
November	31·5	38	6·5 (2⅝ in.)
December	32	39	7 (2¾ in.)
Together	32	39	7 (2¾ in.)
Burghead, November 9, 10, .	31	36	5 (2 in.)

The smaller group is well represented in the collection of 21st–27th November, but it is poorly shown in most of the others. It is obvious that the amount of growth in a year, as indicated in this comparison, is small.

The third or smallest group represented has its upper limit, as stated, about 24cm. ($9\frac{1}{2}$ inches), but the lower limit cannot be determined from these collections, the smallest specimens measuring only 21cm. (216mm.), or $8\frac{1}{2}$ inches, but it may be inferred from the consideration of the brill in the other collections.

The principal reason of the unequal representation of the three groups above referred to in the collections from the Moray Firth is no doubt the depth of water in which the trawling was carried on, $4\frac{1}{2}$ or 5 to 13 and more fathoms. The smaller brill frequent the shallower water, and thus the proportion taken of the larger members of the second series is greater than the proportion of the smaller members, while comparatively few of the third or smallest series were caught, and they were only the larger fishes of that series.

It appears to me that the size—or age-groups—of the brill in these collections may be represented as follows with approximate accuracy:—

	Inches.	Centimetres.
1 year old, . .	$2\frac{3}{4}$–$4\frac{1}{2}$	7·0–11·5
2 ,, ,, . .	5–$7\frac{1}{2}$	12–17·5, 18
3 ,, ,, . .	8–10	19, 20–24
4 ,, ,, . .	10–12	25–30
5 ,, ,, . .	12–14	30–35
6 ,, ,, . .	14–16	35–40
7 ,, ,, . .	16–$17\frac{1}{2}$	40–44

At the same time, it must be recollected that the sexes were not distinguished and separately measured, and, judging from the case in other flat-fishes, the growth of the males will be slower than that of the females after the size of maturity is reached, and it is thus possible that what appears to be an age-group after that size may only be a sex-group. But, from the remarkable agreement in the various collections, as shown by the aggregate or combined curves, and by the separate curves, as to the existence of a division between groups at 34cm. to 35cm., it is clear to me that this confusion does not exist below that point, but that the sexes so far grow equally; and, therefore, that sexual maturity is not reached either by males or females till a size above 34cm. to 35cm. ($13\frac{1}{2}$ to $13\frac{3}{4}$ inches), and that the great spawning group lies, in winter, between 35cm. and 41cm. or 42cm. (14 to 16, 17 inches), when they appear to be about six years old.

It may be added that the weight of a brill at a given length is much greater than with other flat-fishes, except the turbot.* The weight of a plaice about 39cm. is approximately 650 grammes; that of a brill about the same size is approximately 950 grammes. Thus the amount of growth of the brill by the increase of, say, 1cm. in its length is much more than in the plaice with a similar increase.

COD (*Gadus callarias*).

The number of cod measured and dealt with in the present paper, and belonging to 50 separate collections, is 3813, which, with those treated of in the paper published previously, makes a total of this species of 7176, most of which belong to the two or three first generations.

The main points brought out in the paper referred to were that the young cod of the year were on an average in October, when about six or

* See Tables in *Twenty-second Annual Report*, pp. 144, 219.

seven months of age, approximately $4\frac{3}{4}$ inches in length, the size varying from about 3 inches to about $7\frac{1}{2}$ inches, and in December they were of much the same size. It was estimated that the growth during the second year amounted to about 16·7cm., or a little over $6\frac{1}{2}$ inches; that the average size of a cod when about two years of age was approximately a little over 13 inches; when about three years old about 20 inches; and when four years old about 27 or 28 inches; and that though some might reach a size equal to that of sexually mature males when three years of age, the great majority, and perhaps all, would not spawn till they were about four years old.

Since the publication of my paper on the growth of the cod, in the Annual Report for 1900, a number of investigations have been made on the same subject, which may be briefly referred to.

Dr. Petersen gave an estimate of the growth, in Danish waters, as follows:—In its first year it is between 1 and 8 inches long; in its second between 10 and 18; in its third between 20 and 30; and in its fourth year 30 inches and longer; and he states that this rate of growth is somewhat similar to what is given by me in the above paper. Measurements are not given by Dr. Petersen, except in certain cases, viz., of fish taken at the end of March by line, and two groups are shown—first, one in which the first year has been completed, and which measure from about 9cm. to about 22cm. ($3\frac{1}{2}$–$9\frac{3}{4}$ inches); and second, a group which have completed two years, and measure approximately from 27cm. to 52cm. or 53cm. ($10\frac{5}{8}$–$20\frac{1}{2}$ inches), the maximum number in each group being massed about 15cm. or 16cm. (6–$6\frac{1}{4}$ inches) and 36cm. to 39cm. ($14\frac{1}{4}$–$15\frac{1}{2}$ inches); while cod above 52cm. or 53cm. ($20\frac{1}{2}$ inches) are described as of greater age.*

In several of his papers dealing with the Norwegian fishery investigations, Hjort has given an account of the rate of growth of the cod. A length of between 8cm. and 16cm. ($3\frac{1}{2}$–$5\frac{7}{8}$ inches) is assigned to it in its first year, and between 18cm. and 24cm. ($7\frac{1}{8}$–$9\frac{1}{2}$ inches) in the second summer of its life, when it is about $1\frac{1}{2}$ years old, which agrees with my results. In a table of measurements of cod taken on the south-west coast of Norway in August, the following sizes are shown:—(1) a group, about six months old, from 4 cm. to 13cm. ($1\frac{5}{8}$–$5\frac{1}{8}$ inches), most measuring 6cm. (2) A group, about $1\frac{1}{2}$ years old, from 16cm. to 30cm. ($6\frac{1}{4}$–$11\frac{3}{4}$ inches), and most about 25cm. ($9\frac{7}{8}$ inches). (3) A group, about $2\frac{1}{2}$ years of age, from 32cm. to 42cm. ($12\frac{5}{8}$–$16\frac{1}{2}$ inches). All these groups agree with my own determinations.†

In another work on Norwegian fisheries, Hjort, referring to the cod on the coast of Finmarken, distinguishes four age-groups:—(1) One year old, about 20cm. long ($7\frac{7}{8}$ inches). (2) When two years old, and known as "Finmarken cod" or "Lodde cod," and forming an important fishery on the Finmark coast, to which a length of 50cm., or $19\frac{3}{4}$ inches, is assigned. (3) A group, at least three years of age, comprising the largest cod, and forming the basis of the "Skrei" fishery, and measuring about 70cm. in length ($27\frac{1}{2}$ inches) ‡ It seems to me that the two last groups are probably too large; they do not, at least, agree with the rate of growth in the North Sea. No details of the measurements are furnished, except in a diagram, which shows the measurements of the Finmarken cod in April, and of the larger cod on the Malangsgrunden. A growth of 30cm. ($11\frac{3}{4}$ inches) in a year from the first to the second group seems excessive.

In another paper, Hjort refers to the Danish investigations on the "Thor," referred to below, and mentions that with the cod taken by the

* *Report of the Danish Biological Station, IX.*, pp. 4, 30.
† Hjort and Dahl, Fiskeforsög i Norske Fjorde, pp. 75, 77.
‡ Fiskeri og Hvalfangst i det Nordlige Norge, pp. 50-53.

"Michael Sars" between Finmarken and Bear Island, the following groups appeared to exist, though he states that the material at disposal was not abundant or sufficient to make the distinction between the groups very clear:—(1) One year old, 10cm. to 30cm. (4-11¾ inches); (2) 30cm. to 60cm. (11¾-23½ inches); (3) 60cm. to 90cm. (23½-35½ inches). Detailed measurements are not given.*

In connection with the Danish investigations at Iceland, Schmidt, in an important paper,† deals with the rate of growth of the cod, of which very large numbers were measured. His results at Iceland differ from those of other workers in other regions in certain respects. With the exception of the youngest group, the cod were taken on the east coast of the island, between Seydisfjord and Heradsfloi, with eel-seines, English trawls, and long-lines, in depths from 0-350 fathoms. The period was between 19th and 29th July, 1904. The youngest group, from 3cm. to 7cm., are not found in July on the east coast, and those of this series included in his tables and calculations as to age, were taken on 23rd August at Reykiarfjord, on the north coast, with an eel-seine in a few fathoms. These groups are as follows:—

Group.	Probable Age.	Range of Sizes.		Approximate Average Size.		Approximate Annual Growth.	
		Cm.	Inches.	Cm.	Inches.	Cm.	Inches.
1	½ year,	3–8	1¼-3⅛	5	2		
2	1½ years,	9–17	3½-6¾	11 or 12	4½	6·5	2 9/16
3	2½ ,,	18–30	7⅛-11¾	22	8¾	10·0	3 15/16
4	3½ ,,	30–45	11¾-17¾	33 or 34	13¼	11·5	4½
5	4½ ,,	45–81	17¾-32	61	24	27·5	10¾
6	5½ ,,	81–105	32-41½	88	34¾	27·0	10⅝

It will thus be seen that the growth of the cod at Iceland, according to these results, is abnormally slow in the early stages. That a small cod should grow only 2½ inches in a year, and reach an average length of only 4½ inches in the middle of its second summer, is remarkable, while the increase to the third summer is only 4½ inches. These Iceland cod, when approximately 3½ years of age, correspond to the cod in Scotland which are scarcely more than two years old. In the next year, to the middle of the fourth summer, the increase is very much greater—viz., about 10¾ inches; and the increase to the following summer, when they are supposed to be about 5½ years old, is also over 10 inches. The difference between these groups is brought out more strongly when the mean weight is considered, as well as the length of the fish. These are as follows, according to the Tables I published in the Report for 1903‡:—

* Bericht über die Thätigkeit der Kommission A. August, 1902—Februar, 1904; p. 51.

† Fiskeriundersögelser ved Island og Færöerne i Sommeren, 1903, pp. 62 *et seq.*

‡ *Twenty-second Annual Report, Part III.* "The Relation of Length to Weight," pp. 142, 229. I may take this opportunity of pointing out that Dr. Kyle, in his excellent paper on small plaice, "First Report on the Statistical Material received by the Bureau regarding the Quantities of Small Plaice landed in the Various Countries" (Conseil Permanent International pour L'Exploration de la Mer, *Rapports et Procès-Verlaux*, etc., Vol. IV.; Juillet 1904–Juillet 1905 (1905, p. 50), has, by an oversight, referred to my determinations as showing the fish at every 5 centimetres of length, instead of every 0·5 centimetre.

$\frac{1}{2}$ Year,	-	1·04 grammes,	or		$\frac{1}{27}$ oz.
$1\frac{1}{2}$,,	-	13·1	,,	,,	$\frac{1}{2}$,,
$2\frac{1}{2}$,,	-	97·4	,,	,,	$3\frac{1}{2}$,,
$3\frac{1}{2}$,,	-	380·7	,,	,,	$13\frac{1}{2}$,,
$4\frac{1}{2}$,,	-	2129	,,	,, 4 lbs.	$11\frac{1}{4}$,,
$5\frac{1}{2}$,,	-	7000	,,	,, 15 lbs.	$10\frac{3}{4}$,,

The spawning period at Iceland is much the same as in the North Sea, and Dr. Schmidt found that the cod of the last group, with an average size of 88cm., and ranging from "a little under 70cm. and upwards," in July, had spawned in the spring, while those of the group, with an average of about 60cm. (24 inches), would spawn for the first time in the following year.

It may seem to one possible that the second group of small cod, with an average size of $4\frac{1}{2}$ inches, might have been spawned in the spring of the year, and that the smaller fish, taken on the north coast, have a different rate of growth there. It must be remembered, however, as Dr. Schmidt has so well shown, that the physical conditions, as temperature, vary very much at different parts of the coast of Iceland, and that the life and wanderings of the cod are influenced thereby. He, moreover, gives a table showing the growth of young cod at one place (Seydisfjord), and all taken in this case with one apparatus, the eel-seine, between 23rd May and 17th–23rd September, 1903. On 23rd May 180 measured from 7cm. to 11cm., with an average of about 9cm. ($3\frac{1}{2}$ inches); on 23rd July 3300 measured from 10cm. to 17cm. (4–$6\frac{3}{4}$ inches), the average size being placed by him at 12cm. ($4\frac{3}{4}$ inches), though it might perhaps be better at 13cm.; on 17th–23rd September 1350 measured from 13cm. to 20cm. ($5\frac{1}{8}$–$7\frac{7}{8}$ inches), the average being at 16cm. ($6\frac{1}{4}$ inches). The first group thus grew about 3cm. ($1\frac{1}{4}$ inches) in the two months May–July; in the two months from July to September the growth amounted to 4cm ($1\frac{1}{2}$ inches), and in the whole period of four months it amounted to 7cm., or $2\frac{3}{4}$ inches. In the September collection, moreover, 30 much smaller cod were obtained, measuring 4cm. and 5cm. ($1\frac{1}{2}$–2 inches), and relating these to the older group, and taking their average size at 4cm., the growth over the winter would amount to only 5cm., or 2 inches, and from September to September it amounted to about 12cm., or $4\frac{3}{4}$ inches. These fish were caught between the shore and 5 fathoms depth.

A collection made with the eel-seine, from the shore to $6\frac{1}{2}$ fathoms, on 9th September, 1903, at Vaagfjord, Suder, in the Færöes, showed three groups:—(1) The young of the same year, 277 in number, measuring from 4cm. to 12cm. ($1\frac{3}{4}$–$4\frac{3}{4}$ inches), with an average size of about 7cm. ($2\frac{3}{4}$ inches); (2) a group of 87, measuring from 17cm. to 31cm. ($6\frac{3}{4}$–$12\frac{1}{4}$ inches), about $1\frac{1}{2}$ years old, or more, and with an average size of about 25cm. ($9\frac{3}{4}$ inches); (3) a group of 5 cod, from 37cm. to 41cm. ($14\frac{1}{2}$–$16\frac{1}{8}$ inches). These results agree well with my own, and show an increase in the year of about 18cm. ($7\frac{1}{8}$ inches).

Recently a good deal of attention has been given, especially by German investigators, to the growth of fishes as indicated by the markings on the bones, otoliths, and scales. Mr. Stuart Thomson investigated the age of cod by means of the markings on the scales. The specimens were taken on 26th August, and measured 20·9cm. ($8\frac{1}{4}$ inches) and 25·1cm. (9·9 inches), and the age determined in each case was about one year and 4–5 months; the fish were thus well on in their second summer's growth. The result agrees with those obtained by me, as Mr. Thomson points out; they tally almost exactly with the collection on 22nd August, referred to in the Table below.

Most work of this kind, by making use of the hard structures of fish as a guide to their probable age, has been done by Professor Heincke and his coadjutors at the Biological Institute of Heligoland. The results are not yet fully published, but Professor Heincke has given some of his conclusions in two recent publications.* The investigation was made on the cod on the German coast and at Heligoland, a fact to be kept in mind, as it is possible that on the shallow coast on the other side of the North Sea, where the saltness of the water is less than on this side, the cod grow less quickly than they do on the western side, as appears to be the case in the Baltic. Heincke estimates the size of the cod in the southern part of the North Sea as follows:—

Year.	Range of Sizes.		Average Size.		Increase.
	Cm.	Inches.	Cm.	Inches.	Cm.
In first year, - -	8–18	$3\frac{1}{8}$–$7\frac{1}{8}$	14	$5\frac{1}{2}$	
In second year -	—	—	about 27	$10\frac{5}{8}$	13
In third year, - -	—	—	,, 35–40	$13\frac{3}{4}$–$15\frac{3}{4}$	10
In fourth year, -	—	—	,, 45–50	$17\frac{3}{4}$–$19\frac{3}{4}$	10

He says they have learned from a study of the bones that a cod of 50cm. ($19\frac{3}{4}$ inches) "has lived at most four complete years, and we believe—provisionally—that the cod does not spawn for the first time until it has lived four complete years, probably at the end of its fifth, at latest the sixth year." And, again, in the later paper, that it does not become sexually ripe until the completion of the fourth year, and perhaps only after the completion of the fifth year, when the average size is between 55cm. and 60cm. ($21\frac{5}{8}$–$23\frac{1}{2}$ inches).

After spawning, the rapidity of growth diminishes, as in other fishes, so that a cod of 75cm. ($29\frac{1}{2}$ inches) is at least 7 years, and probably 8–9 years old; one of 85cm. ($33\frac{1}{2}$ inches) at least 8, and probably 9 or 10 years old, and one of 100cm. at least 10, and probably 12 or more years of age. Young cod, under one year of age, were found to grow in the aquarium at Heligoland, when well fed, not less than 1mm. daily (or at a rate of about $1\frac{1}{2}$ inches a month) from the beginning of August to the middle of September, and from the middle of September to the end of October $\frac{1}{2}$ to $\frac{1}{3}$ of a millimetre daily; and it is stated that growth in the open sea would certainly be greater. As stated in my previous paper, a cod of $11\frac{3}{4}$ inches in the tank at the Laboratory at Aberdeen grew to $12\frac{7}{8}$ inches between 28th August and 26th September, or at the rate of a millimetre per day.

Mr J. T. Cunningham has also studied the rate of growth or age of cod by the markings on the hard structures, but his conclusions do not quite agree with those of Professor Heincke, and he differs also as to the structures best fitted to show the growth.† Professor Heincke found the otoliths and scales much less satisfactory than the bones, and particularly the coracoid and scapula, especially in the cod, "which, for the rest," he says, "is one of the most difficult species on which to determine the age." On the other hand, Cunningham found these bones and others of the cod unsuitable for the determination of the age, it being impossible, he says, to distinguish with certainty the annual rings or zones. Speaking of the

*"The Occurrence and Distribution of the Eggs, Larvæ, and Various Age-Groups of the Food-Fishes in the North Sea." Conseil Perm. Intern. pour L'Explor. de la Mer. General Report on the Work of the Period, July, 1902–July, 1904, p. 29, 30; Die Beteiligung Deutschlands an der Internationalen Meeresforschung, III. Jahresbericht, p. 75.

† *Twenty-third Annual Report Fishery Board for Scot.*, Part III., p. 131 *et seq.*

zones of the vertebræ, he says "one may count three at one time, and at the next attempt there seem to be four or five, and the total number always remains doubtful and uncertain." He found that tranverse slices of the otoliths showed the markings much better, and he chiefly used them in determining the age of the specimens of cod he studied. Here are some of the results, though doubt is expressed as to the certainty of the determination in some cases :—

Caught 9th November.			Caught 9th March.		
Length.		Probable Age.	Length.		Probable Age.
Cm.	Inches		Cm.	Inches.	
47	$18\frac{4}{5}$	about $2\frac{1}{3}$ years	24·3	10	2 years
54	$21\frac{3}{5}$	$3\frac{1}{2}$,,	30·5	$12\frac{1}{2}$	2 ,,
64	$25\frac{3}{5}$	$3\frac{1}{2}$,,	30·7	$12\frac{1}{4}$	2 ,,
		possibly $2\frac{1}{2}$,,	33·5	$13\frac{2}{5}$	2 ,,
73	$29\frac{1}{5}$	$3\frac{1}{2}$,,	44·3	$17\frac{3}{4}$	3 ,,
			45·6	$18\frac{1}{4}$	3 ,,
			67·5	27	4 ,,

According to these later results, Mr. Cunningham says, the cod at two years of age is 10 to 13 or 14 inches in length, at three years 17 to 19 inches, at four years 27 inches; but, he adds, it would require the examination of a large number of specimens to ascertain the average and range of sizes at these ages. So far as these results go, they are in agreement with my own derived from the method of measuring the fishes.

Lately Dr. S. Strodtmann published a paper on the spawning and migrations of fish in the Baltic, which contains some observations on the growth of young cod, taken in Travemünder Bucht.*

A series numbering 555, taken on 15th October, 1904, measured from 5cm. to 16cm. (2–$6\frac{1}{4}$ inches), the average being 10·0cm., or barely 4 inches. A month later, November 14th, 743 ranged from 5cm. to 15cm., the average being 10·5cm. On December 12th, 333 measured from 7cm. to 19cm ($2\frac{3}{4}$–$7\frac{1}{2}$ inches), the average being 13·5, or $5\frac{3}{8}$ inches. At the beginning of March in the following year they ranged from 9cm. to 17cm., and numbered 75, the average size being 12·8cm., and at the beginning of April 123 ranged from 9cm. to 17cm., the average being 13cm., or $5\frac{1}{8}$ inches. These results agree closely with my own. On September 9th, 84 measured between 16cm. and 30cm. ($6\frac{3}{8}$–$11\frac{3}{4}$ inches), the average being 21·5cm. ($8\frac{1}{2}$ inches), which is also near what will be found in the Tables appended.

It will be noticed that the young cod in December are rather larger than in either March or April, while from November to December they appear to have grown 3cm., which Dr. Strodtmann considers to be improbable at that season. In the course of the summer they increased by 8·5cm., or $3\frac{3}{8}$ inches. He compares the growth at the place indicated with the growth of young cod at Büsum, on the North Sea, and shows that the latter at the beginning of October had a greater range of size and a larger average size than in the Baltic at the middle of the month. The Baltic fish ranged from 5cm. to 15cm., according to the diagram, the average being 10cm., while the North Sea cod ranged from 5cm. to 16cm. or 17cm., and the average was 12cm. or 13cm. ($4\frac{3}{4}$–$5\frac{1}{8}$ inches. At Aberdeen in the same month the average was 12cm. also.

In the Tables appended to this paper will be found the measurements of the cod I have dealt with, grouped into centimetres, and the following

**Laichen und Wandern der Ostseefische*, p. 209.

Tables show details of these and the arrangement into the various series or generations. In some cases, where the number of cod in the collections was fairly large, the distinction of one group from another was tolerably easy, especially when the millimetre measurements and tables were consulted as well as the diagrams or curves. All the measurements were made to millimetres, and curves were constructed of each collection. In other cases, the division of one series from another is only approximate, and one or two or several fish may belong to one or the other. For example, in the collections from Aberdeen Bay, the chief group in July might terminate at 32cm. or 34cm. instead of at 28cm., so far as these measurements by themselves indicate; but this interpretation would be opposed to the limits of the group later in the year. It will be often found, as in the July collections, that a few fish at the end of what may appear to be a compact series are considerably larger than the others and separated from them by a good interval; and it is difficult to decide whether they should be looked upon as stragglers from that series—fish which have grown much quicker than their fellows—or stragglers from the next larger series, which may not be well represented.

COD.

Date.	Group	No.	Range of Size.		Modal Size.	Approximate Mean Length		Approximate Age.		Apparent Growth from Preceding Series.	
			Cm.	Inches.		Cm.	Inch.	Years	M'ths.	Cm.	Inch.
I.—Aberdeen Bay—											
January 15, 1902 -	I.	7	9·7–16·2	$3\frac{13}{16}$–$6\frac{3}{8}$	9–11	12·5	5	..	$9\frac{1}{2}$	..	..
	II.	15	26–40	$10\frac{1}{4}$–$15\frac{3}{4}$	30	31–32	12–$12\frac{1}{2}$	1	$9\frac{1}{2}$	19	$7\frac{1}{2}$
	III.	3	48–59	19–23	..	..	..	2	$9\frac{1}{2}$	..	..
February 11, 1905, -	I.	16	8–17	$3\frac{1}{8}$–$6\frac{3}{4}$	9–10	12·5	5	..	$10\frac{1}{2}$	..	..
March 29, 1905 - -	I.	6	9–19	$3\frac{1}{8}$–$7\frac{1}{2}$	..	13·5	$5\frac{3}{8}$	1	..	..	..
May 13, 1902, - -	II.	5	14–20·7	$5\frac{1}{2}$–$8\frac{1}{8}$	..	..	..	1	$1\frac{1}{2}$	..	..
	III.	5	27–34	$10\frac{5}{8}$–$13\frac{3}{8}$	..	..	..	2	$1\frac{1}{2}$	..	..
June 13, 1901, - -	II.	31	14·3–23	$5\frac{5}{8}$–$9\frac{1}{16}$	18	18·5	$7\frac{1}{4}$	1	$2\frac{1}{2}$	..	..
June 28, 1901, - -	II.	19	19–26	$7\frac{1}{2}$–$10\frac{1}{4}$	21	22	$8\frac{5}{8}$	1	3	..	..
	..	2	29–36	..	..	..	..	2	3	..	..
	..	6	54–60	$21\frac{1}{4}$–$23\frac{1}{2}$	..	..	..	..	..	..	..
July 30, 1901, -	I.	1	6·5	$2\frac{9}{16}$	..	..	..	..	4	..	..
	II.	43	16·7–28	$6\frac{5}{8}$–11	23	23	$9\frac{1}{16}$	1	4	..	..
	III.	26	29·3–46	$11\frac{9}{16}$–$18\frac{1}{8}$	..	..	..	2	4	..	..
	..	1	49·8	..	..	..	..	..	..	..	..
July 31, 1901, - -	II.	32	16·7–27·9	$6\frac{5}{8}$–11	19–23	22·5	$8\frac{7}{8}$	1	4	..	..

COD.—*continued.*

Date.	Group	No	Range of Size.		Modal Size.	Approximate Mean Length		Approximate Age.		Apparent Growth from Preceding Series.	
			Cm.	Inches.		Cm.	Inch.	Years	M'ths.	Cm.	Inch.
1.—Aberdeen Bay—*continued.*											
August 21, 1901 - -	I.	18	6·5–8·8	$2\frac{9}{16}$–$3\frac{1}{2}$	8	7·7	3	..	$4\frac{1}{2}$	..	..
	II.	85	18·7–32·3	$7\frac{3}{8}$–$12\frac{3}{4}$	22	23·5	$9\frac{1}{4}$	1	$4\frac{1}{2}$	15·8	$6\frac{1}{4}$
	III.	12	36·4–48·7	$14\frac{1}{4}$–$19\frac{1}{8}$	..	..	..	2	$4\frac{1}{2}$	..	..
	..	6	51·3,53	..	..	..	..	3	$4\frac{1}{2}$	..	..
	..	..	58·5	..	..	..	..	..	..	..	..
	..	..	60·8 61,63	..	..	..	..	..	..	..	..
September 3, 1901, -	II.	93	18·4–32	$7\frac{1}{4}$–$12\frac{5}{8}$	25	25	$9\frac{7}{8}$	1	5	..	..
	III.	8	39·4–45	$15\frac{1}{2}$–$17\frac{3}{4}$	..	..	..	2	5	..	..
	IV.	6	50–61	$19\frac{3}{4}$–24	..	..	..	3	5	..	..
September 4, 1901, -	I	14	22·3–32	$8\frac{3}{4}$–$12\frac{5}{8}$	25	..	..	1	5	..	..
September 4. 1901, -	II.	24	20·7–29·9	$8\frac{1}{8}$–$11\frac{3}{4}$	25	..	..	1	5	..	..
September 4, 1901, -	I,	1	8·3	$3\frac{1}{4}$	..	..	..	..	5	..	..
	II.	29	19·4–29·8	$7\frac{5}{8}$–$11\frac{3}{4}$	25, 27	..	..	1	5	..	..
September 4, 1901, -	I.	1	8·3	$3\frac{1}{4}$	..	..	..	..	5	..	..
(Three hauls combined.)	II.	67	19·4–32	$7\frac{5}{8}$–$12\frac{5}{8}$	25	25	$9\frac{7}{8}$	1	5	..	..
September 10, 1901, -	I.	41	6·0–15·3	$2\frac{3}{8}$–6	9	9·5	$3\frac{3}{4}$	..	$5\frac{1}{2}$	..	..
	II.	7	18·1–29·3	$7\frac{1}{8}$–$11\frac{9}{16}$	..	..	..	1	$5\frac{1}{2}$	..	..
September 3–10, 1901,-	I.	42	6·0–15·3	$2\frac{3}{8}$–6	9	9·5	$3\frac{3}{4}$	..	5–$5\frac{1}{2}$	..	..
(Combined.)	II.	167	18·1–32	$7\frac{1}{8}$–$12\frac{5}{8}$	25	25	$9\frac{7}{8}$	1	..	15·5	$6\frac{1}{8}$
	III.	8	39·4–45	$15\frac{1}{2}$–$17\frac{3}{4}$	..	..	..	2	..	..	..
	IV.	6	50–61	$19\frac{3}{4}$–24	..	..	..	3	..	..	..
October 18, 1901 - -	I.	75	7·8–19·9	$3\frac{1}{16}$–$7\frac{7}{8}$	12	12	$4\frac{3}{4}$	..	$6\frac{1}{2}$	..	..
	II.	37	22·2–35·8	$8\frac{3}{4}$–$14\frac{1}{8}$	26	28·5	$11\frac{1}{4}$	1	$6\frac{1}{2}$	16·5	$6\frac{1}{2}$
	..	2	51·8–56·0	..	..	..	..	..	..	..	..
October 31, 1903, -	I.	21	4·8–15·7	$1\frac{7}{8}$–$6\frac{3}{16}$	9 & 11	12	$4\frac{3}{4}$	..	7	..	..
	II.	13	22·7–36·0	$8\frac{15}{16}$–$14\frac{3}{16}$	25–27	29	$11\frac{7}{16}$	1	7	17	$6\frac{3}{4}$
	III.	5	39·5–53·3	$15\frac{1}{2}$–$21\frac{1}{4}$	..	..	..	2	7	..	..
	..	1	55·7	..	..	..	..	..	..	..	..
	..	5	69·6–77·8	$27\frac{3}{4}$–$30\frac{1}{2}$	..	..	..	..	..	..	..

COD—*continued.*

Date.	Group	No.	Range of Size.		Modal Size.	Approximate Mean Length		Approximate Age.		Apparent Growth from Preceding Series.	
			Cm.	Inches.		Cm.	Inch.	Years	M'ths.	Cm.	Inch.
I.—Aberdeen Bay—*continued*–											
November 5, 1901, -	II.	20	26·7–35·9	$10\frac{1}{2}$–$14\frac{1}{8}$	30	30·5	12	1	7	..	..
	III.	5	46·4–52	$18\frac{1}{4}$–$20\frac{1}{2}$	..	..	..	2	7	..	..
	..	2	56·8–57·4	..	..	..	..	..	..	..	..
November 6, 1901, -	I.	301	8·6–19·0	$3\frac{3}{8}$–$7\frac{1}{2}$	11	12	$4\frac{3}{4}$	..	7	..	..
November 5 and 6, -	I.	301	8·6–19·0	$3\frac{3}{8}$–$7\frac{1}{2}$	11	12	$4\frac{3}{4}$	..	7	..	..
(Combined.)	II.	20	26·7–35·9	$10\frac{1}{2}$–$14\frac{1}{8}$	30	30·5	12	1	7	18·5	$7\frac{1}{4}$
November 28, 1901 -	I.	1	18·7	..	..	..	..	..	8	..	..
	II.	43	23·8–38·1	$9\frac{3}{8}$–15	31	32	$12\frac{5}{8}$	1	8	..	..
	III.	12	39·7–53·8	$15\frac{5}{8}$–$21\frac{1}{4}$	..	[47	$18\frac{1}{2}$]	2	8	[15	$5\frac{7}{8}$]
November 29, 1901 -	I.	37	7·8–20·7	$3\frac{1}{16}$–$8\frac{3}{16}$	10	10 [13	$3\frac{13}{16}$ $5\frac{1}{8}$]	..	8	..	..
	II.	135	21·8–38·3	$8\frac{5}{8}$–$15\frac{1}{16}$	31	31	$12\frac{1}{4}$	1	8	18	$7\frac{1}{8}$
	III.	21	39·2–57·3	$12\frac{7}{16}$–$22\frac{1}{2}$	..	[47	$18\frac{1}{2}$]	2	8	16	$6\frac{1}{4}$
November 28 and 29, -	I.	38	7·8–20·7	$3\frac{1}{16}$–$8\frac{3}{16}$	10	[13	$5\frac{1}{8}$]	..	8	..	..
(Combined.)	II.	178	21·8–38·3	$8\frac{5}{8}$–$15\frac{1}{16}$	31	31	$12\frac{1}{4}$	1	8	18	$7\frac{1}{8}$
	III.	33	39·2–57·3	$15\frac{7}{16}$–$22\frac{1}{2}$	..	[47	$18\frac{1}{2}$]	2	8	16	$6\frac{1}{4}$
December 16, 1901 -	I.	18	8·3–20·8	$3\frac{1}{4}$–$8\frac{3}{16}$	10	13	$5\frac{1}{8}$	..	$8\frac{1}{2}$	..	..
	II.	70	23–41·8	9–$16\frac{3}{8}$	32	32	$12\frac{5}{8}$	1	$8\frac{1}{2}$	18	$7\frac{1}{8}$
	..	1	51	..	..	..	..	..	..	..	..
December 12, 1904 -	II.	16	31·9–42·2	$12\frac{1}{2}$–$16\frac{5}{8}$	..	..	..	1	$8\frac{1}{2}$	..	..
	III.	35	43·7–61·6	$17\frac{1}{4}$–$24\frac{1}{4}$	..	[49·5	$19\frac{1}{2}$]	2	$8\frac{1}{2}$	..	..
	IV.	33	66·3 66·9–67·1	26–$26\frac{1}{4}$	..	..	..	3	$8\frac{1}{2}$	..	..
II.—Moray Firth.											
Dornoch Firth—											
February 9, 1905, -	I.	7	8·5–16·2	$3\frac{3}{8}$–$6\frac{3}{8}$	..	..	..	..	10	..	..
June 9, 1903, - -	I.	25	3·3–4·8	$1\frac{5}{16}$–$1\frac{7}{8}$	3·5	4·0	$1\frac{9}{16}$	..	$2\frac{1}{2}$	..	..
October, 22, 1903, -	I.	3	6·6–9·8	$2\frac{5}{8}$–$3\frac{7}{8}$	..	..	..	..	7	..	...
	II.	2	21·9–31	$8\frac{5}{8}$–$12\frac{3}{16}$	..	..	..	1	7	..	..
	III.	3	42·3–47·4	$16\frac{5}{8}$–$18\frac{5}{8}$	..	..	..	2	7	..	..

COD—*continued.*

Date.	Group	No.	Range of Size.		Modal Size	Approximate Mean Length		Approximate Age.		Apparent Growth from Preceding Series	
			Cm.	Inches.		Cm.	Inch.	Years	M'ths.		
II.—Moray Firth—*cont.*										Cm.	Inch.
November 9–10, 1901, -	I.	78	9·7–19·1	$3\frac{13}{16}$–$7\frac{1}{2}$	12	12·5	$4\frac{15}{16}$	..	$7\frac{1}{2}$	..	..
	II.	113	20·7–36·7	$8\frac{1}{8}$–$14\frac{7}{16}$	25	27·5	$10\frac{13}{16}$	1	$7\frac{1}{2}$	15	$5\frac{7}{8}$
	III.	4	43·3–52·8	17–$20\frac{3}{4}$	..	..	..	2	$7\frac{1}{2}$	..	..
November 12, 1903 -	I.	4	12·5–20·5	$4\frac{15}{16}$–$8\frac{1}{16}$	..	..	.	..	$7\frac{1}{2}$	..	..
	II.	6	25·7–34·3	$10\frac{1}{8}$–$13\frac{1}{2}$	..	..	.	1	$7\frac{1}{2}$	..	..
	III.	16	44·8–61·0	$17\frac{5}{8}$–24	..	..	.	2	$7\frac{1}{2}$	..	..
	IV.	10	66·4–76	$25\frac{1}{2}$–30	..	..	..	3	$7\frac{1}{2}$	..	..
	V.	10	79–89	31–35	..	..	..	..	..	..	..
	..	3	97, 105, 106	..	..	..	..	..	..	..	..
December 7, 1904, -	I.	13	7·7–11·9	3–$4\frac{3}{4}$	..	..	..	..	8	..	..
	II	2	25·6–27·7	..	..	..	..	1	8	..	..
December 19, 1901, -	II.	41	25–41·6	$9\frac{7}{8}$–$16\frac{3}{8}$	33	31	$12\frac{1}{4}$	1	$8\frac{1}{2}$	..	..
	III.	15	46·0–60·0	18–$23\frac{3}{4}$	..	..	..	2	$8\frac{1}{2}$	..	..
Smith's Bank, - -	I.	4	12·8–20·3	$5\frac{1}{16}$–8	..	..	..	1	..	..	..
April 1, 1904, - -	II.	22	23·1–38·8	$9\frac{1}{8}$–$15\frac{1}{4}$	28	..	..	2	..	..	..
	III.	7	46–59	$17\frac{3}{4}$–$23\frac{1}{4}$	..	..	..	3	..	..	..
October 23, 1903, - -	I.	3	7·2–12·6	$2\frac{7}{8}$–5	..	..	..	..	7	..	..
	II.	6	23·2–39·6	$9\frac{1}{8}$–$15\frac{1}{2}$	..	..	..	1	7	..	..
November 8, 1901, -	I.	4	9·8–13·9	$3\frac{7}{8}$–$5\frac{1}{2}$	..	..	..	..	$7\frac{1}{2}$	..	..
	II.	42	25·9–40·1	$10\frac{3}{16}$–$15\frac{3}{4}$	29	31·5	$12\frac{3}{8}$	1	$7\frac{1}{2}$	..	..
December 27, 1903, -	II.	33	25·0–37·5	$9\frac{7}{8}$–$14\frac{3}{4}$	30	30	$11\frac{3}{4}$	1	9	..	..
	III.	3	45·6–50·2	..	..	.	..	..	..	..	..
Burghead Bay— September 7, 1901 -	I.	1	10·6	..	..	..	..	..	$5\frac{1}{4}$	..	.
	II.	34	20·7–32·3	$8\frac{1}{8}$–$12\frac{11}{16}$	25	26	$10\frac{1}{4}$	1	$5\frac{1}{4}$	..	..
October 20, 1903 -	I.	4	10·0–15·4	4–$6\frac{1}{16}$	..	..	..	..	$6\frac{1}{2}$	..	..
	II.	15	20·9–29·4	$8\frac{1}{4}$–$11\frac{1}{2}$	..	..	..	1	$6\frac{1}{2}$	..	..
December 6, 1904, -	II.	32	21·4–33·2	$8\frac{7}{16}$–$13\frac{1}{16}$	25	27	$10\frac{5}{8}$	..	$8\frac{1}{4}$	..	..

COD—*continued.*

Date.	Group	No.	Range of Size.		Modal Size.	Approximate Mean Length		Approximate Age		Apparent Growth from Preceding Series.	
			Cm.	Inches.		Cm.	Inch.	Years	M'ths.	Cm.	Inch.
II—Moray Firth—*cont.*											
December 20–25, 1901,	I.	91	10·5–21·9	$4\frac{1}{8}$–$7\frac{13}{16}$	15	15	$5\frac{7}{8}$	..	9	..	..
	II.	179	22·9–39·8	9–$15\frac{5}{8}$	26	30·5	12	1	9	15·5	$6\frac{1}{8}$
	III.	40	40·3–59·8	$15\frac{7}{8}$–$23\frac{1}{2}$	..	48	$18\frac{7}{8}$	2	9	17·5	$6\frac{7}{8}$
	IV.	67	61·2–72·4	24–$28\frac{1}{2}$	..	..	..	3	9	..	..
	..	6	76·6–84·5	30–$33\frac{1}{4}$	..	..	..	..	..	..	..
	..	10	91–100	36–$39\frac{1}{2}$	..	..	..	..	..	..	..
	..	3	101,102,103	$39\frac{3}{4}$–$40\frac{1}{2}$	..	..	..	..	..	..	..
	..	1	110	$43\frac{1}{4}$	..	..	..	..	..	..	..
December 29, 1903, -	II.	8	26–39·8	$10\frac{1}{4}$–$15\frac{5}{8}$	..	..	..	..	..	..	..
	III.	3	43·2–45·4	17–$17\frac{7}{8}$	..	..	..	..	..	..	..
	..	..	73, 90, 98	..	..	..	..	..	..	..	..
	..	..	100, 101, 103, 104,	..	..	..	..	..	..	..	..
Cromarty Firth, -	I.	16	8·7–22·2	$3\frac{1}{2}$–$8\frac{3}{4}$	..	..	..	..	$9\frac{3}{4}$	..	..
January 7, 1901, -	II.	22	25·8–39·3	$10\frac{3}{16}$–$15\frac{1}{2}$	..	..	..	1	$9\frac{3}{4}$	..	..
Off Lybster, Caithness.											
October 23, 1903. -	I.	6	5·8–14·3	$2\frac{1}{4}$–$5\frac{5}{8}$	..	..	..	..	6–7	..	..
	II.	3	24·8–32·4	..	..	..	..	1	..	..	..
November 8, 1901, -	II.	114	26·8–37·8	$10\frac{1}{2}$–$14\frac{7}{8}$	32	32	$12\frac{5}{8}$	1	$7\frac{1}{4}$	..	..
Off Dunbeath, Caithness											
January 17–18, 1902 -	I.	17	13·8–22·3	$5\frac{1}{2}$–$8\frac{3}{4}$	..	..	..	..	$9\frac{1}{2}$	..	..
	II.	280	23·1–40·7	$9\frac{1}{8}$–16	31	31·5	$12\frac{3}{8}$	1	$9\frac{1}{2}$	..	..
	III.	41	41·9–62·5	$16\frac{1}{2}$–$24\frac{5}{8}$	..	[50	$19\frac{3}{4}$]	2	$9\frac{1}{2}$	..	..
Sinclair Bay—											
June 4, 1901, - -	III.	20	26·6–36·3	$10\frac{1}{2}$–$14\frac{3}{8}$	..	..	..	2	2	..	..
	IV.	13	40·5–56·5	16–$22\frac{1}{4}$	..	..	..	3	2	..	..
		2	65·3–68·7	..	..	..	..	..	..	..	..
III.—Firth of Forth.											
May 13–16, 1901, - -	II.	145	9·6–23·0	$3\frac{3}{4}$–$9\frac{1}{8}$	13	15	$5\frac{7}{8}$	1	$1\frac{1}{2}$	..	..
	III.	3	25–27	..	..	..	..	..	..	..	..
July 23, 1901 - -	I.	29	4·6–8·4	$1\frac{13}{16}$–$3\frac{5}{16}$	5	6 (5)	$2\frac{3}{8}$ (2)	..	4	..	..
	II.	77	15·2–30	6–$11\frac{3}{4}$	20	22	$8\frac{5}{8}$	1	4	17	$6\frac{3}{4}$
	III.	2	32·2–33·8	..	..	..	..	..	..	..	..

COD—*continued.*

Date.	Group	No.	Range of Size.		Modal Size.	Approximate Mean Length		Approximate Age		Apparent Growth from Preceding Series.	
			Cm.	Inches.		Cm.	Inch.	Years	M'ths.		
III.—Firth of Forth—*continued.*											
August 19, 1901, -	I.	90	5·4–11·3	$2\frac{1}{8}$–$4\frac{7}{16}$	7	7·5	3	..	$4\frac{1}{2}$–5	..	..
	II.	93	14·8–31·6	$5\frac{13}{16}$–$12\frac{7}{16}$	21	22·5	$8\frac{7}{8}$	1	$4\frac{1}{2}$–5	15	$5\frac{15}{16}$
August 22, 1901, - -	I.	46	5·8–13·2	$2\frac{1}{4}$–$5\frac{3}{16}$	7	8	$3\frac{1}{8}$	..	$4\frac{1}{2}$–5	..	..
	II.	47	16·8–29·7	$6\frac{5}{8}$–$11\frac{3}{4}$	22	22·5	$8\frac{7}{8}$	1	$4\frac{1}{2}$–5	14·5	$5\frac{3}{4}$
August 21, 1901, - -	I.	10	6·4–7·9	$2\frac{1}{2}$–$3\frac{1}{8}$	7	7	$2\frac{3}{4}$	..	$4\frac{1}{2}$–5	..	..
	II.	19	18·8–29·2	$7\frac{3}{8}$–$11\frac{1}{2}$	22	23·5	$9\frac{1}{4}$	1	$4\frac{1}{2}$–5	16·5	$6\frac{1}{2}$
August 19–22, - -	I.	146	5·4–13·2	$2\frac{1}{8}$–$5\frac{3}{16}$	7	7·5	3	..	$4\frac{1}{2}$–5	..	..
(Combined.)	II.	159	14·8–31·6	$5\frac{13}{16}$–$12\frac{7}{16}$	21	22·5	$8\frac{7}{8}$	1	$4\frac{1}{2}$–5	15	$5\frac{15}{16}$
IV.—Off Shetland Isles											
May 19–22, 1901, -	II.	3	18·1–23·7	$7\frac{1}{8}$–$9\frac{3}{8}$	..	..	..	1	$1\frac{1}{2}$	..	..
	III.	268	25·2–41·2	$9\frac{15}{16}$–$16\frac{1}{4}$	32	32·5	$12\frac{3}{4}$	2	$1\frac{1}{2}$	..	..
	IV.	141	41·8–61·6	16–$24\frac{1}{4}$	50	50	$19\frac{3}{4}$	3	$1\frac{1}{2}$	18	$7\frac{1}{8}$

The first series, that is, cod in their first year, comprises over 900 specimens, and they are present in greater or less numbers in thirty-four of the collections.

They first appeared in a collection made in the Dornoch Firth on 9th June 1903, the haul being made with the small-meshed net around the cod-end of the otter trawl, in from 8 to 11 fathoms. Twenty-five were taken measuring from 33mm. to 48mm. ($1\frac{5}{16}$–$1\frac{7}{8}$ inches), the average size being 38·8 mm., or a trifle over $1\frac{1}{2}$ inches. These young cod were approximately $2\frac{1}{2}$ months old. It is of interest to note that on 30th March in the following year (1904), a shoal of spawning cod of large size were discovered on the same ground, a little further off, in from 13 to 15 or 16 fathoms.*

They next appear in the collections of 30th July, in Aberdeen Bay, and of 23rd July in the Firth of Forth. In the latter case 29 were obtained, measuring from 4·6cm. to 8·4cm. ($1\frac{13}{16}$–$3\frac{5}{16}$ inches), and with an average size of about 6cm., or $2\frac{3}{8}$ inches. The arithmetical average was 61·3mm. An examination of the curve shows that the smaller cod are not duly represented, the rise from 4cm. to 5cm. being very abrupt; more probably 2·5cm. or 3cm. would indicate the lower limit of the group, and 5cm., or 2 inches, the average size. In the collections made in the Firth of Forth from 19th to 22nd August, or nearly a month later than the above, the range in size of 146 specimens was from 5·4cm. to 13·2cm. ($2\frac{1}{8}$–$5\frac{3}{16}$ inches), and the average size was about 7cm., or $2\frac{3}{4}$ inches, an increase of about 2cm., or $\frac{3}{4}$ of an inch (fig. 5, pl. XII.).

* *Vide Twenty-third Annual Report.* Part III, p. 21.

In Aberdeen Bay, 18, obtained on 21st August, measured from 6·5cm. to 8·8cm. ($2\frac{9}{16}$–$3\frac{1}{2}$ inches), the average size being 7·7cm., or 3 inches. In collections from the 3rd to the 10th September, the range of the 42 specimens was from 6cm. to 15·3cm. ($2\frac{3}{8}$–6 inches), the average size being 9·5cm., or $3\frac{3}{4}$ inches (fig. 6, pl. XII.). On 18th October 75 measured from 7·8cm. to 19·9cm. ($3\frac{1}{16}$–$7\frac{7}{8}$ inches), the average size being 12cm., or $4\frac{3}{4}$ inches. On the 31st of the same month, but in a different year, 21 ranged from 4·8cm. to 15·7cm. ($1\frac{7}{8}$–$6\frac{3}{16}$ inches), the average size being 12cm., or $4\frac{3}{4}$ inches. A week later, on the 6th November, a large collection of 301 had a range from 8·6cm. to 19cm. ($3\frac{3}{8}$–$7\frac{1}{2}$ inches), the average being 12cm., or $4\frac{3}{4}$ inches, the same as on 18th October. At the end of the month, on the 28th and 29th, 38 measured from 7·8cm. to 20·7cm. ($3\frac{1}{16}$–$8\frac{3}{16}$ inches), the average being approximately 13cm., or $5\frac{1}{8}$ inches; and on 16th December in the same year, 18 ranged from 8·3cm. to 20·8cm. ($3\frac{1}{4}$–$8\frac{5}{16}$ inches), also with an approximate average of 13cm.

At the middle of January, 7 ranged from 9·7cm. to 16·2cm. ($4\frac{13}{16}$–$6\frac{3}{8}$ inches), the average size being about 12·5cm., or 5 inches. Then on 11th February in another year, 16 were from 8cm. to 17cm. ($3\frac{1}{8}$–$6\frac{3}{4}$ inches), the average being the same, and on 29th March, the last collection from Aberdeen Bay containing fish under one year of age, 6 ranged from 9cm. to 19cm. ($3\frac{1}{8}$–$7\frac{1}{2}$ inches), the average size being about 13·5cm., or $5\frac{3}{8}$ inches.

It will thus be seen that the young cod increase in size rapidly in the summer and up to October, and that after that to March the increase appears to be but slight. The numbers obtained in the winter and early spring were, however, small. The increase from August to the end of the year was about 2 inches or a little more.

The collections of cod under one year of age from other parts of the east coast are, as a rule, small, but one or two are fairly large. In the Dornoch Firth, on 9th and 10th November, 78 measured from 9·7cm. to 19·1cm. ($3\frac{13}{16}$–$7\frac{1}{2}$ inches), and the average size was about 12·5cm., or $4\frac{15}{16}$ inches (fig. 6, pl. XII.). In Burghead Bay, also in the Moray Firth, on 20th and 25th December, in another year, 91 ranged in length from 10·5cm. to 21·9cm. ($4\frac{1}{8}$–$7\frac{5}{16}$ inches), the average size being about 15cm., or $5\frac{7}{8}$ inches. In the Cromarty Firth, on 7th January, 16 measured from 8·7cm. to 22·2cm. ($3\frac{1}{2}$–$8\frac{3}{4}$ inches), and on 17th January, in another part of the Moray Firth, 17 ranged in length from 13·8cm. to 22·3cm. ($5\frac{1}{2}$–$8\frac{3}{4}$ inches), but these fish were taken in the ordinary trawl-net, and the smaller specimens are not duly represented.

The collections when the cod is one year of age, in April or the end of March, are not sufficient to show with precision its size at that period, but, from what has been said and from what follows as to the size a little later, it may be placed at about $5\frac{1}{4}$ or $5\frac{1}{2}$ inches (13cm. or 14cm.), with a range from 3 to 8 inches or a little more (7·5cm. to 20cm.). The growth of the cod in its second year appears to be somewhat more rapid, probably owing to its becoming more and more piscivorous in its feeding.

The second series, comprising cod in their second year, is well represented by over 2000 fish in 48 of the collections. The growth in summer is rapid. In Aberdeen Bay, 5 taken on 13th May ranged from 14cm. to 20·7cm. ($5\frac{1}{2}$–$8\frac{1}{8}$ inches). In the Firth of Forth, 145, caught between 13th and 16th May, measured from 9·6cm. to to 23cm. ($3\frac{3}{4}$–$9\frac{1}{8}$ inches), with an average length of 15cm., or $5\frac{7}{8}$ inches. On 1st April, 4 caught at Smith Bank, in the Moray Firth, were from 12·8cm. to 20·3cm. ($5\frac{1}{16}$–8 inches), and 3 taken in deep water off the Shetlands on 19th and 22nd May were from 18·1cm. to 23·7cm., or between $7\frac{1}{8}$ and $9\frac{3}{8}$ inches.

On 13th June, in Aberdeen Bay, 31 specimens, computed to be about 1 year and $2\frac{1}{2}$ months old, measured from 14·3cm. to 23cm. ($5\frac{5}{8}$–$9\frac{1}{16}$ inches), the mean size being 18·5cm., or $7\frac{1}{4}$ inches. On the 28th, 19 caught in the "Doghole," in 65 fathoms, ranged from 19cm. to 26cm. ($7\frac{1}{2}$–$10\frac{1}{4}$ inches), the mean being 22cm., or $8\frac{5}{8}$ inches; the arithmetically computed average was 21·9cm.

In July two collections were made in Aberdeen Bay and one in the Firth of Forth. In the former, on the 30th, 43 measured from 16·7cm. to 28cm. ($6\frac{5}{8}$–11 inches), the average being 23cm., or $9\frac{1}{16}$ inches; these were taken at the "Doghole," in 62 fathoms. On the next day, 32, caught in 11–13 fathoms, ranged from 16·7cm. to 27·9cm., or the same, the average length being a little less, viz., about 22·5cm., or $8\frac{7}{8}$ inches.

On the 23rd the collection in the Firth of Forth comprised 77 specimens, about 1 year and 4 months old; they ranged from 15·2cm. to 30 cm. (6–$11\frac{3}{4}$ inches), the average being 22cm., or $8\frac{5}{8}$ inches.

On 21st August, 85, from the "Doghole," in 58 fathoms, were from 18·7cm. to 32·3cm. ($7\frac{3}{8}$–$12\frac{3}{4}$ inches), the average being about 23·5cm., or $9\frac{1}{4}$ inches. Their age was about 1 year and 4 or 5 months. In the Firth of Forth they were represented in three collections in August, as follows:—On the 19th, 93 varied from 14·8cm. to 31·6cm. ($5\frac{13}{16}$–$12\frac{7}{16}$ inches), the average being 22·5cm., or $8\frac{7}{8}$ inches; on the 21st, 19 ranged from 18·8 to 29·2cm. ($7\frac{3}{8}$–$11\frac{1}{2}$ inches), the average being 23·5cm., or $9\frac{1}{4}$ inches; on the 22nd, 47 measured from 16·8cm. to 29·7cm. ($6\frac{5}{8}$–$11\frac{3}{4}$ inches), the average being 22·5cm., or $8\frac{7}{8}$ inches (fig. 5, pl. XII.).

In September, in Aberdeen Bay, 167 were caught between the 3rd and 10th; they ranged in length from 18·1cm. to 32cm. ($7\frac{1}{8}$–$12\frac{5}{8}$ inches), the average being about 25cm., or $9\frac{7}{8}$ inches. At Burghead Bay, on 7th September, 34 ranged from 20·7cm. to 32·3cm. ($8\frac{1}{8}$–$12\frac{11}{16}$ inches), the mean size being about 26cm., or $10\frac{1}{4}$ inches (fig. 6, pl. XII.). These fish were one year and five or six months old.

Several collections were got in October. In Aberdeen Bay, on the 18th, 37 measured from 22·2cm. to 35·8cm. ($8\frac{3}{4}$–$14\frac{1}{8}$ inches), the mean being 28·5cm., or $11\frac{1}{4}$ inches. On the 31st, 13 ranged from 22·7cm. to 36cm. ($8\frac{15}{16}$–$14\frac{3}{16}$ inches), the mean being about 29cm., or $11\frac{7}{16}$ inches. The numbers of this series in the October collections from the Moray Firth are small. In the Dornoch Firth, on the 22nd, two measured 21·9cm. and 31cm.; at Smith Bank, on the 23rd, six ranged from 23·2cm. to 39·6cm. ($9\frac{1}{8}$–$15\frac{1}{2}$ inches; in Burghead Bay, on the 20th, 15 measured from 20·9cm. to 29·4cm. ($8\frac{1}{4}$–$11\frac{1}{2}$ inches); and on the 23rd, off Lybster, on the coast of Caithness, three were from 24·8cm. to 32·4cm.

On 5th November, at the "Doghole," in 70 fathoms, 20 of this series were obtained; they ranged from 26·7cm. to 35·9cm. $10\frac{1}{2}$–$14\frac{1}{8}$ inches), the mean being about 30·5cm., or 12 inches. On the 28th, 43, taken with the ordinary trawl-net in Aberdeen Bay, measured from 23·8cm. to 38·1cm. ($9\frac{3}{8}$–15 inches), the mean being about 32cm., or $12\frac{5}{8}$ inches. On the following day a collection of 135 belonging to this series ranged from 21·8cm. to 38 3cm. ($8\frac{5}{8}$–$15\frac{1}{16}$ inches), the mean being 31cm., or $12\frac{1}{4}$ inches. These were about 1 year and 8 months old.

In the Dornoch Firth, on the 9th and 10th, 113 measured from 20·7cm. to 36·7cm. ($8\frac{1}{8}$–$14\frac{7}{16}$ inches), the average length being about 27·5cm., or $11\frac{13}{16}$ inches (fig. 6, pl. XII.). At Smith Bank, on the 8th, 42 ranged from 25·9cm. to 40·1cm. ($10\frac{3}{16}$–$15\frac{3}{4}$ inches), the mean being 31·5cm., or $12\frac{3}{8}$ inches. Off Lybster, on the 8th, 114 measured from 26·8cm. to 37·8cm., ($10\frac{1}{2}$–$14\frac{7}{8}$ inches), the average being 32cm., or $12\frac{5}{8}$ inches.

In December, in Aberdeen Bay, 70 measured from 23cm. to 41·8cm.

(9–16$\frac{3}{8}$ inches), the average being 32cm., or 12$\frac{5}{8}$ inches. The largest member of the group in this case might be one at 38·6cm. (15$\frac{1}{4}$ inches), as in the November collections, but in that of 12th December the division is not so placed. In the latter, 16 measured from 31·9cm. to 42·2cm. (12$\frac{1}{2}$–16$\frac{5}{8}$ inches).

In the Dornoch Firth, on 19th December, 41 measured from 25cm. to 41·6cm. (9$\frac{7}{8}$–16$\frac{3}{8}$ inches), the mean being about 31cm., or 12$\frac{1}{4}$ inches. At Smith Bank, on the 27th December, 33 ranged from 25cm. to 37·5cm. (9$\frac{7}{8}$–14$\frac{3}{4}$ inches), the next fish measuring 45 6cm.; the average size was about 30cm., or 11$\frac{3}{4}$ inches. On 6th December, at Burghead Bay, 32 measured from 21·4cm. to 33·2cm. (8$\frac{7}{16}$–13$\frac{1}{16}$ inches), the mean being about 27cm., or 10$\frac{5}{8}$ inches. In this collection, as the other tables of measurements show, the larger fishes of the series were not present in due numbers, and the two smaller fishes, 21·4cm. and 21·8cm., may belong to the younger series, which is not otherwise represented.

A large collection of this series was obtained in Burghead Bay between the 20th and 25th December. They numbered 179, ranging from 22·9cm. to 39·8cm. (9–15$\frac{5}{8}$ inches), the average size being about 30·5cm., or 12 inches. A small collection on the 29th of the same month in another year, comprised 8 specimens of this series, their sizes ranging from 26cm. to 39·8cm. (10$\frac{1}{4}$–15$\frac{5}{8}$ inches) (fig. 5, pl. XII.).

In January, in Aberdeen Bay, 15 of this series measured from 26cm. to 40cm. (10$\frac{1}{4}$–15$\frac{3}{4}$ inches), the mean being 31cm. to 32cm., or 12$\frac{1}{2}$ inches. In the Cromarty Firth, on the 7th, 22 were from 25·8cm. to 39·3cm. (10$\frac{3}{16}$–15$\frac{1}{2}$ inches), the mean being about 32cm., or 12$\frac{5}{8}$ inches. A large collection was obtained off Dunbeath, on the Caithness coast, on 17th January, and the 280 cod comprised in the series measured from 23·1cm. to 40·7cm. (9$\frac{1}{8}$–16 inches), the average being about 31·5cm., or 12$\frac{3}{8}$ inches. These fish were obtained in the ordinary trawl-net, but at this size the fact will not affect the average to any material extent.

No cod of this series were in the collections in February and March. On 1st April, 22, caught at Smith Bank, in the Moray Firth, ranged in length from 23·1cm. to 38·8cm. (9$\frac{1}{8}$–15$\frac{1}{2}$ inches), but the higher limit of the series is less than it ought to be from the absence of the larger fishes; the next longest to the one at 38cm. was one about 46cm. In May (when they were over two years old) five taken in Aberdeen Bay measured from 27cm. to 34cm. (10$\frac{5}{8}$–13$\frac{3}{8}$ inches), and three in the Firth of Forth were from 25cm. to 27cm. (9$\frac{7}{8}$–10$\frac{5}{8}$ inches). The numbers are too small, of course, on which to base a conclusion. In a large collection made up of the cod taken in several hauls of the ordinary trawl-net in deep water off the Shetlands (65 fathoms) between 19th and 22nd May, 268 belonged to this group, and ranged in size from 25·2cm. to 41·2cm. (9$\frac{15}{16}$–16$\frac{1}{4}$ inches), by far the greater proportion measuring 31cm. to 34cm. (12$\frac{1}{4}$–13$\frac{3}{8}$ inches), and the mean being approximately 32·5cm., or 12$\frac{3}{4}$ inches, the arithmetic average being a little higher, viz., 32·7cm. (fig. 5, pl. XII.).

Looking to these averages and the averages in January and December, it appears that the cod on the east coast of Scotland when two years of age measures, on the average, a little over 12 inches in length, probably 12$\frac{1}{4}$–12$\frac{1}{2}$ (31cm. to 32cm.); the range of sizes may be placed at from about 9 to over 16 inches.

In the third year of life, after it has attained the size mentioned, growth is again rapid in the summer. I have referred to the size in May, when the fish are about thirteen months old.

At Sinclair Bay, on the coast of Caithness, on 4th June, 20 specimens measured from 26·6cm. to 36·3cm. (16–22$\frac{1}{4}$ inches) when they were about 2 years and 2 months old.

At the "Doghole," off Aberdeen, on 30th July, 26 measured from 29·3cm. to 46cm. ($11\frac{9}{16}$–$18\frac{1}{8}$ inches); on 21st August, 12 ranged from 36·4cm. to 48·7cm. ($14\frac{1}{4}$–$19\frac{1}{8}$ inches); on 3rd September, 8 taken at the "Doghole" were from 39·4cm. to 45cm. ($15\frac{1}{2}$–$17\frac{3}{4}$ inches); 5 on 31st October measured from 39·5cm. to 53·5cm. ($15\frac{1}{2}$–$21\frac{1}{4}$ inches); 5 on 5th November were from 46·4cm. to 52cm. ($18\frac{1}{4}$–$20\frac{1}{2}$ inches); and on 28th and 29th November, 33 measured from 39·2cm. to 57·3cm. ($15\frac{7}{16}$–$22\frac{1}{2}$ inches). On 12th December, 35 measured from 43·7cm. to 61·6cm. ($17\frac{1}{4}$–$24\frac{1}{4}$ inches), the mean size being calculated at 49·5cm., or $19\frac{1}{2}$ inches, and the age at 32 or 33 months.

Comparatively few were taken in the Moray Firth. On 12th November 16 ranged from 44·8cm. to 61cm. ($17\frac{5}{8}$–24 inches); on 19th December, 15 were from 46cm. to 60cm. (18–$23\frac{1}{4}$ inches); on 20th to 25th December, 40 measured from 40·3 to 59·8cm. ($15\frac{7}{8}$–$23\frac{1}{2}$ inches); on 17th January, off Dunbeath, 41 measured from 41·9cm. to 62·5cm. ($16\frac{1}{2}$–$24\frac{5}{8}$ inches).

In May, off the Shetlands, when they had begun their fourth year, 141 measured from 41·8cm. to 61·6cm. (16–$24\frac{1}{4}$ inches). The mean in this case is about 50cm., and the arithmetical average 50·9cm., or exactly 20 inches.

The average size of the cod on the east coast of Scotland when three years old may be placed at from between 19 and 20 inches, and the probable range of sizes from about 16 to about 24 inches.

The number of cod older than this in the collections was very small, and their distinction into groups problematical. In the haul on 12th November, in the Dornoch Firth, I have placed ten, measuring from 66·4cm. to 76cm. ($25\frac{1}{2}$–30 inches), as approaching their fourth year. And on 20–25th December, in Burghead Bay, six measured from 61·2cm. to 73·4cm. (24–$28\frac{1}{2}$ inches), which are assumed to be about the same age.

It is now desirable to compare the differences in the average length of the different groups, which represents the extent of the growth in a year from one annual series to the next. Considering first the means of the first and second series, as given in the Table, there are twelve cases in which this comparison can be made. The difference between the means varies in different collections from 14·5cm. to 19cm., and the average amounts to 16·57cm., or $6\frac{1}{2}$ inches. Some are better than others, and if we select the nine cases in which the number of fishes in either of the series does not fall below 20, we find that the variation is from 14·5cm. to 18·5cm., and the average of the lot is 16·2cm., or $6\frac{3}{8}$ inches. If the comparison is limited to the cases in which more than 70 fishes are represented in each series, and the numbers are fairly equal—and these cases are three in number—the differences are respectively 15cm., 15·5cm., and 15cm., the average being 15·2cm., or almost exactly 6 inches.

There is another method by which comparison of the differences between the groups can be made, viz., by comparing the difference between the sizes at which the maximum numbers of fishes occur—between the maximum ordinates, "modes," or apex, of each curve. As might be expected from these collections, which contain only moderate numbers of fishes, the members of any given group are not duly represented throughout; in some instances the larger fishes predominate in numbers, in others the smaller, and so on; and thus in a single collection of this kind comparison of the modes or maximum ordinates of two groups may be far from showing the true differences between these groups. Thus, in the fourteen cases in which such comparison can be made between the cod in their first year and those in their second year, the distance between the maximum ordinates varies from 11cm. to 22cm., or exactly double. The mean of these numbers,

however, is 16·5cm., or very nearly the figure derived from the comparison of the mean sizes; and if the average be made of all the instances, the figure is 16·1cm., or $6\frac{3}{8}$ inches. If the collections are selected according to the numbers of fishes they contain, as above described in dealing with the approximate means, we get in the nine cases an average of 15·33cm., or a trifle over 6 inches. It seems very probable, then, that the cod on the east coast of Scotland increases in length at this early period of its life by from 6 to $6\frac{1}{2}$ inches in the course of a year, and it is likely to be nearer the former figure than the latter. The particulars of the computation in the nine cases referred to are given in the accompanying Table:—

Month.	Number of Fish.		Difference between the Approximate Means.	Difference between the Modes or Maximum Ordinates.
	1st Series.	2nd Series.		
			Cm.	Cm.
September, . .	42	167	15·5	16
October, . . .	75	37	16·5	14
November, . .	301	20	18·5	19
,, . .	38	178	18	21
,, . .	78	113	15	13
December, . .	91	179	15·5	11
July, . . .	29	77	17	15
August, . . .	90	93	15	14
,, . . .	46	47	14·5	15
			16·2	15·33

In my previous paper, in which I dealt with the growth of the cod, the number of collections as well as the number of fishes was much less; but in the ten cases where comparison was possible the mean difference between the arithmetic averages of the two series (the method then made use of) was 16·7 cm., and in the five instances with the greatest numbers of fish it was 16·0cm., or $6\frac{1}{4}$ inches.

With regard to the difference between the second and third groups, the collections in which this can be determined are much less numerous. The five cases are as follows:—

Month.	Number of Fish.		Difference between the Approximate Means.	Difference between the Modes or Maximum Ordinates.
	1st Series.	2nd Series.		
			Cm.	Cm.
November, . .	178	33	16	–
December, . .	41	15	15	16
,, . .	179	40	17·5	–
January, . . .	280	41	18·5	–
May, ...	268	141	18	17·5
			17	16·7

The last collection (May) represents fish a little over two and three years of age. In my last paper there was only one instance in which comparison between these groups could be made, and the difference (arithmetical averages) was 18·2cm.; when incorporated with the others given above the average remains 17cm., or $6\frac{11}{16}$ inches.

It is very desirable that complete observations should be made with exactitude as to the average size, and the limits of size, at which the cod becomes mature for the first time. Until this be done it is not possible to be quite certain as to the age at which reproduction begins. It is certainly not before four years, and it may be five years, of age.

HADDOCK (*Gadus æglefinus*).

The number of haddocks measured was 6682, making, with those whose measurements are dealt with in the two previous papers referred to, a total of 28,760 specimens of this species. The collections were partly from Aberdeen Bay and neighbourhood and partly from the Moray Firth; the measurements in one-centimetre grouping are given in the appended Table XXII.

A collection made on 15th January 1902 at the "Doghole," off Aberdeen, in 57 fathoms, 802 haddocks, most of them belonging to the first group, or fish of the previous spawning. These numbered 775, measuring from 150mm. to 210mm. ($5\frac{7}{8}$–$8\frac{1}{4}$ inches); most were aggregated between 16cm. and 19cm., the apex of the curve formed by the measurements being at 17·5, which was also the mean, while the arithmetic average was 180·5. The second group was represented by only a few fish, from 240mm. to 324mm., or near it, and the computed average size was 286·8mm., or about $11\frac{5}{16}$ inches, the annual increment being thus about $4\frac{3}{16}$ inches.

On 13th May, in the same year, another lot of 596 haddocks was taken on the same ground, in 52 fathoms, most of them belonging to the first group, now over one year of age. They measured from 145mm. to 239mm. ($5\frac{3}{4}$–$9\frac{3}{8}$ inches); most were between 17cm. and 22cm., the apex of the curve was at 19·5cm., and the mean was the same (nearly $7\frac{3}{4}$ inches). The growth in the interval of about 118 days was thus approximately 2cm., or $\frac{3}{4}$ of an inch. The second group was represented by only a few fishes, from about 25cm. to 32cm., or more.

On 31st October 1903 a large collection of 1249 haddocks was obtained in Aberdeen Bay, in 8–12 fathoms, and the measurements are of some interest, as three groups at least are well represented, and a considerable number of them—all those above 27cm., and many below that size—were differentiated according to sex (fig. 7A, pl. XII.). It may be said at once that, contrary to the rule among flatfishes, the males and females are of approximately the same size, and thus grow at the same rate, though the females are in excess as to numbers. The first group, that is to say, haddocks approximately seven months old, ranged in length from 136mm. to 207mm. ($5\frac{3}{8}$–$8\frac{1}{8}$ inches), most being between 14cm. and 19cm.; the mode was at 16cm., and the mean at 16·5cm., or $6\frac{1}{2}$ inches.

The second group extended from 217mm. to 310mm. ($8\frac{1}{2}$–$12\frac{1}{4}$ inches); most measured from 25cm. to 30cm., the apex of the curve was at 27cm., and the mean was 27·5cm., or a little above $10\frac{3}{4}$ inches. The division between this group and the third group is very distinct in curves made on ·5cm. grouping, at 31cm., and it is the same for the males as for the females. These fish were about one year and seven months old.

The third group extended from 31cm. to about 38cm., the bulk of the haddocks were between 32cm. and 35cm., the mode is at 33cm., and the mean is 33·5cm., or $13\frac{1}{4}$ inches. This group is partly fused with the last, and it is to be noticed that in the ·5cm. curves there is a slight depression at 34cm., both with regard to the males and the females, suggestive of two groups.

The means of the three groups, taking the last provisionally as one, are thus as follows:—

[TABLE.

	Age.	Mean Size.		Approximate Annual Growth Indicated.	
		Cm.	Inches.	Cm.	Inches.
1st	7 months.	16·5	$6\frac{1}{2}$	–	–
2nd	1 year and 7 months.	27·5	$10\frac{3}{4}$	11	$4\frac{1}{4}$
3rd	2 years and 7 months.	33·5	$13\frac{1}{4}$	6	$2\frac{3}{8}$

The third group will constitute the great spawning shoal in the following spring.

On 29th December in the same year, 162 haddocks, taken in Aberdeen Bay, showed the presence of three groups. The first extended from 146mm. to 215mm., or near it ($5\frac{3}{4}$–$8\frac{1}{2}$ inches); most were between 15cm. and a little over 19cm., the apex of the curve was at 17·5cm., and the mean was about 17·2cm., or $6\frac{3}{4}$ inches. The number is not large, but the measurements show an increase in length of about 1cm. from 31st October. The other groups are but slightly represented; one appeared to extend from 23cm. to 30cm., and the other from the latter to 36cm.; there were also 7 haddocks from 40cm. to 43cm. ($15\frac{3}{4}$–17 inches), probably approaching their fourth year.

A collection made with the small-meshed net on 29th March, 1905, numbered 314, and belonged to the first group. It extended from 133mm. to 204mm. ($5\frac{1}{4}$–8 inches); most were between 15cm. and 18·5cm., the apex of the curve was at 17cm. and the mean about 16·5cme or $6\frac{1}{2}$ inches. A few small haddocks belonging to this haul wer., omitted to be measured.

Four collections of haddocks from Smith Bank, in the Moray Firth, were measured, the depth in which they were taken being usually 22 or 23 fathoms.

On 1st April, 1904, they numbered 885, and three groups were represented, the first only by a few fish from 15·8cm. to 20cm. or 21cm. The second series was well shown; it extended from 20cm. or 21cm. to 29cm. (8–$11\frac{1}{2}$ inches); most measured between 23cm. and 27·5cm., the apex of the curve constructed on the measurements was at 25cm., and the mean was 25·2cm. or 25·3cm, (10 inches). These haddocks were about two years of age.

The next group extended from 29cm. to about 37cm. ($11\frac{1}{2}$–$14\frac{1}{2}$ inches), most of them were between 30cm. and 34cm. ($11\frac{1}{4}$–$13\frac{1}{2}$ inches), the apex of the curve was at 31cm., and the mean was about 32cm., or $12\frac{1}{2}$ inches. These fish were about three years of age. The particulars are these:—

	Age.	Average Size.		Apparent Annual Growth.	
		Cm.	Inches.	Cm.	Inches.
1st	1 year old.	–	–	–	–
2nd	2 years old.	25·2	10	–	–
3rd	3 years old.	32	$12\frac{1}{2}$	6·5	$2\frac{1}{2}$

On 23rd October, 1903, 306 haddocks were obtained on Smith Bank, representing three groups, but only the second was at all well indicated. The first group consisted of 8 haddocks from 115mm. to 204mm. The second group extended from 21cm. to 28cm. or 29cm.; most of them were between 22·5cm. and 26cm. ($8\frac{7}{8}$–$10\frac{1}{4}$ inches), the apex of the curve was at 25cm., and the mean was about 24·3cm., or $9\frac{1}{2}$ inches. The rest of the haddocks were insufficient to indicate the limits or average size of the next group. One haddock measured 49cm. ($19\frac{1}{4}$ inches) (fig. 7B, pl. XII.).

Another collection of 62 haddocks, on 14th November, 1903, also contained members of three groups, but only the second was of value as regards the rate of growth. It extended from 24·7cm. to 33cm. or 34cm. ($9\frac{3}{4}$–13 inches); most were aggregated between 29cm. and 32cm., the apex of the curve was at 30cm., and the mean was about 28·5cm., or $11\frac{1}{4}$ inches. There was one haddock at 52cm. ($20\frac{1}{2}$ inches).

A collection of 756 haddocks on 12th December, 1904, belonged to the first group, all but one. It extended from 137mm. to 208mm. ($5\frac{3}{8}$–$8\frac{1}{4}$ inches); most measured between 15cm. and 18·5cm. ($5\frac{7}{8}$–$7\frac{1}{4}$ inches); the apex of the curve was at 16·5cm., and the mean was 16·7cm, or $6\frac{5}{8}$ inches.

Other collections of haddocks obtained in the Moray Firth, off Burghead, Kinnaird Head, Lybster, and the Dornoch Firth were measured.

Those obtained in the Dornoch Firth are small in number, haddocks usually not being caught there in any quantity.

On 22nd October, 1903, 95 haddocks belonging to three or four annual series were measured, but none of the groups are well indicated. The first contained 7 haddocks, from 109mm. to 153mm. The second contained most of the fish, but its limits are not very clear. The smallest was 24·2cm.; most were between 26cm. and 28cm. ($10\frac{1}{4}$–$10\frac{5}{8}$ inches); the apex of the curve was at 27cm., and the group apparently terminated about 31cm. or 32cm. (fig. 7B, pl. XII.).

In a haul on 13th November, the first and second series were represented by 22 haddocks, and in another, on the 27th December, 42 haddocks were taken, mostly belonging to the third series.

At Burghead Bay, on 20th October, 1903, 248 haddocks mostly belonged to the second series. The first group was represented by 30 haddocks, measuring from 105mm. to 165mm. ($4\frac{1}{8}$–$6\frac{1}{2}$ inches); the apex of the curve was at 12cm., and the mean about 12·5cm., or $4\frac{7}{8}$ inches. The second series extended from 23·1cm. to about 30cm.; most measured between 25cm. and 27cm. ($9\frac{7}{8}$–$10\frac{5}{8}$ inches); the apex was at 26cm., and the mean about 25·5cm., or 10 inches (fig. 7B, pl. XII.).

In a collection made on 29th December, 1903, 138 haddocks were obtained belonging to several groups. The first included 9 haddocks, from 150mm. to 206mm. The second group extended from 23·2cm. to about 30cm. ($9\frac{1}{4}$–$11\frac{3}{4}$ inches), most ranging between 24cm. and 28cm.; the apex of the curve was at 27cm., and the mean was about 26cm., or $10\frac{1}{4}$ inches. The rest of the haddocks were few in number. There were three very large ones, measuring respectively 60cm. ($23\frac{3}{4}$ inches), 73·6cm. (29 inches), and 74cm. ($29\frac{1}{2}$ inches).

A haul on the witch ground off Kinnaird Head, in from 40 to 50 fathoms, on 23rd January, 1904, yielded 199 haddocks belonging to several series. The first ranged from 14·3cm. to 18·8cm. ($5\frac{5}{8}$–$7\frac{3}{8}$ inches), most being between 14·5cm. and 17cm.; the apex of the curve, or the greatest number in the series, was at 16cm., and the mean was about 15·8cm., or $6\frac{1}{4}$ inches.

The second group extended from 21·2cm. to a point not easy to determine; most of the haddocks measured from 22cm. to 27cm., the apex of

the curve was at 25cm. The third group consisted of a few specimens, mostly between 32cm. and 35cm. ($12\frac{5}{8}$–$13\frac{3}{4}$ inches), and apparently extending to about 40cm., and no doubt represented the spawning shoal.

A collection off Lybster, on the coast of Caithness, on 22nd October, 1903, yielded a number of various groups. The small-meshed net around the cod-end was ruptured, and only contained 4 haddocks. The first series was represented by 4 fishes, 12cm. and 13cm. The second group extended from 21·4cm to 29cm. ($8\frac{1}{2}$–$11\frac{1}{2}$ inches); most were between 25cm. and 27cm., the apex of the curve was at 26cm., and the mean was about 26·5cm., or $10\frac{1}{2}$ inches. The smaller members of the group were not present in normal numbers.

The next group extended from about 29cm., apparently, to 36cm. ($11\frac{1}{2}$–$14\frac{1}{8}$ inches); most were aggregated between 31cm. and 34cm., the apex of the curve was at 32cm., and the mean was about 32·5cm., or $12\frac{3}{4}$ inches.

It may be noted that in the curve of this group, as in the curves for the collection from Aberdeen Bay on 31st October, and for the collection from Smith Bank on 1st April, the descending slope is interrupted, suggestive of a division. It is better shown in ·5cm., as below:—

	Cm.	32	32·5	33	33·5	34	34·5	35	35·5	36	36·5
31st October,	♀	22	24	27	29	20	27	31	16	18	9
	♂	7	7	10	16	10	16	7	6	4	8
	Cm.	29	31	37	45	30	43	38	22	22	17
1st April . .		33	24	22	22	28	20	12	8	7	5
22nd October .		34	52	33	44	37	40	25	23	3	7

At this size (reproductive) growth is slower and the fusion of the groups greater, and it is quite likely that the division indicated is a real one.

WHITING (*Gadus merlangus*).

Twenty-one collections of whitings were measured, most of them taken in the Moray Firth, the number being 8346, which, with those contained in my previous papers, makes about 58,000 of this species measured. The results as regards growth are confirmatory of the conclusions previously reached, and the collections may be briefly referred to.

Six collections were obtained from the Dornoch Firth, as shown in Table XXIII. The first was on 22nd October, 1903, and it comprised 233 whitings, taken in from 6 or 7 to 13 fathoms. The smallest was 51mm. (2 inches), and the largest of the first series, to which almost all the specimens belonged, was apparently 176mm. ($7\frac{3}{8}$ inches). The great majority of the fishes were aggregated between 9cm. and 13cm., the apex of the curve, or point of greatest aggregation, being 11cm., which was also the mean between the limits named; the arithmetical average was about 105·6mm. The average size of these whitings was thus about $4\frac{1}{4}$ inches. Two specimens of 21cm. and 22cm. probably represent a second series, and there is a third at 36cm.

The next collection, on 11th November, comprised 421 whitings, all but one (at 27cm.) apparently belonging to the same series. The smallest measured 58mm. ($2\frac{1}{4}$ inches) and the largest 194mm. ($7\frac{5}{8}$ inches); most were aggregated between 10cm. and 14cm., the apex of the curve being at 12cm., which was also the mean, while the computed average was approximately 120·5cm. ($4\frac{3}{4}$ inches).

On 27th December, 1903, a collection of 494 whitings belonged almost entirely to the first series. Most were aggregated between 11cm. and 16cm.; the apex of the curve was 13cm., and the mean about 13·5cm., or about $5\frac{1}{4}$ inches. The smallest of the group measured 85mm. ($3\frac{3}{8}$ inches) and the largest probably 211mm., but it may have been less.

The next collection was on the 28th December. It comprised 1209 whitings from the small meshed net only, the whitings obtained in the trawl net having been omitted from measurement. The smallest was 76mm. (3 inches) and the largest 177mm.; most were aggregated between 10cm. and 13cm., the apex being at 12cm. and the mean at 11·5cm., or about $4\frac{1}{2}$ inches. The low average is due to the omission referred to.

Another collection, on 7th December, 1904, included 496 whitings, the smallest being 79mm. ($3\frac{1}{8}$ inches) and the largest 183mm. ($7\frac{1}{4}$ inches). Most were aggregated between 12cm. and 15cm., the mean being 13·5cm., or $5\frac{5}{16}$ inches.

The sixth collection from the Dornoch Firth was on 9th February, 1905, and contained 628 whitings. Nearly all belonged to the first group, now approaching one year of age, and the bulk of the specimens were aggregated between 11cm. and 15·5cm., the average being 13·2cm., or $5\frac{1}{4}$ inches.

On the south coast of the Moray Firth, at Burghead Bay and in that neighbourhood, another series of collections of whitings was made, and in most of these cases two groups were represented. The first was on 20th October, 1903; it comprised only 94 whitings, 47 belonging to each series, and the numbers are thus small. In the first group the smallest whiting was 75mm. (almost 3 inches), the largest being 146mm., and the mean about 10·5cm. ($4\frac{1}{8}$ inches). In the second group the smallest was 182mm. ($7\frac{3}{16}$ inches), and the largest apparently 299mm., or $11\frac{3}{4}$ inches; the mean size was about 23·5cm., or $9\frac{1}{4}$ inches. The curves for the measurements are a little irregular, but, so far as they go, they show a difference between the two groups, both between the actual apices of the curves (or modes) and the means, of about 13cm., or $5\frac{1}{8}$ inches.

The second collection, on 14th November, 1903, comprised 355 whitings, mostly of the two first groups referred to. The younger group contained 193 whitings measuring from 81mm. to 174mm. ($3\frac{1}{4}$–$6\frac{7}{8}$ inches); most were aggregated between 10cm. and 14cm., the apex being at 13cm.; the mean about 12cm. ($4\frac{3}{4}$ inches), and the arithmetic average 121·8cm. The curve of the second group is less regular, the apex is at 28cm., and the mean about 27·5cm. ($10\frac{3}{4}$ inches). The difference is 15cm. and 15·5cm., or $5\frac{7}{8}$ inches. These whitings were taken further off the shore, in water of 30 fathoms depth.

In a collection made on 28th December, 1903, in the same locality, in water of 30 fathoms, comprising 386 whitings, the first group, which included most of them, ranged from 75mm. to 185mm. (3–$7\frac{1}{4}$ inches). The great majority were aggregated between 11cm. and 15cm., the apex of the curve was at 13cm., or $5\frac{1}{8}$ inches, and this was also the mean, while the arithmetic average was 129mm.; the second group were represented by only a few, insufficient to show the limits or average size.

Another small collection of 29 whitings was obtained on 29th December, the first group ranging from 110cm. to 184cm.

A collection on 23rd January, 1904, in 50 fathoms, off Kinnaird Head, numbered 131, and chiefly belonged to the first group. This group ranged in size from 76mm. to 165mm. Most were aggregated between 10cm. and 13·5cm., the apex of the curve being at 12cm., and the mean a little less; the arithmetic average was 120·7mm. The second group included few fishes, most being at 24cm. to 37cm.

At Findhorn, in the same neighbourhood, a collection of 293 was taken on 1st April, 1904, in 30 to 32 fathoms. They belonged for the most part to the second group, the sizes extending from 177mm. (7 inches) to about 30cm. or 31cm.; most were between 22cm. and 28cm., the mean and average being at 25cm. ($9\frac{7}{8}$ inches). They represent whitings at nearly two years of age.

Other collections were made on Smith Bank, in the Moray Firth, usually in 22 or 23 fathoms of water. The first of these was on 23rd October, 1903, when 420 whitings were taken, two groups being represented. The smaller, or fish spawned in the same year, ranged from 87mm. to 160mm. ($3\frac{1}{2}$—$6\frac{3}{8}$ inches); most measured between 11cm. and 13cm.; the mean was 12cm., and the arithmetic average 128mm., or a trifle over 5 inches. The second series, which included 221 fishes, ranging from 200mm. to 292mm., were mostly between 20cm. and 24·5cm.; the apex of the curve was at 22cm., and the arithmetic average was 233mm., or a trifle over $9\frac{1}{8}$ inches. From apex to apex of the two groups, the distance is 10cm., or 4 inches; the difference between the arithmetic averages is 10·5cm., or $4\frac{1}{8}$ inches.

On 27th December, 1903, 147 whitings taken in the same locality were measured, two groups being represented. The first extended from 113mm. to 181mm., most being aggregated under 13cm. The second group extended from 207mm. to, apparently, 305mm., most being aggregated between 23cm. and 25cm. The numbers are too few, and the curves formed on the measurements too irregular, to enable any satisfactory comparison to be made between the two groups in this case.

Another collection of 955 whitings at Smith Bank, on 1st April, 1904, was represented almost entirely by one group, the second. It extended from 19cm. or 20cm. to 30cm. or 31cm. or 32cm.; most were aggregated between 22cm. and 26cm., the greatest number being under 23cm., and the mean size was about 24·5cm., or $9\frac{5}{8}$ inches. These fish were nearing their second year of age.

A small collection of 124 whitings taken in the same locality on 12th December, 1904, was limited almost entirely to the first group. It contained one whiting of 75mm. (3 inches), the next measuring 110mm., and the small fish were thus imperfectly represented. Most were aggregated between 13cm. and 16cm.

A few collections of whitings taken in Aberdeen Bay and neighbourhood were also measured. In one, on 13th May, at the "Doghole," or deep depression lying a few miles off the coast, in 55 fathoms, the 275 fish belonged mostly to the second group, the first being imperfectly indicated. The smallest whiting taken measured 115mm., or $4\frac{1}{2}$ inches. The majority were between 19cm. and 26cm., most being at 22cm., and the mean size was 22·5cm. or $8\frac{7}{8}$ inches.

In a collection of 148, on 11th February, 1905, in Aberdeen Bay, the smallest measured 76mm. The greatest number were between 11cm. and 14cm., most being at 13cm. ($5\frac{1}{8}$ inches), and the mean was a trifle higher.

On 29th March following 362 whitings were measured which belonged to the first group. The smallest measured 110cm. The greater number measured between 13cm. and 15cm. The apex of the curve of measurements was at 14cm. ($5\frac{1}{2}$ inches), and the mean was a trifle above this. These were approaching one year of age.

In a haul on 31st October, 1903, 701 whitings were obtained. In the first group the smallest whiting was 56mm. ($2\frac{1}{4}$ inches), and the largest 181mm., or thereabout. As in some other cases in autumn, the smaller fish formed a little semi-isolated group, suggesting a series of younger fishes, the ·5cm. grouping being as follows:—

5·5	6	6·5	7	7·5	8	8.5	9	9·5	10	10·5	11	11·5	
5	4	5	4	5	1	2	1	4	2	14	21	29	&c.

As I pointed out in my previous papers, these very young whitings have been leading a pelagic life, and now descend to the bottom when the seasonal change of temperature makes the water there warmer than the surface layers.

Most of the fishes in this series were aggregated between 10cm. and 16cm., the apex being at 13cm., as well as the mean, and the arithmetic average was 132mm., or nearly $5\frac{1}{4}$ inches. The grouping of the larger whitings is not very clear, but most of them measured from 21cm. to 30cm., the mean being about 25·5cm., or 10 inches, a difference of about 12·5cm., or about $4\frac{7}{8}$ inches from the average of the younger group.

In a collection made on 29th December, 1903, 498 whitings were obtained, nearly all belonging to the first group. Their sizes ranged from 115mm. to 180mm.; most were between 12cm. and 16cm., the greater number, or the apex of the curve, being 14cm. ($5\frac{1}{2}$ inches), which was also the mean.

The principal results in regard to the growth of the first group may be tabulated as follows :—

	Date.	Average Size.		Smallest Size.		Largest Size.	
		Cm.	Inches	Cm.	Inches	Cm.	Inches
Dornoch Firth,	22nd October, .	11	$4\frac{3}{8}$	5·1	2	17·6	$7\frac{3}{8}$
Do., . . .	11th November,	12	$4\frac{3}{4}$	5·8	$2\frac{1}{4}$	19·4	$7\frac{5}{8}$
Do., . . .	27th December,	13	$5\frac{1}{8}$	8·5	$3\frac{3}{8}$	21·1	$8\frac{1}{4}$
Do., . . .	7th December,	13·5	$5\frac{5}{16}$				
Burghead, .	20th October, .	10·5	$4\frac{1}{8}$	7·5	3	14·6	$5\frac{3}{4}$
Do., . . .	14th November	12	$4\frac{3}{4}$	8·1	$3\frac{1}{4}$	17·4	$6\frac{7}{8}$
Do.. . . .	28th December,	13	$5\frac{1}{8}$	7·5	3	18·5	$7\frac{1}{4}$
Off Kinnaird, .	23rd January, .	12	$4\frac{3}{4}$	7·6	3	16·5	$6\frac{1}{2}$
Smith Bank, .	23rd October, .	12·3	$4\frac{3}{4}$	8·7	$3\frac{1}{2}$	16·0	$6\frac{3}{8}$
Aberdeen Bay,	11th February,	13	$5\frac{1}{8}$	7·6	3		
Do., . .	29th March, .	14	$5\frac{1}{2}$	11·0	$4\frac{3}{8}$		
Do., . .	31st October, .	13	$5\frac{1}{8}$	5·6	$2\frac{1}{4}$	18·1	$7\frac{1}{8}$
Do., . .	29th December,	14	$5\frac{1}{2}$	11·5	$4\frac{1}{2}$	18·0	$7\frac{1}{8}$

The mean sizes of the second group of whitings varied as follows :—Burghead—20th October, 23·5cm., or $9\frac{1}{4}$ inches; 14th November, 27·5cm., or $10\frac{3}{4}$ inches. Smith Bank—1st April, 24·5cm., or $9\frac{5}{8}$ inches. Aberdeen Bay—13th May, 22·5cm., or $8\frac{7}{8}$ inches; 31st October, 22·5cm., or 10 inches.

GREY OR COMMON GURNARD (*Trigla gurnardus*).

The number of specimens of the grey gurnard measured in connection with the observations in this paper was 5495, belonging to about 50 collections.

Another paper in which the growth of this fish is dealt with was published in the *Seventeenth Annual Report.**

The spawning period of the gurnard is prolonged, extending from April to the latter part of August, and into September, or, according to Heincke and Ehrenbaum, to October; spawning is at its height in the early part of June. In May the duration of "incubation" is eight or ten days, but in

* "On the Migratory Movements and Rate of Growth of the Grey or Common Gurnard," Part III., p. 210.

June and July it is shorter, so that one may look to the period when the swarms of young gurnards appear as about the middle of June or a little later.

The gurnard reaches maturity at a minimum length of about 8 to 8½ inches, say, 20cm. to 22cm. Thus, in 201 which were fully mature, the smallest of the 17 males which were ripe measured 11 inches, and the smallest of the 184 females was 8½ inches. Of 49 males which were nearly mature the smallest was 9 inches, and of 273 females of the same class the smallest was 8½ inches.

Among 601 gurnards which were about half to three-parts mature, the smallest of the 172 males was 7½ inches, and the smallest of the 429 females was 8 inches.

While gurnards may be mature at the sizes stated, it must be remembered that they are the minimum sizes, and represent only the smallest fishes of the group which first reaches maturity. They may spawn in their third year, as I stated in my former paper as the probable age of first-maturity, but it is possible that they may not spawn till a year later, at least the female fishes, when the average size is somewhat larger.

Owing to the unusually prolonged spawning season, and the fact that it begins at a time when the temperature of the water has commenced to rise and ends when the temperature has fallen, one might expect that the young gurnards from the same spawning will show much difference in size.

Those which have been hatched at the commencement of the season, say in April or early in May, meet with a rising temperature and have the whole of the summer, the period most favourable for growth; while those hatched in September or October meet with a rapidly falling temperature and the winter period, which is as a rule unfavourable to growth.

Thus we find in September, in the tow-nets, gurnards as small as 5mm. to 6mm., that is to say, not very long hatched, and in October they may be 12mm. and 20mm.

I have made a Table of the post-larval and young gurnards obtained over a series of years, both in tow-nets and small-meshed trawl nets, which is appended. Almost all below about 30mm. were got by tow-nets, and most of those larger by the trawls. The places from which the collections came were Aberdeen Bay (A.), the Moray Firth (M.F.), Firth of Forth (F.), the Clyde (C.).

| TABLE.

GURNARD.

Mm.	August.				September.			October.				November.			Dec.	Feb.		May.	Summary.						
	I. MF. 8–26	II. A. 25	III. C. 24	IV. F. 29	I. MF. 2	II. A. 1–25	III. MF. 21	I. A. 8–13	II. C. 10	III. MF. 29	IV. F. 29	I. MF. 3–11	II. C. 26	III. A. 18–21	I. MF. 7–27	I. A. 11	II. MF. 9	I.	August.	September.	October.	November.	December.	February.	May.
5–6	10	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	10	1	..	..	..	..	..
7–8	11	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	11	..	..	..	..	..	..
9–10	4	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	4	2	..	..	..	..	..
11–12	1	..	..	..	..	..	2	..	..	1	..	..	..	..	..	..	..	..	2	2	1	..	..	..	..
13–14	2	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..
15–16	1	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..
17–18	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
19–20	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..
21–22	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..
23–24	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..
25–26	..	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..	..	..	..
27–28	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..
29–30	..	..	..	..	..	..	..	2	..	..	1	..	..	..	..	..	..	..	..	..	3	..	..	..	..
31–32	..	1	..	..	1	2	..	3	..	..	..	..	..	..	..	..	..	..	1	3	3	..	..	..	..
33–34	..	1	..	..	..	1	..	2	..	..	..	..	..	..	..	..	..	..	1	1	2	..	..	..	..
35–36	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
37–38	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
39–40	..	..	..	..	..	..	..	1	..	..	..	..	..	..	.	..	..	..	..	..	1	..	..	..	..
41–42	..	..	..	..	1	..	..	.	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
43–44	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
45–46	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	1	..	..
47–48	..	..	..	..	..	2	..	..	..	..	..	..	..	..	1	..	..	..	..	2	..	..	1	..	..
49–50	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
51–52	..	..	..	..	..	3	..	1	..	..	..	1	1	..	1	..	..	..	..	3	1	2	1	..	..
53–54	..	..	..	..	..	3	..	..	..	..	..	1	..	..	1	..	..	..	..	3	..	1	1	..	..
55–56	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
57–58	..	..	..	..	..	2	..	2	..	..	..	..	..	..	1	..	..	..	..	2	2	..	1	..	..
59–60	..	..	..	..	..	1	..	1	..	..	..	1	..	..	..	..	..	..	..	1	1	1	..	..	..
61–62	..	..	..	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..	..	..
63–64	..	..	..	..	..	1	..	1	..	..	..	2	..	1	..	..	..	..	..	1	1	3	..	..	..
65–66	..	..	..	..	..	..	..	1	..	..	..	2	..	1	..	..	..	..	..	..	1	3	..	..	..
67–68	..	..	..	..	..	1	..	2	..	..	..	3	..	..	..	..	2	..	..	1	2	3	..	2	..
69–70	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	1	..	..	..	..	..	1	..	1	..
71–72	..	..	..	..	..	1	..	1	1	1	..	1	..	..	..	..	..	..	..	1	3	1	..	..	..
73–74	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1	..	1	..	..	..	..	1	1	1	..
75–76	..	..	..	..	..	..	..	..	..	..	..	5	..	..	2	..	..	..	..	..	..	5	2	..	..
77–78	..	..	..	..	..	..	..	2	..	..	..	3	..	..	1	..	2	..	..	..	2	3	1	2	..
79–80	..	..	..	..	..	..	..	2	1	..	..	7	..	..	..	..	..	2	..	..	3	7	..	..	2
81–82	..	..	..	..	..	..	..	..	..	..	..	7	..	..	4	..	..	..	..	..	..	7	4	..	..
83–84	..	..	..	..	..	..	..	..	..	..	..	12	..	..	1	1	..	2	..	..	..	12	1	1	2

In this Table it will be noticed, especially in the columns in which the various collections in each month are summed up, that these small gurnards were got only in certain months, viz., August, September, October, November, December, February, and May. None under 5cm. were got in November, and none under 4·5cm. in December, while in February the smallest was 6·7cm., and in May 7·9cm. They do not appear in the collections before August, and the Table shows that their growth at this stage is fairly rapid.

In my former paper I gave a Table of all the small gurnards under 3 inches which were obtained by the fine-meshed trawl-nets of the "Garland," arranged according to months, and it may be summarised here. None under 3 inches (7·6cm) were caught between May and September—a fact also borne out by the above Table—and the greater number were obtained in October and September. The absence of the small gurnards was not due to hauls of the net not having been made in the intervening months, since 27 were made in June, July, and August. The number caught in each month in which hauls with the fine net were made, and the average number of gurnards under 3 inches taken per haul are given in the following Table :—

	Jan.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
Number of Hauls, .	12	41	34	10	6	11	23	25	13
Number of Gurnards under 3 in. (7·6cm.),	1	3	8	–	–	–	2	30	24
Average per Haul, .	0·08	0·07	0·23	0·0	0·0	0·0	0·09	1·2	1·8

The conclusion drawn from the facts was that those taken in January, April, and May belonged to the previous year, and that the absence of gurnards under 3 inches in June, July, and August was due to the growth in summer taking them above that size.

It was also concluded that the gurnards ranging about 6 inches (15cm.) in length in the spring were from 18 months to 2 years old; that the gurnard did not reach maturity until the third year; and that there appeared to be annual groups differing in length by about two inches from each other—the measurements having been in inches and fractions of an inch.

In the collections referred to in the present paper, the early groups are sometimes distinctly marked off from one another, and little difficulty has been experienced in determining the rate of growth of this fish.

It may be mentioned that the difficulty in regard to the prolonged spawning period, and the summer or winter season for the early and late larvæ to which reference has been made, is counteracted by a rather slow rate of growth on the part of this fish, and possibly by the growth in the winter not being retarded to the extent that is usual amongst other young fishes. In this respect the young gurnard offers a striking contrast to the young plaice or dab, which may be even shorter in early spring after passing through the cold winter months than they were at the onset of winter. In the latter case the habitat is in the shallow water, exposed to the changes in the air temperature and varying with it, whereas the gurnard is pre-eminently a migratory fish at all stages, and leaves the inshore waters for deeper water, where the temperature is higher, in autumn.

In my previous paper I showed that an extremely close relation existed between the changes of the temperature of the water and the abundance and migration of the gurnard, none of them entering the Firth of Forth until the temperature reached about 40·5° F. The average number of gurnards taken in that Firth per haul of the net in the various months of the year, and the mean bottom temperature, are as follows:—

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Gurnards, .	·02	·04	·29	11·1	44·2	30·2	24·0	21·6	18·9	8·4	1·1	·2
Temperature,	42·2	40·6	40·0	42·2	45·6	47·6	50·8	53·5	53·3	51·4	48·1	44·8

On the other hand, in the Moray Firth and the Firth of Clyde, where there is deep water, the gurnards moved out into the deeper water. Here are the similar details for the deep-water stations in the Moray Firth and for the Clyde:—

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Moray Firth—												
Gurnards, .	–	–	–	–	21·0	19·2	23·1	37·3	–	39·4	29·6	–
Temperature,	–	–	–	–	45·5	47·7	50·2	52·1	–	52·6	49·4	–
Clyde—												
Gurnards, .	13·6	0·0	26·5	22·2	18·6	–	10·6	63·6	11·8	27	19	31·1

There are not complete observations in regard to the Clyde to enable the mean temperature to be given, but they show that in January at the deeper stations, where the gurnards were chiefly caught, the temperature is from 47–48 F., and in December it is about 6 F. higher than in the Firth of Forth at the same period.

It is thus to be inferred, from what is known in regard to the relation between the temperature of the water and the growth of fishes, that the young gurnards do not cease growing in winter, but that, migrating to regions where the winter temperature is high, they continue to grow and are found to be larger in spring. The explanation is necessary to account for the different groups in the collections.

In a number of Tables appended to this paper the collections of gurnards have been tabulated in one-centimetre groups, but in many cases the limits of the groups are much better brought out by a ·5cm. arrangement of the measurements, and some of these will now be given.

I have arranged in the following Table the measurements of certain collections from Aberdeen Bay, the Firth of Forth, and the Dornoch Firth, in ·5cm. up to 34cm. The columns refer to the collections, as follows:—

Col.	I.	Aberdeen Bay,	Summary of	July collections.
,,	II.	,,	,, ,,	September collections.
,,	III.	,,	,, ,,	October collections.
,,	IV.	Dornoch Firth,	Summary of	November collections.
,,	V.	Burghead Bay,	,,	September collections.
,,	VI.	Firth of Forth,	,,	May collections.
,,	VII.	,,	,, ,,	July collections.

Col VIII. Firth of Forth, Summary of August collections.
„ IX. Summary of all July collections.
„ X. „ „ October collections.
„ XI. „ „ November collections.

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
2	–	–	–	–	–	–	–	–	–	–	–
·5	–	1	1	–	–	–	–	–	–	–	–
3	–	1	4	–	–	–	–	–	–	4	–
·5	–	1	1	–	–	–	–	–	–	1	–
4	–	–	–	–	–	–	–	–	–	–	–
·5	–	1	–	–	–	–	–	–	–	–	–
5	–	6	1	–	–	–	–	–	–	1	2
·5	–	4	2	1	–	–	–	–	–	2	1
6	–	3	3	2	–	–	–	–	–	3	2
·5	–	1	3	3	–	–	–	–	–	3	5
7	–	1	1	3	–	–	–	–	–	2	3
·5	–	–	3	10	–	2	–	–	–	3	14
8	–	–	2	14	–	2	–	–	–	1	20
·5	–	–	1	13	–	1	–	–	–	2	15
9	–	2	1	12	–	4	–	–	–	1	15
·5	1	1	1	7	–	4	–	–	1	1	8
10	1	–	–	7	–	–	–	–	1	–	10
·5	11	–	2	4	–	2	–	1	11	2	5
11	24	–	1	4	–	–	1	2	25	1	5
·5	26	1	1	–	–	2	6	3	32	1	1
12	28	1	3	1	–	–	6	9	34	4	1
·5	14	1	3	3	–	3	10	14	24	3	4
13	7	6	4	1	–	1	5	14	12	12	5
·5	3	5	6	–	–	–	4	14	7	15	2
14	4	7	5	–	1	1	1	9	5	7	6
·5	5	10	6	–	–	4	4	8	9	14	13
15	4	11	7	–	–	2	5	2	9	18	20
·5	7	6	8	2	4	2	7	1	14	12	34
16	8	3	5	–	2	4	8	2	16	12	37
·5	9	1	4	1	1	5	26	2	36	14	36
17	19	2	2	1	3	1	9	3	28	10	19
·5	11	2	1	1	4	7	18	3	32	9	14
18	9	3	–	–	6	2	9	2	19	4	18
·5	10	–	1	1	21	1	11	3	24	6	21
19	4	4	1	1	21	1	5	2	10	9	24
·5	4	5	–	1	32	3	2	3	7	4	22
20	3	4	–	1	21	2	2	4	5	8	27
·5	4	8	1	2	27	1	–	3	4	4	37
21	4	3	2	4	20	4	1	2	5	4	36
·5	–	4	4	1	10	4	1	1	3	7	29
22	2	1	1	–	16	1	2	2	4	8	28
·5	–	4	2	–	8	3	2	1	3	6	22
23	1	3	–	–	6	–	2	1	4	3	19
·5	3	–	1	–	16	1	–	3	6	3	23
24	2	–	–	–	9	1	1	–	5	1	18
·5	1	2	1	–	28	–	1	5	2	5	19
25	1	1	1	–	18	1	–	1	2	1	17
·5	–	–	1	–	21	3	1	3	2	3	18
26	–	1	–	–	12	1	–	–	1	1	21
·5	1	–	–	–	21	1	1	–	2	–	14
27	1	1	–	1	15	4	–		3	2	22
·5	–	1	1	–	19	1	–	2	1	3	12
28	–	2	1	1	13	1	–	1	1	2	11
·5	1	–	–	–	9	2	–	1	1	2	17
29	–	1	–	1	5	–	–	–	2	2	17
·5	–	–	–	–	14	1	–	1	–	5	10
30	1	–	–	–	10	3	–	–	1	2	13
·5	–	–	–	–	13	3	–	–	–	4	9
31	–	–	–	–	11	2	1	1	1	4	12
·5	–	–	–	–	8	1	2	–	2	8	10
32	–	–	–	–	6	2	–	3	–	9	4
·5	–	–	–	2	3	1	–	2	–	5	11
33	–	–	–	–	6	–	–	–	–	8	–
·5	–	–	–	–	10	–	–	–	–	8	–
34	–	–	–	–	3	1	–	1	–	3	–

In many of these cases the division into groups is obvious. A few of them may be considered in detail, in order to make clear the rate of growth.

In the Firth of Forth, in May, from 9th to 13th, a number of gurnards were taken, belonging to at least five annual series (pl. XIII.). The smallest, representing the fishes from the previous year's spawning, and being therefore from seven months to fully a year old, and principally about eleven months, numbered 21. They varied in size from 7·9cm. to 13·1cm. ($3\frac{1}{8}$–$5\frac{1}{8}$ inches), a range or difference of 5·2cm.; the maximum number measured about 9cm. (the apex, mode or maximum ordinate, of the curve), the mean was about 10·5cm., and the arithmetical average 0·1cm., or 4 inches.

The next group numbered 32, varying in size from 14cm. to 19·1cm. ($5\frac{1}{2}$–$7\frac{1}{2}$ inches), and were a year older, on an average about 1 year and 11 months. The maximum number were at 16·5cm., the mean was 16cm., and the arithmetical average 16·21cm., or $6\frac{3}{8}$ inches. The growth from the previous series was thus about 6·1cm., or $2\frac{3}{8}$ inches, which represents the increment in a year.

The third series numbered 20, the range was from 19·6cm. to 24·1cm., ($7\frac{3}{4}$–$9\frac{1}{2}$ inches), the maximum number were at 21cm., the mean was 21·3cm., and the arithmetical average was 21·54cm., or $8\frac{1}{2}$ inches. These fishes were very nearly three years old, and the growth indicated in a year from the preceding group was 5·3cm., or $2\frac{1}{16}$ inches.

The fourth series numbered 14, varying in length from 25·2cm. to 28·9cm. ($9\frac{15}{16}$–$11\frac{3}{8}$ inches); the maximum number were at 27cm., the mean was 26·5cm., and the average 27cm., or $10\frac{5}{8}$ inches. The indicated growth in a year amounted to 5·46cm., or $2\frac{1}{8}$ inches. These gurnards were approximately four years old.

A fifth series consisted of 13 fish, varying from 29·7cm. to 32·5cm. ($11\frac{3}{4}$–$13\frac{3}{4}$ inches); the maximum number were at 30cm., the mean was 31cm., and the calculated arithmetical average was 30·97cm., or $12\frac{1}{8}$ inches. The growth from the previous series was about $1\frac{1}{2}$ inches, and the age of the series nearly five years.

Towards the end of July another collection from the Firth of Forth was examined (pl. XIII.). The first series of 32 varied from 11cm. to 13·7cm. ($4\frac{3}{8}$–$5\frac{3}{8}$ inches), and was obviously incomplete by the absence of many of the smaller gurnards, the range of sizes amounting to only 2·7cm. The maximum number were at 12·5cm., the mean was the same, and the average 12·4cm., or $4\frac{15}{16}$ inches. These fish were probably rather over one year of age.

The second group was represented by 107 gurnards, ranging in length from 14·3cm. to 20·2cm. ($5\frac{5}{8}$–$7\frac{15}{16}$ inches); the maximum number were at 16·5cm., the mean was 17cm., and the average was 17·1cm., or $6\frac{3}{4}$ inches. The indicated growth from the previous generation was 4·7cm., which is too small, owing to the reason stated—the absence of the smaller fishes.

The next group numbered 12, varying from 21cm. to 26·5cm.; the maximum number were at 22·5cm., the mean was 23·5cm., and the calculated average 23·3cm., or $9\frac{3}{16}$ inches. These fish were about three years of age, and the growth indicated from the previous series was 6·2cm., or $2\frac{7}{16}$ inches, which is too great.

In the August collection (pl. XIII.), the first series included 78 gurnards from 10·8cm. to 15·6cm. ($4\frac{1}{4}$–$5\frac{3}{8}$ inches); the maximum number or mode was about 13cm., which was also the mean, while the computed average was 13·14cm., or $5\frac{1}{8}$ inches. These fish were about 13 or 14 months old.

The second series numbered 33 fishes, the sizes ranging from 16·4cm. to 22·6cm. ($6\frac{1}{2}$–$8\frac{7}{8}$ inches); the maximum numbers were at 20cm., the

mean was 19cm., and the average 19·26cm., or $7\frac{5}{8}$ inches. The growth indicated in a year, from the former series, was 6·12cm., or $2\frac{7}{16}$ inches. These fishes were over two years of age.

In this collection there were also a few of larger size, but their number is not sufficient to indicate grouping.

From Aberdeen Bay a number of collections were also obtained, some of which may be referred to (pl. XIII.).

On the 5th July, the first series was represented by 109 gurnards, measuring from 9·7cm. to 13·8cm. ($3\frac{13}{16}$–$5\frac{1}{2}$ inches); the greater number measured about 11·5cm. to 12cm., the mean was 12cm., and the computed average 11·56cm., or $4\frac{9}{16}$ inches. These fish were about a year old.

The next series included 61 gurnards from 14·2cm. to 19·9cm. ($5\frac{5}{8}$–$7\frac{7}{8}$ inches). The maximum number were at 17cm., the mean size was also 17cm., and the computed average 16·90cm., or $6\frac{5}{8}$ inches. The amount of growth indicated in a year from the preceding series was thus about 5·34cm., or $2\frac{1}{8}$ inches.

On the 30th and 31st July, the first series comprised 12 gurnards from 11·2cm. to 15·1cm. ($4\frac{3}{8}$–6 inches). The maximum number were at 14cm., the mean was 13cm., and the average 13·49cm., or $5\frac{5}{16}$ inches, which is about 1cm. greater than it ought to be, owing to the absence of small fishes.

The next series consisted of 33 gurnards, measuring from 16·7cm. to 21·4cm. ($6\frac{9}{16}$–$8\frac{7}{16}$ inches). The maximum number were at 18·5cm., the mean was the same, and the average was 18·73cm., or $7\frac{3}{8}$ inches. These fish were over two years old, and the amount of growth indicated in a year from the preceding series was 5·24cm., or 2 inches, which is rather under the normal, owing to the absence of small fishes in the preceding series.

On 1st September the young gurnards are represented in the collection. On that day 17 were taken, measuring from 32mm. to 71mm. ($1\frac{1}{4}$–$2\frac{3}{4}$ inches); the maximum number were at 5cm., which was also the mean, and the computed average was 54·1cm., or $2\frac{1}{8}$ inches. The age of these fishes was probably 3 or 4 months.

On the 20th September five of this series were got, measuring from 5·3cm. to 9·7cm., but the October collection shows that the smaller fishes were not present.

The second group numbered 52, varying in length from 11·6cm. to 16·7cm. ($4\frac{9}{16}$–$6\frac{9}{16}$ inches); the maximum was 15cm., the mean 14cm., and the average 14·57cm., or $5\frac{3}{4}$ inches, the probable age being about 16 months.

In the third series there were 37 gurnards, ranging from 17·2cm. to 22cm. ($6\frac{3}{4}$–$8\frac{3}{4}$ inches); the maximum number were at 20·5cm., the mean was 19·5cm., and the average 20·02cm., or $7\frac{7}{8}$ inches. The growth of this series, about 2 years and 4 months of age, was apparently 5·45cm., or $2\frac{1}{8}$ inches in the year.

A collection on the 13th October contained 24 gurnards of the first series. They varied in length from 2·1cm. to 8cm. ($\frac{7}{8}$–$3\frac{1}{8}$ inches); the maximum number were at 6cm., and the mean was 6cm., the computed average being 4·65cm., or $1\frac{13}{16}$ inches, which is too small, owing to the smaller fishes being over-represented.

The next series included 18 gurnards, from 12cm. to 16·8cm. ($4\frac{3}{4}$–$6\frac{5}{8}$ inches); the maximum number were at 14·5cm., the mean was the same, and the average 14·63cm., or $5\frac{3}{4}$ inches. These fish were about 1 year and 4 months old.

The third series comprised only two fishes, 19·3cm. and 22·8cm. in length.

On 8th October another collection contained four of the first group. They varied from 5·7cm. to 8·5cm. The second group consisted of 15 fishes, from 10·9cm. to 17·4cm. ($4\frac{5}{16}$–$6\frac{7}{8}$ inches); the mean was 14·5cm., and the average 14·49cm., or $5\frac{3}{4}$ inches.

A third series was represented by five fishes, from 21·3cm. to 22·7cm., the average being 21·72cm., or $8\frac{9}{16}$ inches. The smaller fishes of the series were not present.

Another collection, from the Dornoch Firth on 5th and 11th November, may be referred to. The first group contained 82 gurnards, from 5·9cm. to 11·3cm. ($2\frac{5}{16}$–$4\frac{7}{16}$ inches); the maximum number were at 8cm., the mean was about 8·3cm., and the average 8·44cm., or $3\frac{5}{16}$ inches.

There were eleven gurnards in the next group, the sizes ranging from 12·1cm. to 18·5cm., ($4\frac{3}{4}$–$7\frac{5}{16}$ inches); the mean was 15cm., and the average 14·98cm., or $5\frac{15}{16}$ inches. The apparent growth in the year from the preceding generation was thus 6·54cm., or $2\frac{9}{16}$ inches.

The third series contained ten fishes, from 19·2cm. to 21·5cm. ($7\frac{9}{16}$–$8\frac{5}{16}$ inches). The maximum number were at 21cm., and the average was at 20·62cm., or $8\frac{1}{8}$ inches. These fishes were in the middle of their third year; the apparent growth from the previous series was 5·64cm., or $2\frac{3}{16}$ inches.

The other groups were represented by a few fishes. An examination of the figures in the Tables appended will show that the growth in the Firth of Forth in 100 days, from the early part of May to the middle of August, amounted for the first group, that is, fish about a year or more of age, to 3cm., or $1\frac{3}{16}$ inches. Precisely the same amount is indicated for the growth of the corresponding series in 100 days, from the beginning of July to the middle of October, in Aberdeen Bay. The older group, fish about two years or over, increased also by 3cm., in the 100 days in the Forth, and by 1·83cm. in 25 days and 1·29cm. in 76 days in Aberdeen Bay.

Date and Place.	Number of Days.	Series I.		Series II.	
		Average Size.	Increase.	Average Size.	Increase.
		Cm.	Cm.	Cm.	Cm.
Aberdeen Bay.					
Summer.					
5th July,	–	11·56	–	16·90	–
30th–31st July,	25	(13·49)	1·93	18·73	1·83
20th September,	76	14·57	3·01	20·02	1·29
13th October,	100	14·63	3·07	–	–
Winter.					
5th July,	265	16·90	2·27	–	–
Firth of Forth.					
Summer.					
9th–13th May,	–	10·1	–	16·2	–
23rd July,	73	12·40	2·29	17·1	0·9
16th–21st August,	100	13·14	3·03	19·26	3·06
Winter.					
9th–13th May,	265	16·21	3·07	21·54	2·28

About half the growth thus takes place during the few months in summer, the growth in the 100 days being almost exactly the same as in the remaining 265 days, which include the winter months.

If the differences between the averages of the successive series are considered, as in the following Table, it will be found that between the first and second groups the differences vary from 5·24cm. to 9·98cm., and the mean of this is 6·40cm., or $2\frac{1}{2}$ inches. It appears, however, to be a trifle too high. The best collections, in which the series are most equally represented at the different sizes, indicate a very slightly smaller rate of growth. It may be said that the gurnard in the early generations grows about 6·0cm., or $2\frac{3}{8}$–$2\frac{1}{2}$ inches, in a year.

In the later generations growth is slower. In some of the collections five or six series belonging to different years can be made out.

In some large collections made during the spawning period, in Sinclair Bay, Moray Firth, the sexes were determined and separately measured, but the tables of measurements and the curves constructed on them did not show the grouping very clearly. The clue furnished by the study of the smaller collections above described enables the divisions between the earlier series to be indicated, and it will be seen they agree with the statements made as to the grouping and the rate of growth. These collections from the northern part of the Moray Firth show that at least eight or nine generations are present.

GURNARD.

Date and Place.	Group	No.	Range of Size. Cm	Difference. Cm.	Modal Size.	Mean Cm.	Arithmetic Average.		Approximate Age.		Apparent Growth from Preceding Series.	
							Cm.	Inch.	Years	M'ths	Cm.	Inch.
FIRTH OF FORTH—												
May 9–13, 1901, - -	I	21	7·9–13·1	5·2	9	10·5	10·11	4	..	11	..	..
	II.	32	14 0–19·1	5·1	16·5	16	16·21	$6\frac{3}{8}$	1	11	6·1	$2\frac{7}{16}$
	III.	20	19·6 24·1	4·5	21	21·3	21·54	$8\frac{1}{2}$	2	11	5·3	$2\frac{1}{16}$
	IV.	14	25·2 28·9	3·7	27	26·5	27·0	$10\frac{5}{8}$	3	11	5·46	$2\frac{1}{8}$
	V.	13	29·7–32·5	2·8	30	31	30·97	$12\frac{1}{8}$	4	11	3·97	..
	..	3	34·3	..	..	..	..	..	..	..	..	..
July 23, 1901, - -	I.	32	11·0 13·7	2·7	12 5	12·5	[12·4	$4\frac{15}{16}$]	1	1	..	..
	II.	107	14·3 20·2	5·9	16·5	17	17·1	$6\frac{3}{4}$	2	1	[4·7	$1\frac{7}{8}$]
	III.	12	21·0–26·5	5·5	22·5	23·5	23·3	$9\frac{3}{16}$	3	1	6·2	$2\frac{7}{16}$
August 16–21, 1901, -	I.	78	10·8–15·6	4·8	13	13	13·14	$5\frac{1}{4}$	1	1–2	..	..
	II.	33	16·4–22·6	6·2	20	19	19·26	$7\frac{5}{8}$	2	1–2	6·12	$2\frac{7}{16}$
ABERDEEN BAY—												
July 5, 1901, - -	I.	109	9·7–13·8	4·1	11·5–12	12	11·56	$4\frac{9}{16}$	1	..	.	.
	II.	61	14·2–19·9	5·7	17	17	16·90	$6\frac{5}{8}$	2	..	5·34	$2\frac{1}{8}$

GURNARD—*continued.*

Date and Place	Group	No.	Range of Size. Cm.	Difference. Cm.	Modal Size.	Mean Cm.	Arithmetic Average. Cm.	Arithmetic Average. Inch.	Approximate Age. Years	Approximate Age. M'ths.	Apparent Growth from Preceding Series. Cm.	Apparent Growth from Preceding Series. Inch.
Aberdeen Bay—*contd.*												
July 30–31, - - -	I.	12	11·2–15·1	3·9	14	13	[13·49	$5\frac{5}{16}$]	1	1	..	..
	II.	33	16·7–21·4	4·7	18·5	18·5	18·73	$7\frac{3}{8}$	2	1	5·24	$2\frac{1}{16}$
September 1, - -	I.	17	3·2– 7·1	3·9	5	5	54·1	$2\frac{1}{8}$	..	3–4	..	..
September 20, - -	I.	5	5·3– 9·7	4·4	..	..	..	..	..	4	..	..
	II.	52	11·6–16·7	5·1	15	14	14·57	$5\frac{3}{4}$	1	4	..	..
	III.	37	17·2–22·0	4·8	20·5	19·5	20·02	$7\frac{7}{8}$	2	4	5·45	$2\frac{1}{8}$
October 13, - - -	I.	24	2·1– 8·0	5·9	6	6	4·65	..	..	4	..	..
	II.	18	12·0–16·8	4·8	14·5	14·5	14·63	$5\frac{3}{4}$	1	4	..	..
	III.	2	19·3–22·8	..	..	..	..	..	..	..	..	..
October 8, - - -	I.	4	5·7– 8·5	2·8	..	..	..	..	..	4	..	..
	II.	15	10·9–17·4	6·5	..	14·5	14·49	$5\frac{3}{4}$	1	4	..	..
	III.	5	21·3–22·7	1·4	..	..	21·72	$8\frac{9}{16}$	2	4	..	..
Dornoch Firth—												
November 5–11, 1901, -	I.	82	5·9–11·3	5·4	8	8·3	8·44	$3\frac{5}{16}$	..	5	..	..
	II.	11	12·1–18·5	6·4	..	15	14·98	$5\frac{15}{16}$	1	5	6·54	$2\frac{9}{16}$
	III.	10	19·2–21·5	2·3	21	..	20·62	$8\frac{1}{8}$	2	5	5·64	$2\frac{3}{16}$
	IV.	3	27·0,28·0,29·4	..	..	..	..	..	..	..	..	..

I.—PLAICE, LOCHFYNE, 1901.

PUSH-NET.

(1) JULY.

Col. I.	Big Harbour,	1st and 3rd
,, II.	Salen,	2nd
,, III.	Strachur,	4th and 5th
,, IV.	Inveraray,	4th and 5th
,, V.	Lochgilphead,	2nd
,, VI.	Cairndow,	6th

(2) AUGUST.

Col. I.	Big Harbour,	28th, 29th
,, II.	Salen,	29th
,, III.	Strachur,	30th
,, IV.	Inveraray,	30th, 31st

	JULY.							AUGUST.				
MM.	I.	II.	III.	IV.	V.	VI.	Total.	I.	II.	III.	IV.	Total.
11	–	–	–	–	–	–	–	–	–	–	–	–
12	5	–	–	–	–	–	5	–	–	–	–	–
13	5	–	–	–	–	–	5	–	–	–	–	–
14	6	1	–	–	–	–	7	–	–	–	–	–
15	9	–	–	–	–	–	9	–	–	–	–	–
16	8	1	1	–	–	–	10	–	–	–	–	–
17	3	3	–	–	–	–	6	–	–	–	–	–
18	11	3	4	–	–	–	18	–	–	–	–	–
19	11	8	8	1	–	–	28	–	–	–	–	–
20	16	22	10	–	–	–	48	–	–	–	–	–
21	23	25	10	–	–	–	58	–	–	–	–	–
22	31	51	25	–	–	–	107	–	–	–	–	–
23	39	70	36	5	–	–	150	–	–	–	–	–
24	54	80	54	4	1	–	193	–	–	–	–	–
25	76	114	52	8	1	–	251	–	–	–	–	–
26	75	97	42	3	1	–	218	–		–	–	–
27	86	89	69	14	–	–	258	–	–	–	–	–
28	67	70	64	18	2	1	222	–	–	–	–	–
29	67	62	59	42	3	1	234	–	–	–	–	–
30	56	44	46	68	1	2	217	–	–	–	–	–
31	49	18	44	78	–	–	189	–	–	–	–	–
32	39	10	27	91	5	1	173	–	–	–	–	–
33	15	8	25	82	5	–	135	–	–	–	–	–
34	16	5	14	92	2	–	129	1	–	2	–	3
35	10	4	11	94	2	–	121	–	–	2	–	2
36	7	6	17	86	2	2	120	–	–	1	–	1
37	8	5	12	81	2	2	110	1	–	3	–	4
38	7	1	10	71	3	–	92	–	–	3	–	3
39	6	1	7	55	1	–	70	2	–	7	–	9
40	4	2	6	49	5	–	66	3	–	4	–	7
41	2	2	2	31	2	1	40	7	1	5	–	13
42	1	–	3	31	3	–	38	10	3	5	–	18
43	2	1	1	26	2	–	32	4	–	5	–	9
44	1	–	2	22	–	–	25	10	1	4	–	15
45	1	–	1	22	4	1	29	10	2	1	–	13
46	–	–	1	18	5	–	24	6	3	2	–	11
47	2	–	2	15	–	–	19	17	3	2	–	22
48	1	–	1	9	2	–	13	15	3	2	1	21
49	1	2	–	8	–	1	12	16	8	1	–	25
50	1	–	1	10	1	–	13	15	4	2	–	21
51	1	1	1	8	1	–	12	14	7	1	1	23
52	–	–	–	7	1	1	9	21	1	–	–	22
53	–	–	–	3	–	–	3	13	3	1	–	17
54	–	–	–	2	–	–	2	16	3	–	–	19
55	–	–	–	3	–	–	3	17	2	1	2	22
56	–	–	–	2	–	–	2	14	3	–	1	18
57	–	–	–	3	–	–	3	12	2	–	4	18
58	–	–	–	1	–	–	1	9	–	–	1	10
59	–	–	–	–	–	–	–	8	1	2	4	15
60	–	–	–	–	–	–	–	10	1	1	8	20
61	–	–	–	–	–	–	–	8	–	1	5	14
62	–	–	–	–	–	–	–	3	–	–	11	14
63	–	–	–	–	–	–	–	3	–	1	12	16
64	–	–	–	–	–	–	–	5	–	–	6	11
65	–	–	–	–	–	–	–	2	–	–	9	11
66	–	–	–	–	–	–	–	2	–	–	6	8
67	–	–	–	–	–	–	–	1	–	1	9	11
68	–	–	–	–	–	–	–	–	–	2	5	7
69	–	–	–	–	–	–	–	4	–	1	5	10
70	–	–	–	–	–	–	–	1	–	–	8	9
71	–	–	–	–	–	–	–	2	–	–	3	5
72	–	–	–	–	–	–	–	2	1	–	7	10
73	–	–	–	–	–	–	–	–	–	2	3	5
74	–	–	–	–	–	–	–	1	–	1	2	4

I.—PLAICE, LOCHFYNE, 1901—*continued.*

	July.							August.				
MM.	I.	II.	III.	IV.	V.	VI.	Total.	I.	II.	III.	IV.	Total.
75	–	–	–	–	–	–	–	2	–	3	5	10
76	–	–	–	–	–	–	–	–	–	1	1	2
77	–	–	–	–	–	–	–	1	–	1	3	5
78	–	–	–	–	–	–	–	1	–	–	1	2
79	–	–	–	–	–	–	–	1	–	1	4	6
80	–	–	–	–	–	–	–	–	–	–	2	2
81	–	–	–	–	–	–	–	–	–	1	–	1
82	–	–	–	–	–	–	–	–	–	1	2	3
83	–	–	–	–	–	–	–	1	–	1	–	2
84	–	–	–	–	–	–	–	–	–	1	–	1
85	–	–	–	–	–	–	–	–	–	–	1	1
86	–	–	–	–	–	–	–	1	–	1	–	2
87	–	–	–	–	–	–	–	–	–	1	1	2
88	–	–	–	–	–	–	–	–	–	1	–	1
	822	806	668	1163	57	13	3529	292	52	79	133	556

II.—PLAICE, LOCHFYNE, 1903.

PUSH-NET.

MM.	Inveraray.		Strachur.		Big Harbour.		Loch-gilp-head.	Total, June	Total, July
	June 22	July 10–11	June 24	July 13	June 25	July 13	June 26		
14	–	–	–	–	–	–	–	–	–
15	–	–	5	–	–	–	–	5	–
16	–	–	9	–	–	–	–	9	–
17	1	1	12	–	1	–	1	15	1
18	1	2	11	–	1	–	–	13	2
19	1	2	12	1	3	3	1	17	6
20	4	2	11	4	2	4	1	18	10
21	5	–	6	3	2	5	2	15	8
22	5	3	6	5	3	6	–	14	14
23	8	4	5	6	4	6	–	17	16
24	5	8	6	4	6	12	–	17	24
25	5	7	3	4	1	19	–	9	30
26	2	8	4	3	1	27	–	7	38
27	3	7	3	5	–	27	–	6	39
28	8	4	–	5	1	30	1	10	39
29	6	5	1	2	–	26	1	8	33
30	8	6	–	1	–	29	–	8	36
31	4	9	–	–	–	24	1	5	33
32	7	8	–	–	–	17	–	7	25
33	3	8	–	1	–	17	–	3	26
34	2	6	–	–	–	7	1	3	13
35	2	3	–	–	–	7	–	2	10
36	1	3	–	1	–	6	1	2	10
37	–	1	–	1	–	4	–	–	6
38	–	1	–	–	–	5	–	–	6
39	1	1	–	1	–	2	–	1	4
40	–	2	–	–	–	–	–	–	2
41	–	–	–	–	–	2	–	–	2
42	1	–	–	–	–	1	1	2	1
43	–	–	–	–	–	1	1	1	1
44	2	1	–	–	–	2	–	2	3
45	–	–	–	–	–	–	–	–	–
46	–	–	–	1	–	1	1	1	2
47	1	1	–	1	–	–	–	1	2
48	–	1	–	–	–	2	–	–	3
49	–	–	–	–	–	–	–	–	–
50	–	1	–	–	–	–	–	–	1
51	–	–	–	–	–	1	–	–	1
52	–	–	–	–	–	–	–	–	–
53	–	–	–	–	–	–	–	–	–
54	–	–	–	–	–	–	–	–	–
55	–	–	–	–	–	–	–	–	–
56	–	–	–	–	–	–	–	–	–
57	–	–	–	1	–	–	–	–	1
	86	105	94	50	25	293	13	218	448

III.—PLAICE, LOCHFYNE, 1901.

PUSH-NET.

(*Preceding Table arranged in ·5 Centimetres.*)

(1) JULY.
Col. I. Big Harbour.
,, II. Salen.
,, III. Strachur.
,, IV. Inveraray.
,, V. Lochgilphead.
,, VI. Cairndow.

(2) AUGUST.
Col. I. Big Harbour.
,, II. Salen.
,, III. Strachur.
,, IV. Inveraray.

	JULY 1–6.							AUGUST 28–31.				
CM.	I.	II.	III.	IV.	V.	VI.	Total.	I.	II.	III.	IV.	Total.
1	5	–	–	–	–	–	5	–	–	–	–	–
·5	31	5	1	–	–	–	37	–	–	–	–	–
2	92	109	57	1	–	–	259	–	–	–	–	–
·5	330	450	253	34	3	–	1070	–	–	–	–	–
3	278	204	240	297	11	5	1035	–	–	–	–	–
·5	56	28	79	435	13	4	615	2	–	8	–	10
4	20	6	28	237	14	1	306	22	4	24	–	50
·5	6	1	7	103	11	1	129	47	9	14	–	70
5	4	3	3	42	5	2	59	81	23	6	2	112
·5	–	–	–	13	–	–	13	72	13	2	7	94
6	–	–	–	1	–	–	1	38	2	4	29	73
·5	–	–	–	–	–	–	–	13	–	2	42	57
7	–	–	–	–	–	–	–	9	1	3	28	41
·5	–	–	–	–	–	–	–	4	–	8	14	26
8	–	–	–	–	–	–	–	2	–	3	9	14
·5	–	–	–	–	–	–	–	2	–	4	2	8
9	–	–	–	–	–	–	–	–	–	1	–	1
	822	806	668	1163	57	13	3529	292	52	79	133	556

1903.

	JUNE 22–26.					JULY 10–13.			
CM.	I.	II.	III.	IV.	Total.	I.	II.	III.	Total.
1	–	–	–	–	–	–	–	–	–
·5	1	26	1	1	29	1	–	–	1
2	16	46	11	4	77	9	13	18	40
·5	23	21	12	–	56	34	22	91	147
3	33	1	1	3	38	32	8	126	166
·5	8	–	–	2	10	21	3	41	65
4	2	–	–	1	3	4	1	10	15
·5	3	–	–	2	5	2	2	4	8
5	–	–	–	–	–	2	–	3	5
·5	–	–	–	–	–	–	1	–	1
	86	94	25	13	218	105	50	293	448

IV.—PLAICE.

CM.	ABERDEEN BAY (Donmouth to Bathing Station).									DORNOCH FIRTH.				ANNAN.										
	21st Mar. 1904.	8th April 1904.	16th April 1904.	26th April 1904.	12th May 1904.	18th May 1904.	1st Sept. 1904.	19th Nov. 1904.	5th May 1905.	31st March, 1904.			9th Feb. 1905.	12th April, 1904.			23rd April, 1904.				28th April, 1904.			Total, April.
										Fem.	Male.	Total.		Fem.	Male.	Total.	Fem.	Male.	?	Total.	Fem.	Male.	Total.	
4	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	3	3	–	–	–	4
·5	2	–	–	–	–	–	1	1	1	–	–	–	–	5	2	7	–	–	45	45	–	1	1	53
5	3	–	1	–	–	–	–	–	4	–	–	–	1	6	7	13	2	–	73	75	–	2	2	90
·5	4	–	1	–	–	1	1	–	10	–	–	–	7	3	2	5	1	2	34	37	–	2	2	44
6	–	–	1	–	1	3	–	–	4	–	–	–	20	–	–	–	1	3	7	11	–	3	3	14
·5	2	1	4	–	–	–	–	1	8	–	–	–	39	1	2	3	3	3	2	8	1	4	5	16
7	–	–	1	–	–	–	–	1	4	–	–	–	57	–	1	1	5	8	–	13	2	9	11	25
·5	2	–	3	2	–	–	–	–	4	–	–	–	58	3	1	4	12	8	–	20	2	9	11	35
8	–	–	3	–	–	–	2	1	4	–	–	–	52	1	2	3	11	8	–	19	5	5	10	32
·5	–	–	–	–	–	–	–	–	2	–	–	–	26	3	2	5	6	8	–	14	3	14	17	36
9	1	–	1	2	1	1	–	–	3	–	1	1	15	7	1	8	11	6	–	17	9	13	22	47
·5	–	1	–	–	–	–	–	–	1	–	–	–	4	11	5	16	8	12	–	20	14	23	37	73
10	–	–	–	–	–	–	–	–	–	–	–	–	3	8	11	19	13	15	–	28	14	33	47	94
·5	–	–	–	–	–	–	–	–	–	–	–	–	3	8	10	18	7	7	–	14	21	23	44	76
11	–	–	–	–	1	–	–	1	–	–	1	1	1	10	8	18	3	9	–	12	17	23	40	70
·5	–	–	–	1	–	–	–	–	1	–	–	–	6	11	9	20	5	6	–	11	14	20	34	65
12	–	–	1	–	–	–	–	2	–	1	–	1	6	7	5	12	3	2	–	5	11	21	32	49
·5	–	–	–	–	–	–	–	–	–	–	–	–	8	11	8	19	2	6	–	8	16	13	29	56
13	–	–	–	–	–	–	–	1	–	1	2	3	13	7	4	11	5	1	–	6	8	7	15	32
·5	–	–	–	–	–	–	–	–	–	1	3	4	8	10	13	23	2	2	–	4	4	3	7	34
14	–	–	–	–	–	–	–	–	–	1	2	3	7	11	12	23	5	1	–	6	2	1	3	32
·5	–	–	–	–	–	–	–	–	–	–	–	–	12	9	11	20	2	2	–	4	–	1	1	25
15	–	–	–	–	–	–	–	–	–	–	3	3	4	1	9	10	1	2	–	3	4	–	4	17
·5	–	–	–	–	–	1	–	–	–	2	1	3	4	5	7	12	1	1	–	2	–	–	–	14
16	–	–	–	–	–	1	–	–	–	1	4	5	1	6	7	13	3	–	–	3	–	–	–	16
·5	–	1	–	–	–	–	1	–	–	–	3	3	–	5	7	12	–	–	–	–	–	–	–	12
17	–	–	–	–	–	–	–	1	–	–	–	–	–	4	3	7	1	–	–	1	–	–	–	8
·5	–	–	–	1	–	1	–	–	–	–	1	1	–	1	–	1	–	–	–	–	–	–	–	1
18	–	–	–	–	–	–	–	1	–	–	–	–	–	2	3	5	1	–	–	1	–	–	–	6
·5	–	–	–	1	–	–	–	–	–	–	1	1	–	1	–	1	–	–	–	–	–	–	–	1

19	–	–	1	–	–	–	–	–	–	–	1	1	–	2	–	2	–	–	–	–	–	–	–	2
·5	–	–	–	–	–	–	–	–	–	–	1	1	–	1	2	3	–	–	–	–	–	–	–	3
20	–	–	–	–	1	–	–	–	–	–	–	–	–	3	1	4	–	–	–	–	–	–	–	4
21	–	–	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
24	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
25	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
27	–	2	1	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
28	–	–	1	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
29	–	2	4	1	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
30	–	–	2	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
31	–	3	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
32	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
33	–	2	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
34	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	14	12	35	14	4	10	6	18	46	7	24	31	355	164	155	319	114	112	164	390	147	230	377	1086

V.—PLAICE.

Cm.	BURGHEAD BAY, *6th December* 1904.											
	Haul 1.			Haul 5.			Haul 6.			Hauls 1, 5, 6.		
	Fem.	Male.	Total.	Fem.	Male.	Total.	Fem.	Male.	Total.	Fem.	Male.	Total.
18	1	–	1	–	–	–	–	–	–	1	–	1
19	–	–	–	–	–	–	–	–	–	–	–	–
20	1	1	2	–	–	–	–	–	–	1	1	2
21	–	4	4	–	–	–	–	–	–	–	4	4
22	2	1	3	–	1	1	–	–	–	2	2	4
23	1	5	6	2	2	4	–	–	–	3	7	10
24	3	1	4	1	1	2	–	1	1	4	3	7
25	4	4	8	1	–	1	–	1	1	5	5	10
26	6	9	15	9	17	26	3	2	5	18	28	46
27	14	19	33	16	24	40	1	5	6	31	48	79
28	27	38	65	25	32	57	2	3	5	54	73	127
29	27	24	51	29	41	70	5	10	15	61	75	136
30	30	25	55	30	43	73	8	10	18	68	78	146
31	34	31	65	30	34	64	9	11	20	73	76	149
32	22	26	48	24	37	61	4	11	15	50	74	124
33	25	25	50	19	31	50	4	5	9	48	61	109
34	14	20	34	24	32	56	2	6	8	40	58	98
35	19	30	49	24	30	54	3	9	12	46	69	115
36	21	24	45	23	22	45	4	8	12	48	54	102
37	24	25	49	21	29	50	3	5	8	48	59	107
38	21	25	46	18	22	40	8	5	13	47	52	99
39	13	11	24	15	22	37	2	3	5	30	36	66
40	16	12	28	17	6	23	7	1	8	40	19	59
41	8	10	18	10	8	18	2	3	5	20	21	41
42	5	4	9	5	3	8	1	–	1	11	7	18
43	2	–	2	6	4	10	–	2	2	8	6	14
44	4	1	5	3	3	6	2	1	3	9	5	14
45	2	–	2	1	1	2	1	1	2	4	2	6
46	4	–	4	1		1	–	–	–	5	–	5
47	4	–	4	4	–	4	–	–	–	8	–	8
48	2	–	2	2	1	3	–	–	–	4	1	5
49	1	–	1	4	–	4	–	–	–	5	–	5
50	–	–	–	1	–	1	2		2	3	–	3
51	1	–	1	–	1	1	–	–	–	1	1	2
52	1	–	1	–	–	–	–	–	–	1	–	1
53	2	–	2	1	–	1	–	–	–	3	–	3
54	3	–	3	–	–	–	–	–	–	3	–	3
55	–	–	–	–	–	–	–	–	–	–	–	–
56	1	–	1	1	–	1	–	–	–	2	–	2
57	–	–	–	–	–	–	–	–	–	–	–	–
58	–	–	–	–	–	–	–	–	–	–	–	–
59	–	–	–	1	–	1	–	–	–	1	–	1
60	–	–	–	–	–	–	–	–	–	–	–	–
61	–	–	–	–	–	–	–	–	–	–	–	–
62	1	–	1	1	–	1	–	–	–	2	–	2
63	1	–	1	–	–	–	–	–	–	1	–	1
64	1	–	1	–	–	–	–	–	–	1	–	1
65	–	–	–	–	–	–	–	–	–	–	–	–
66	–	–	–	–	–	–	–	–	–	–	–	–
67	–	–	–	–	–	–	–	–	–	–	–	–
68	–	–	–	–	–	–	–	–	–	–	–	–
69	–	–	–	–	–	–	–	–	–	–	–	–
70	1	–	1	–	–	–	–	–	–	1	–	1
71	–	–	–	–	–	–	–	–	–	–	–	–
72	–	–	–	–	–	–	–	–	–	–	–	–
73	–	–	–	–	–	–	–	–	–	–	–	–
74	1	–	1	–	–	–	–	–	–	1	–	1
	370	375	745	360	447	816	73	103	176	812	925	1737

VI.—PLAICE.

Cm.	Burghead Bay.	Dornoch Firth.								
	20th Oct. 1903.	22nd Oct. 1903.	11th Nov. 1903.	13th Nov. 1903.	Total, 11th & 13th	27th Dec. 1903.	7th December 1904.			
							Fem.	Male.	?	Total.
5	–	–	–	–	–	–	–	–	–	–
6	–	–	–	.	–	–	–	–	1	1
7	–	–	–	–	–	–	–	–	5	5
8	–	–	–	–	–	–	–	1	7	8
9	–	–	–	–	–	–	–	–	5	5
10	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	3	3
13	–	–	–	–	–	–	–	–	6	6
14	–	–	1	1	2	1	–	1	3	4
15	–	5	–	1	1	3	–	–	–	–
16	–	2	–	1	1	1	–	–	–	–
17	1	6	–	–	–	1	1	–	–	1
18	–	5	–	–	–	–	–	1	–	1
19	1	2	–	–	–	–	1	–	–	1
20	–	3	–	1	1	–	2	–	–	2
21	3	15	1	4	5	–	1	1	–	2
22	5	28	3	4	7	3	2	11	–	13
23	14	34	3	8	11	–	2	4	–	6
24	22	31	2	8	10	2	4	6	–	10
25	25	38	6	12	18	1	3	5	–	8
26	35	35	2	10	12	1	5	7	–	12
27	19	28	15	20	35	1	6	–	–	6
28	15	18	10	22	32	4	2	5	–	7
29	10	25	10	20	30	8	4	3	–	7
30	9	8	13	23	36	8	6	10	–	16
31	16	10	8	22	30	11	6	10	–	16
32	12	15	5	19	24	11	5	5	–	10
33	7	14	1	7	8	9	1	6	–	7
34	7	6	7	14	21	9	5	4	–	9
35	8	8	2	6	8	8	3	3	–	6
36	6	6	2	8	10	10	1	–	–	1
37	4	6	2	8	10	8	–	5	–	5
38	3	2	3	3	6	9	–	–	–	–
39	3	1	–	–	–	2	–	1	–	1
40	2	6	1	2	3	2	1	–	–	1
41	–	2	2	–	2	1	1	–	–	1
42	1	1	–	–	–	1	–	–	–	–
43	1	–	–	1	1	2	–	–	–	–
44	–	1	–	–	–	–	–	–	–	–
45	–	–	–	–	–	1	–	–	–	–
46	–	–	–	1	1	–	–	–	–	–
47	–	–	–	–	–	–	1	–	–	1
48	–	–	–	–	–	–	–	–	–	–
49	–	–	–	1	1	1	–	–	–	–
50	–	–	–	–	–	–	–	–	–	–
51	1	1	–	–	–	–	–	–	–	–
52	–	–	–	–	–	–	–	–	–	–
53	1	1	–	–	–	–	–	–	–	–
54	1	–	–	–	–	–	–	–	–	–
55	–	–	–	–	–	–	–	–	–	–
56	1	–	–	–	–	–	–	–	–	–
	233	363	99	227	326	121	63	89	30	182

VII.—PLAICE.—BURGHEAD BAY, February 7, 1905.

Cm.	A.									B.						C.									D.						A, B, C, D.											
	Ripe.			Nearly Ripe.			Immature.			Nearly Ripe.			Immature.			Ripe			Nearly Ripe.			Immature.			Nearly Ripe.			Immature.			Ripe.			Spent.			Nearly Ripe.			Immature.		
	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.
20	–	–	–		–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
21	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	3	3
22	–	–	–	–	–	–	–	–	–	–	–	–	2	1	3	–	–	–	–	–	–	1	1	2	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	3	4	7
23	–	–	–	–	–	–	–	–	–	–	–	–	1	1	2	–	–	–	–	–	–	–	2	2	–	–	–	–	3	3	–	–	–	–	–	–	–	–	–	1	6	7
24	–	–	–	–	–	–	–	1	1	–	–	–	–	6	6	–	–	–	–	–	–	1	–	1	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	2	7	9
25	–	–	–	–	–	–	1	1	2	–	–	–	3	3	6	–	–	–	–	–	–	2	2	4	–	–	–	2	1	3	–	–	–	–	–	–	–	–	–	8	7	15
26	–	–	–	–	–	–	–	–	–	–	–	–	3	6	9	–	–	–	–	–	–	1	3	4	–	–	–	3	3	6	–	–	–	–	–	–	–	–	–	7	12	19
27	–	–	–	–	–	–	2	5	7	–	–	–	4	14	18	–	–	–	–	–	–	4	1	5	–	–	–	1	1	2	–	–	–	–	–	–	–	–	–	11	21	32
28	–	–	–	–	–	–	6	6	12	–	–	–	15	18	33	–	–	–	–	–	–	2	5	7	–	–	–	5	10	15	–	–	–	–	–	–	–	–	–	28	39	67
29	–	–	–	–	–	–	7	8	15	–	–	–	14	22	36	–	–	–	–	–	–	5	7	12	–	–	–	7	7	14	–	–	–	–	–	–	–	–	–	33	44	77
30	–	–	–	–	–	–	10	14	24	–	–	–	22	21	43	–	–	–	–	–	–	19	20	39	–	–	–	8	15	23	–	–	–	–	–	–	–	–	–	59	70	129
31	–	–	–	–	–	–	10	11	21	–	–	–	21	31	52	–	–	–	–	–	–	10	17	27	–	–	–	14	10	24	–	–	–	–	–	–	–	–	–	55	69	124
32	–	–	–	–	–	–	6	11	17	–	–	–	14	30	44	–	–	–	–	–	–	4	24	28	–	–	–	13	12	25	–	–	–	–	–	–	–	–	–	37	77	114
33	–	–	–	–	–	–	10	13	23	–	–	–	16	30	46	–	–	–	–	–	–	16	12	28	–	–	–	11	25	36	–	–	–	–	–	–	–	–	–	53	80	133
34	–	–	–	–	–	–	12	7	19	–	–	–	22	22	44	–	–	–	–	–	–	22	22	44	–	–	–	10	23	33	–	–	–	–	–	–	–	–	–	66	74	140
35	–	–	–	–	–	–	16	9	25	–	–	–	11	31	42	–	–	–	–	–	–	9	20	29	–	–	–	14	16	30	–	–	–	–	–	–	–	–	–	50	76	126
36	–	–	–	–	–	–	10	12	22	–	–	–	17	18	35	–	–	–	–	–	–	12	19	31	–	–	–	12	15	27	–	–	–	–	–	–	–	–	–	51	64	115
37	–	–	–	–	–	–	9	9	18	–	–	–	17	20	37	–	–	–	–	–	–	13	21	34	–	–	–	17	14	31	–	–	–	–	–	–	–	–	–	56	64	120
38	–	–	–	–	–	–	11	7	18	–	–	–	16	11	27	–	–	–	–	–	–	8	13	21	–	–	–	12	6	18	–	–	–	–	–	–	–	–	–	47	37	84
39	–	1	1	2	1	3	6	5	11	1	–	1	16	13	29	–	–	–	2	–	2	9	7	16	–	–	–	9	3	12	–	1	1	–	–	–	5	1	6	40	28	68
40	–	–	–	2	–	2	3	3	6	–	–	–	10	5	15	–	–	–	1	–	1	10	3	13	–	–	–	5	1	6	–	–	–	–	–	–	3	–	3	28	12	40
41	–	–	–	1	1	2	3	–	3	–	–	–	6	2	8	–	–	–	1	–	1	6	–	6	2	–	2	4	1	5	–	–	–	–	–	–	4	1	5	19	3	22

42	-	1	1	2	-	2	1	1	2	1	-	1	3	1	4	-	-	-	3	-	3	3	-	3	-	-	-	8	-	8	-	1	1	-	-	-	6	-	6	15	2	17
43	-	-	-	-	-	-	3	-	3	-	-	-	2	-	2	-	-	-	2	-	2	2	1	3	-	-		1	-	1	-	-	-	-	-	-	2	-	2	8	1	9
44	-	1	1	-	1	1	-	-	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	1	1	-	-	-	3	1	4	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
46	-	-	-	2	-	2	-	-	-	2	-	2	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	5	-	5	1	-	1
47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
48	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	-	-	-
49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
50	-	-	-	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
53	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	I	-	1	-	-	-
54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
56	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
59	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-		-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
63	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
67	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
68	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	I	1	-	1	-	-	-	-	-	-
	1	3	4	18	3	21	126	123	249	9	-	9	235	308	543	4	-	4	12	-	12	160	200	360	4	-	4	158	170	328	5	3	8	1	-	1	43	3	46	679	801	1480

VIII.—COMMON DAB, ABERDEEN BAY.

Col. I. Off Ythan, 13th Nov. 1900. Shrimp net, 6–9 fathoms.
,, II. Off Ythan, 19th Nov. 1900. Shrimp net, 2–10 fathoms.
,, III. Donmouth to Bathing Station, 8th April 1904. Shrimp net, 4–6 fathoms.
,, IV. Donmouth to Bathing Station, 16th April 1904. Shrimp net, 4–6 fathoms.
,, V. Donmouth to Bathing Station, 26th April 1904. Shrimp net, 4–6 fathoms.
,, VI. Totals of III.–V.
,, VII. Donmouth to Bathing Station, 4th May 1904. Shrimp net, 3–7 fathoms.
,, VIII. Donmouth to Bathing Station, 12th, 18th May 1904. Shrimp net, 3–7 fathoms.
,, IX. Donmouth to Bathing Station, 1st Sept. 1904. Shrimp net, 4–9 fathoms.
,, X. Off Quarries, 11th Feb. 1905. Small-meshed net, 8–12 fathoms.
,, XI. Donmouth to Black Dog, 27th March 1905. Small-meshed net, 5–10 fathoms.
,, XII. Donmouth to Black Dog, 30th Jan. 1906. Small-meshed trawl, 8 fathoms.

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
2	3	–	–	–	–	–	–	–	1	–	–	–
·5	3	–	18	5	3	26	–	–	10	–	–	1
3	4	–	60	17	13	90	3	2	43	1	4	31
·5	5	6	104	55	54	213	10	8	75	4	7	99
4	14	13	61	76	54	191	11	16	77	5	11	105
·5	9	22	22	66	36	124	9	25	51	4	24	46
5	16	26	12	54	13	79	4	14	15	1	28	31
·5	19	23	4	17	1	22	–	4	6	–	28	8
6	13	11	–	10	–	10	–	1	1	–	26	1
·5	19	6	1	4	–	5	–	–	–	1	19	1
7	3	1	–	1	1	2	–	–	–	–	5	–
·5	4	–	–	1	2	3	–	–	–	–	2	–
8	2	–	–	2	–	2	–	–	–	–	–	–
·5	–	–	–	–	1	1	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	1	–	–	–
·5	–	–	–	–	–	–	–	–	2	–	–	–
10	–	1	–	–	–	–	–	–	2	–	–	–
·5	–	–	–	–	–	–	–	–	8	1	–	–
11	–	–	–	–	1	1	–	–	9	–	–	–
·5	–	–	–	–	2	2	–	–	7	–	–	–
12	–	–	–	–	3	3	–	–	7	–	–	–
·5	–	1	–	–	8	8	–	–	3	–	–	–
13	–	–	1	–	10	11	–	–	5	–	–	–
·5	–	–	–	–	6	6	–	–	4	–	–	–
14	–	–	–	–	5	5	–		5	–	–	–
·5	–	–	–	–	6	6	–	–	2	–	–	–
15	–	–	–	1	3	4	–	–	4	–	–	–
·5	–	–	–	–	2	2	–	–	1	–	–	–
16	–	1	–	–	3	3	–	–	–	–	–	–
·5	–	–	–	–	1	1	–	–	2	1	–	–
17	–	–	–	–	–	–	–	–	1	–	–	–
·5	–	–	–	–	–	–	–	–	1	–	–	–
18	–	–	–	–	1	1	–	–	3	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–
	114	111	283	309	229	821	37	70	366	18	154	323

IX.—COMMON DABS.

DORNOCH FIRTH—MORAY FIRTH.

Col. I. 9th February 1905—6½-10 fathoms.
,, II. 31st March 1904.
,, III. 8th June 1903—10-11 fathoms.
,, IV. 22nd October 1903—8-13 fathoms.

Col. V. 7th December 1904.
,, VI. 27th December 1903.
,, VII. 28th December 1903.

Cm.	I.	II.	III.	IV.	V.	VI.			VII.		
						Female.	Male.	Total.	Female.	Male.	Total.
2	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	4	–	–	–	–	–	1
3	14	–	–	–	30	–	–	–	–	–	3
·5	34	–	–	–	86	–	–	–	–	–	–
4	66	–	–	–	60	–	–	–	–	–	2
·5	83	–	–	–	19	–	–	–	–	–	1
5	72	1	–	–	8	–	–	–	–	–	–
·5	48	1	–	–	7	–	–	–	–	–	–
6	33	1	–	–	3	–	–	–	1	1	2
·5	17	–	–	–	2	–	–	–	2	3	5
7	8	–	1	1	–	–	–	–	3	2	5
·5	2	–	1	–	–	–	–	–	2	–	2
8	2	–	2	–	–	–	–	–	1	1	2
·5	2	1	–	3	–	–	–	–	3	1	4
9	4	–	–	6	1	–	1	1	4	7	11
·5	6	–	2	75	–	7	3	10	15	39	54
10	17	–	–	98	2	9	9	18	43	59	102
·5	23	2	1	182	6	17	11	28	71	50	121
11	22	2	1	85	9	12	14	26	49	38	87
·5	15	2	–	69	6	16	6	22	31	25	56
12	4	1	–	41	3	7	3	10	17	16	33
·5	3	–	–	24	2	6	4	10	11	9	20
13	8	2	1	8	2	5	3	8	6	9	15
·5	10	1	2	14	1	3	5	8	6	9	15
14	5	3	–	9	3	3	5	8	5	11	16
·5	5	5	1	14	2	7	6	13	7	8	15
15	7	–	1	11	1	1	4	5	3	5	8
·5	7	3	1	14	1	5	3	8	10	9	19
16	4	3	1	3	–	5	1	6	5	3	8
·5	1	3	–	9	–	4	–	4	2	2	4
17	1	3	–	6	–	3	–	3	6	4	10
·5	1	5	1	5	–	1	–	1	2	1	3
18	–	3	–	3	–	1	–	1	1	1	2
·5	–	4	–	12	–	1	–	1	1	1	2
19	–	2	–	3	–	–	–	–	2	–	2
·5	–	1	–	3	–	–	–	–	1	–	1
20	–	3	–	5	–	1	–	1	–	1	1
21	–	–	–	4	–	–	–	–	1	–	1
22		–	–	3	–	–	–	–	–	–	–
23	–	1	–	1	–	–	–	–	1	–	1
24	–	–	–	3	–	–	–	–	–	–	–
25	–	–	–	4	–	–	–	2	–	–	–
26	–	–	–	2	–	–	–	1	–	–	–
27	–	–	–	1	–	–	–	1	–	–	–
28	–	–	–	1	–	–	–	3	–	–	–
29	–	–	–	–	–	–	–	–	–	–	–
30	–	–	–	1	–	–	–	1	–	–	–
31	–	–	–	1	–	–	–	1	–	–	–
	524	53	16	724	258	114	78	201	312	315	634

X.—COMMON DAB.

WITCH GROUND, MORAY FIRTH.

Col. I. 14th November 1903.
,, II. 28th December 1903.
,, III. 23rd January 1904.

SMITH BANK.

Col. I. 1st April 1904.
,, II. 23rd October 1903.
,, III. 12th December 1904.
,, IV. 27th December 1903.

BURGHEAD BAY.

Col. I. 20th October 1903.
,, II. 6th December 1904.

OFF FINDHORN.

Col. I. 1st April 1904.

Cm.	Witch Ground (off Cromarty).					Smith Bank.						Burghead Bay.		Off Findhorn
	I.	II.	III.			I.	II.	III.	IV.			I.	II.	I.
			Fem.	Male.	Total.				Fem.	Male.	Total.			
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	1	–	–	–	10	–	–	–
3	–	–	–	–	–	–	–	–	–	–	27	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	8	–	–	–
4	–	–	–	–	–	–	–	–	–	–	5	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	3	–	–	–
5	–	–	–	–	–	–	–	–	–	–	2	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	5	–	–	–
6	–	–	–	–	–	–	–	–	–	–	3	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	3	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	1	2	1	–	1	–	–	–
9	–	1	–	–	–	–	2	2	3	2	5	1	–	–
·5	1	9	–	–	–	–	13	8	13	10	23	4	–	–
10	1	8	–	1	1	2	25	28	22	19	41	12	–	–
·5	4	18	3	2	5	1	47	85	31	42	73	11	–	–
11	5	4	3	8	11	5	66	111	48	55	103	8	–	–
·5	7	7	4	7	11	10	82	124	75	44	119	14	–	1
12	12	1	5	12	17	8	54	99	59	37	96	10	–	2
·5	12	9	10	19	29	11	81	91	56	36	92	26	–	–
13	7	3	11	34	45	3	68	87	35	34	69	16	–	–
·5	15	1	21	90	111	5	77	123	41	26	67	24	–	2
14	6	1	23	116	139	7	75	109	36	20	56	20	–	1
·5	9	6	41	134	175	8	89	118	42	22	64	18	6	5
15	5	2	44	115	159	10	63	114	34	14	48	15	4	2
·5	8	6	43	115	158	9	66	92	32	9	41	27	–	2
16	7	5	24	85	109	4	30	83	26	8	34	16	1	2
·5	4	6	37	78	115	4	36	56	25	4	29	21	3	1
17	5	5	24	62	86	2	29	34	18	2	20	14	6	4
·5	5	7	23	61	84	3	22	45	14	–	14	15	8	7
18	1	5	19	33	52	–	16	25	7	–	7	7	4	1
·5	2	8	24	18	42	3	9	22	6	1	7	16	6	6
19	5	2	20	21	41	1	5	14	8	–	8	4	6	4
·5	2	5	8	14	22	1	6	14	5	1	6	4	7	4
20	4	5	20	11	31	–	–	13	3	2	5	16	14	6
21	2	6	11	7	18	1	–	15	2	1	3	15	14	2
22	1	5	11	2	13	1	–	7	2	1	3	2	10	4
23	–	3	4	1	5	–	–	2	2	–	2	1	9	–
24	–	3	7	2	9	–	–	3	1	–	1	–	6	–
25	–	2	1	–	1	–	–	1	1	–	1	1	14	–
26	–	2	3	–	3	–	–	1	–	1	1	–	7	–
27	–	2	1	1	2	–	–	1	–	–	–	–	9	–
28	–	–	–	–	–	–	–	1	–	–	–	–	8	–
29	–	1	1	–	1	–	–	2	–	–	–	–	14	–
30	–	–	–	–	–	–	–	–	–	–	–	–	13	–
31	–	–	1	–	1	–	–	–	–	–	–	–	8	–
32	–	–	1	–	1	–	–	–	–	–	–	–	15	–
33	–	–	–	–	–	–	–	–	–	–	–	–	5	–
34	–	–	–	–	–	–	–	–	–	–	–	–	3	–
35	–	–	–	–	–	–	–	–	–	–	–	–	2	–
36	–	–	–	–	–	–	–	–	–	–	–	–	1	–
37	–	–	–	–	–	–	–	–	–	–	–	–	1	–
38	–	–	–	–	–	–	–	–	–	–	–	–	1	–
39	–	–	–	–	–	–	–	–	–	–	–	–	1	–
40	–	–	–	–	–	–	–	–	–	–	–	–	1	–
45	–	–	–	–	–	–	–	–	–	–	–	–	1	–
	130	148	448	1049	1497	99	963	1532	648	391	1106	338	208	56

XI.—FLOUNDER.

Col.	I.	Lochfyne,	5th July 1901.	Push-net.
,,	II.	,,	10th Sept. 1900.	,,
,,	III.	,,	27th March 1901.	,,
,,	IV.	,,	16th April 1901.	,,
,,	V.	,,	23rd June 1903.	,,
,,	VI.	,,	13th July 1903.	,,
,,	VII.	,,	31st Aug. 1901.	,,
,,	VIII.	Dornoch Firth,	25th May 1901.	,,
,,	IX.	Annan,	23rd April 1900.	Shrimp-net.
,,	X.	,,	24th May 1900.	,,
,,	XI.	Dornoch Firth,	30th March 1904.	Otter-trawl.

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.		
											Fem.	Male.	Total.
1	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	2	–	–	–	1	–	–	–	–	–	–	–	–
2	2	–	–	–	–	–	–	–	–	–	–	–	–
·5	3	–	–	–	–	–	–	–	–	–	–	–	–
3	11	–	–	–	–	1	–	–	–	–	–	–	–
·5	6	–	–	–	–	–	–	–	–	–	–	–	–
4	4	–	–	–	–	1	–	–	–	–	–	–	–
·5	1	3	–	–	–	–	1	–	–	–	–	–	–
5	1	5	–	–	–	–	–	–	–	–	–	–	–
·5	1	5	–	–	–	–	–	–	–	–	–	–	–
6	–	2	–	–	–	–	–	1	–	–	–	–	–
·5	–	–	1	–	–	–	1	–	–	–	–	–	–
7	–	–	–	–	–	–	–	1	–	–	–	–	–
·5	–	1	–	–	–	–	–	–	–	–	–	–	–
8	–	1	–	–	–	–	–	–	1	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	1	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	1	1	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	1	–	–	–
·5	–	–	–	1	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
13	–	–	–	1	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	1	–	–	–	–
14	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
15	–	–	–	–	–	1	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
16	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
17	–	–	–	–	–	–	–	2	1	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
18	–	–	–	–	–	–	–	1	–	1	–	–	–
·5	–	–	–	–	–	–	–	–	–	1	–	–	–
19	–	–	–	–	–	–	–	1	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	1	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–	4	–	4
21	–	–	–	–	–	–	–	–	–	–	6	–	6
22	–	–	–	–	–	–	–	–	–	–	6	–	6
23	–	–	–	–	–	–	–	–	–	–	6	–	6
24	–	–	–	–	–	–	–	–	–	–	10	–	10
25	–	–	–	–	–	–	–	–	–	–	3	3	6
26	–	–	–	–	–	–	–	–	–	–	8	–	8
27	–	–	–	–	–	–	–	–	–	–	8	1	9
28	–	–	–	–	–	–	–	–	–	–	7	1	8
29	–	–	–	–	–	–	–	–	–	–	7	3	10
30	–	–	–	–	–	–	–	–	–	–	7	2	9
31	–	–	–	–	–	–	–	–	–	–	11	1	12
32	–	–	–	–	–	–	–	–	–	–	4	3	7
33	–	–	–	–	–	–	–	–	–	–	15	1	16
34	–	–	–	–	–	–	–	–	–	–	15	1	16
35	–	–	–	–	–	–	–	–	–	–	7	1	8
36	–	–	–	–	–	–	–	–	–	–	2	1	3
37	–	–	–	–	–	–	–	–	–	–	1	1	2
38	–	–	–	–	–	–	–	–	–	–	3	1	4
39	–	–	–	–	–	–	–	–	–	–	–	–	–
40	–	–	–	–	–	–	–	–	–	–	4	–	4
41	–	–	–	–	–	–	–	–	–	–	1	1	2
42	–	–	–	–	–	–	–	–	–	–	1	1	1
45	–	–	–	–	–	–	–	–	–	–	–	–	1
	31	17	2	3	1	3	2	6	5	3	136	22	158

XII.—LEMON DABS.

ANNAN.

Cm.	2nd Sept. 1904.			9th Sept. 1904.			15th and 16th Sept. 1904.			Totals—2nd to 16th Sept. 1904.			22nd April 1905.			6th May 1905.			15th May 1905.			24th May 1905.			Total—May 1905.			25th Sept. 1905.		
	F.	M.	Total.	F.	M.	Total.	F.	M.	Total.	F.	M.	Total.	F.	M.	Total.	F.	M.	Total.	F.	M.	Total.	F.	M.	Total.	F.	M.	Total.	F.	M.	Total.
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
7	–	–	–	–	–	–	–	–	–	–		–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	1	1	2
8	–	–	–	–	1	1	1	–	1	1	1	2	1	1	2	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
·5	–	–	–	–	–	–	1	2	3	1	2	3	3	2	5	–	1	1	–	–	–	1	–	1	1	1	2	3	1	4
9	–	–	–	2	–	2	–	–	–	2	–	2	1	–	1	–	1	1	1	1	2	–	–	–	1	2	3	1	1	2
·5	–	–	–	–	1	1	–	3	3	–	4	4	–	2	2	1	1	2	2	1	3	1	1	2	4	3	7	–	1	1
10	–	2	2	–	2	2	–	3	3	–	7	7	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	3	1	4	1	1	2	4	4	8	8	6	14	–	–	–	1	–	1	1	–	1	–	–	–	2	–	2	1	–	1
11	1	1	2	3	6	9	4	1	5	8	8	16	1	–	1	1	2	3	1	–	1	–	–	–	2	2	4	2	–	2
·5	–	–	–	6	6	12	12	5	17	18	11	29	1	1	2	1	4	5	1	1	2	–	1	1	2	6	8	2	–	2
12	–	1	1	7	3	10	5	4	9	12	8	20	1	–	1	2	4	6	–	1	1	1	–	1	3	5	8	3	2	5
·5	1	1	2	10	12	22	6	6	12	17	19	36	1	1	2	4	1	5	–	3	3	–	–	–	4	4	8	1	2	3
13	–	2	2	4	8	12	3	3	6	7	13	20	1	1	2	7	1	8	1	1	2	–	–	–	8	2	10	–	1	1
·5	–	–	–	3	4	7	14	7	21	17	11	28	–	1	1	3	4	7	3	1	4	–	–	–	6	5	11	1	–	1
14	1	–	1	4	2	6	16	6	22	21	8	29	2	–	2	5	4	9	1	1	2	–	–	–	6	5	11	–	–	–
·5	1	–	1	4	4	8	7	5	12	12	9	21	–	1	1	5	5	10	2	1	3	–	1	1	7	7	14	–	1	1
15	1	–	1	1	7	8	12	9	21	14	16	30	–	1	1	2	7	9	1	–	1	–	–	–	3	7	10	–	1	1
·5	1	–	1	10	3	13	9	13	22	20	16	36	2	–	2	2	1	3	1	1	2	1	–	1	4	2	6	–	–	–
16	–	1	1	6	8	14	7	9	16	13	18	31	1	–	1	3	1	4	1	–	1	–	–	–	4	1	5	1	–	1
·5	1	1	2	6	3	9	12	7	19	19	11	30	2	–	2	3	1	4	1	1	2	1	–	1	5	2	7	–	–	–
17	1	–	1	11	5	16	8	8	16	20	13	33	1	–	1	6	1	7	3	–	3	2	1	3	11	2	13	–	–	–
·5	1	–	1	8	5	13	6	9	15	15	14	29	–	–	–	6	1	7	1	1	2	1	–	1	8	2	10	–	–	–
18	–	–	–	1	2	3	11	8	19	12	10	22	1	1	2	6	2	8	1	–	1	–	–	–	7	2	9	–	–	–
·5	–	–	–	–	1	1	3	1	4	3	2	5	–	–	–	2	1	3	–	–	–	–	–	–	2	1	3	–	–	–
19	–	–	–	–	–	–	3	–	3	3	–	3	–	–	–	1	1	2	–	–	–	–	–	–	1	1	2	–	–	–
·5	–	1	1	–	1	1	3	1	4	3	3	6	–	–	–	–	2	2	–	–	–	–	–	–	–	2	2	–	–	–
20	–	–	–	–	–	–	2	–	2	2	–	2	–	–	–	2	–	2	–	–	–	–	–	–	2	–	2	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	12	11	23	87	85	172	149	114	263	248	210	458	21	15	36	68	46	109	22	14	36	8	4	12	93	64	157	18	12	30

XIII.—LEMON DAB.

Col. I. Moray Firth and Aberdeen Bay, 8th–13th October 1900.
,, II. ,, ,, 31st October–9th November 1900.
,, III. Totals of I. and II.
,, IV. Near Fair Isle, October 1900.
,, V. Aberdeen Bay, 8th October 1900.
,, VI. ,, 31st October and 1st November 1900.
,, VII. ,, 23rd October 1900.
,, VIII. ,, November 1900.

Cm.	I.	II.	III.	IV.	V.			VI.			VII.			VIII.		
					F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.
9	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	1	–	–	–	1	1	2	–	–	–	–	–	–
12	–	1	1	–	3	–	3	–	1	1	1	1	2	–	–	–
·5	–	–	–	–	–	–	–	1	–	1	1	1	2	–	–	–
13	–	3	3	–	–	–	–	–	1	1	–	–	–	1	–	1
·5	–	1	1	1	–	–	–	–	1	1	2	–	2	–	1	1
14	1	2	3	–	1	1	2	–	–	–	–	1	1	–	–	–
·5	1	1	2	–	–	1	1	–	1	1	–	–	–	–	–	–
15	1	3	4	1	–	–	–	1	–	1	2	–	2	–	–	–
·5	–	8	8	1	–	–	–	2	–	2	–	1	1	–	–	–
16	–	9	9	1	–	–	–	–	–	–	–	2	2	–	–	–
·5	1	7	8	–	–	–	–	2	–	2	1	–	1	1	–	1
17	1	9	10	2	–	–		4	–	4	1	–	1	–	–	–
·5	2	12	14	2	–	1	1	–	–	–	–	–	–	–	–	–
18	5	13	18	3	–	–	–	1	–	1	–	–	–	–	–	–
·5	12	12	24	3	1	–	1	–	–	–	–	–	–	–	–	–
19	9	11	20		–	–	–	–	–	–	3	–	3	–	–	–
·5	3	3	6	–	1	–	1	–	–	–	1	1	2	–	–	–
20	9	6	15	2	–	–	–	–	–	–	–	–	–	–	–	–
·5	8	6	14	1	–	–	–	–	–	–	–	1	1	–	–	–
21	16	7	23	4	1	–	1	–	–	–	–	–	–	–	–	–
·5	9	7	16	3	–	–	–	–	–	–	1	1	2	–	–	–
22	10	9	19	–	–	–	–	1	–	1	1	1	2	–	–	–
·5	5	4	9	–	–	–	–	–		–	1	–	1	–	–	–
23	13	6	19	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	5	5	10	1	–	–	–	–	–	–	–	–	–	–	–	–
24	4	7	11	–	–	–	–	–	–	–	–	2	2	–	–	–
·5	8	3	11	2	–	–	–	–	1	1	1	–	1	–	–	–
25	2	4	6	2	–	–	–	–	–	–	–	–	–	–	–	–
·5	5	6	11	–	–	–	–	–	–	–	–	–	–	–	–	–
26	6	3	9	2	1	–	1	–	–	–	–	–	–	–	–	–
·5	1	5	6	1	–	–	–	–	–	–	–	–	–	–	–	–
27	4	1	5	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	2	1	3	–	–	–	–	–	–	–	–	–	–	–	–	–
28	3	2	5	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	1	5	6	–	–	–	–	–	–	–	–	–	–	–	–	–
29	2	4	6	2	–	–	–	–	–	–	–	–	–	–	–	–
·5	4	3	7	1	–	–	–	–	–	–	–	–	–	–	–	–
30	5	7	12	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	4	3	7	2	1	–	1	–	–	–	–	–	–	–	–	–
31	6	1	7	3	–	–	–	–	–	–	–	–	–	–	–	–
·5	5	1	6	–	–	–	–	–	–	–	2	–	2	–	–	–
32	4	3	7	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	5	–	5	2	–	–	–	–	–	–	–	–	–	–	–	–
33	11	–	11	6	–	–	–	–	–	–	–	–	–	–	–	–
·5	9	2	11	2	–	–	–	–	–	–	–	–	–	–	–	–
34	17	2	19	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	14	–	14	5	–	–	–	–	–	–	–	–	–	–	–	–
35	14	2	16	7	–	–	–	–	–	–	–	–	–	–	–	–
·5	17	–	17	6	–	–	–	–	–	–	–	–	–	–	–	–
36	24	2	26	9	–	–	–	–	–	–	–	–	–	–	–	–
·5	23	5	28	8	–	–	–	–	–	–	–	–	–	–	–	–
37	12	2	14	8	–	–	–	–	–	–	–	–	–	–	–	–
·5	15	2	17	7	–	–	–	–	–	–	–	–	–	–	–	–
38	11	–	11	12	–	–	–	–	–	–	–	–	–	–	–	–
·5	9	1	10	12	–	–	–	–	–	–	–	–	–	–	–	–

XIII.—LEMON DAB—*continued.*

Cm.	I.	II.	III.	IV.	V.			VI.			VII.			VIII.		
						F.	Tl.	M.	F.	Tl.	M.	F.	Tl.	M.	F.	Tl.
39	15	–	15	9	–	–	–	–	–	–	–	–	–	–	–	–
·5	7	1	8	4	–	–	–	–	–	–	–	–	–	–	–	–
40	10	1	11	4	–	–	–	–	–	–	–	–	–	–	–	–
·5	5	1	6	5	–	–	–	–	–	–	–	–	–	–	–	–
41	1	–	1	5	–	–	–	–	–	–	–	–	–	–	–	–
·5	3	–	3	4	–	–	–	–	–	–	–	–	–	–	–	–
42	6	–	6	7	–	–	–	–	–	–	–	–	–	–	–	–
·5	5	1	6	2	–	–	–	–	–	–	–	–	–	–	–	–
43	1	1	2	3	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
44	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–
·5	1	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–
45	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
46	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
47	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	412	227	639	182	9	3	12	14	6	20	18	12	30	2	1	3

XIV.—LEMON DAB.

Col IX. Aberdeen Bay, 6th June 1901.
,, X. ,, 30th July 1901.
,, XI. ,, 31st July 1901.
,, XII. ,, 21st August 1901.
,, XIII. ,, 10th September 1901.
,, XIV. ,, 28th November 1901.
,, XV. ,, 17th December 1901.
,, XVI. Firth of Forth, III., May 1901.

Col. XVII. Firth of Forth, III., 23rd July 1901.
,, XVIII. ,, V., 24th July 1901.
,, XIX. ,, V., August 1901.
,, XX. Smith Bank, Moray Firth, 23rd Oct. 1901.
,, XXI. ,, ,, 8th Nov. 1901.
,, XXII. ,, ,, 27th Dec. 1901.
,, XXIII. Dornoch Firth, ,, 22nd Oct. 1903.

Cm.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.				XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
								Fem.	Male.	?	Total.							
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
10	–	–	–	–	–	–	–	1	–	–	1	–	1	1	–	–	–	–
·5	–	–	–	2	–	–	–	–	–	–	–	–	–	2	–	–	–	–
11	–	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	1	–	2	–	–	–	–	1	–	1	2	–	–	–	–	–	–
12	–	–	–	1	–	–	–	1	–	–	1	1	–	–	–	–	–	–
·5	–	–	1	1	–	–	–	–	–	–	–	–	–	2	–	–	–	–
13	–	1	–	1	–	–	–	–	1	–	1	–	–	2	–	–	–	1
·5	–	–	1	1	1	–	–	–	–	–	–	2	–	–	3	–	–	1
14	–	–	1	1	–	–	–	2	–	–	2	1	–	1	–	1	–	1
·5	–	–	–	1	–	–	–	1	3	–	4	3	–	1	2	1	–	–
15	–	–	–	–	–	–	–	4	1	1	6	–	1	1	2	1	–	–
·5	–	–	1	1	–	–	–	2	–	–	2	1	–	–	3	1	–	–
16	–	–	–	1	–	–	–	4	1	–	5	–	1	1	2	1	–	–
·5	–	–	–	–	–	–	–	5	1	–	6	3	–	2	–	–	–	
17	–	–	–	2	–	–	–	–	–	1	1	2	–	–	–	–	–	–
·5	–	–	1	4	–	–	–	1	–	–	1	–	–	1	–	2	–	–
18	–	–		6		–	–	–	–	–	–	–	–	2	–	–	–	–
·5	–	1		1	–	–	–	1	–	–	1	1	–	1	–	–	–	–
19	–	2	–	1	1	–	–	–	–	–	–	1	–	2	–	2	–	–
·5	–	–	–	4	–	–	–	–	–	1	1	2	–	3	–	3	–	–

XIV.—LEMON DAB—*continued.*

Cm.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI. Male.	XVI. Fem.	XVI. ?	XVI. Total.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
20	–	1	–	7	–	–	–	–	–	–	–	2	–	3	–	2	–	–
·5	–	1	2	3	–	–	–	1	–	–	1	–	–	–	2	–	–	–
21	–	–	–	8	–	–	1	1	–	1	2	2	–	3	–	1	–	–
·5	–	–	–	5	–	–	–	–	–	–	–	2	–	3	–	–	–	–
22	–	–	–	1	–	–	–	1	–	–	1	1	–	–	1	–	1	–
·5	–	2	1	2	–	–		–	–	–	–	1	–	1	1	–	–	–
23	–	–	–	2	–	–	–	–	–	–	–	2	–	–	–	–	–	–
·5	–	–	–	1	–	1	–	1	1	–	2	–	–	–	–	–	–	–
24	1	–	–	4	–	–	–	–	3	–	3	–	–	1	–	–	–	–
·5	–	2	–	1	–	–	–	2	–	1	3	2	–	–	–	–	–	–
25	1	–	–	1	–	–	1	2	2	–	4	1	–	–	1	–	1	–
·5	1	–	–	3	1	–	–	–	–	–	–	1	–	–	–	–	–	–
26	–	–	–	5	–	1	–	1	–	2	3	2	–	–	–	–	–	–
·5	–	3	–	1	–	–	–	1	–	–	1	–	–	–	–	–	–	–
27	1	–	–	3	1	–	–	–	–	3	3	2	–	–	–	–	–	–
·5	–	2	–	8	1	–	1	1	–	–	1	–	–	–	1	–	–	–
28	–	–	–	2	–	–	–	–	1	2	3	–	–	1	–	–	2	–
·5	–	–	–	5	2	–	–	1	1	1	3	–	–	–	–	–	–	–
29	1	3	–	2	–	–	–	2	–	–	2	–	1	–	–	–	–	–
·5	–	3	–	1	–	–	–	1	1	–	2	–	–	–	–	–	–	–
30	–	2	–	1	–	–	–	–	1	–	1	–	–	–	–	–	–	–
·5	2	2	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
31	–	4	–	3	1	1	1	–	–	–	–	–	–	–	–	–	1	–
·5	–	3	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
32	–	4	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	1	2	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
33	1	–	1	1	–	–	1	–	–	–	–	–	–	–	–	–	1	–
·5	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
34	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	4	–	3	–	–	1	–	–	–	–	–	–	–	–	–	–	–
35	–	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	2	–	2	–	–	1	–	–	–	–	–	–	–	–	–	–	–
36	–	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	1	–	–	–	–	–	–	–	–	–		–	–	1	–	–	–
37	–	4	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–
·5	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–
38	–	5	–	–	–	–	1	–	–	–	–	–	–	–	1	–	1	–
·5	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
39	–	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–
·5	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
40	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
·5	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
41	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
·5	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
42	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–
43	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
44	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
45	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
46	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–
	10	89	9	118	10	5	10	37	18	13	68	37	4	35	20	15	13	3

XV.—LEMON DAB.

Col. XXIV. Dornoch Firth, Moray Firth, 11th November 1901.
,, XXV. Off Lybster, ,, 22nd ,, 1903.
,, XXVI. Firth of Clyde, 5th September 1899.
,, XXVII. ,, 4th October 1899.
,, XXVIII. ,, 5th ,, ,,

Cm.	XXIV.	XXV.	XXXVI.				XXVII.	XXVIII.			
			Fem.	Male.	?	Total.		Fem.	Male.	?	Total.
8	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	1	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	2	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	1	1	–	–	–	–	–
·5	–	–	–	–	1	1	–	–	–	–	–
12	–	–	1	–	1	2	2	–	–	–	–
·5	–	–	1	1	–	2	–	–	1	–	1
13	–	–	2	2	1	5	–	–	3	–	3
·5	–	–	6	3	2	11	2	–	1	1	2
14	–	–	2	2	–	4	–	2	4	–	6
·5	1	–	1	1	1	3	–	2	–	1	3
15	–	–	5	–	–	5	–	–	2	–	2
·5	1	–	2	1	1	4	–	–	1	–	1
16	1	–	6	3	–	9	–	1	4	1	6
·5	2	–	5	2	–	7	–	2	–	1	3
17	–	–	7	–	–	7	–	1	–	–	1
·5	–	–	1	1	–	2	–	2	1	–	3
18	1	–	2	–	–	2	–	3	–	–	3
·5	–	–	–	1	–	1	–	3	1	–	4
19	–	–	–	–	–	–	–	4	–	–	4
·5	–	–	–	–	–	–	–	–	–	–	–
20	1	–	2	–	1	3	–	–	1	–	1
·5	–	–	–	–	–	–	–	–	–	–	–
21	–	–	2	1	–	3	–	1	–	–	1
·5	–	–	–	–	–	–	–	–	–	–	–
22	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	1	–	1	–	–	–	–	–
23	–	–	–	1	–	1	–	–	–	–	–
·5	–	–	–	–	–	–	–	1	–	–	1
24	–	–	–	–	–	–	–	–	1	–	1
·5	–	–	–	–	–	–	–	1	–	–	1
25	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	1	–	–	1	–	–	1	–	1
26	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	1	–	–	1	–	–	–	–	–
27	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–
28	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	1	–	–	1	–	–	–	–	–
29	–	–	–	–	–	–	–	–	–	–	–
·5	–	1	1	–	–	1	–	–	–	–	–
30	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–
31	–	1	–	–	–	–	–	–	–	–	–
·5	–	1	–	–	–	–	–	–	–	–	–
32	–	–	1	–	–	1	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–
33	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–
34	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–
35	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–
36	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–
37	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–
38	–	1	–	–	–	–	–	–	–	–	–
·5	–	1	–	–	–	–	–	–	–	–	–
	7	5	50	20	9	79	7	23	21	4	48

XVI.—LONG ROUGH DAB.

Cm.	Dog Hole, off Aberdeen. 15th January 1902.			Dog Hole, off Aberdeen. 13th May 1902.			Witch Ground, off Cromarty, 30 Fms., 14th Nov., 1903.	Witch Ground, off Burghead, 30 Fathoms. 28th December 1903.				Off Findhorn, 1st April 1904.				Witch Ground, off Kinnaird Head, 50 Fathoms, 23rd November 1904.			
	Female.	Male.	Total.	Female.	Male.	Total.		Female.	Male.	?	Total.	Female.	Male.	?	Total.	Female.	Male.	?	Total.
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	1	–	–	2	2	–	–	1	1	–	–	5	5
5	–	–	–	–	–	–	1	–	–	12	12	–	–	6	6	–	–	8	8
·5	–	–	–	–	–	–	6	–	–	27	27	–	–	37	37	–	–	25	25
6	–	–	–	–	–	–	1	–	–	25	25	–	–	30	30	–	–	16	16
·5	–	–	–	–	–	–	–	–	–	7	7	–	–	7	7	–	–	3	3
7	–	–	–	–	–	–	–	–	–	–	–	–	–	3	3	–	–	–	–
·5	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	2	1	3	7	2	1	–	3	–	–	–	–	1	2	–	3
9	–	–	–	1	2	3	32	–	10	–	10	1	12	–	13	3	8	–	11
·5	–	–	–	1	1	2	89	5	33	3	41	13	35	–	48	14	16	–	30
10	–	–	–	–	–	–	109	11	58	6	75	17	29	–	46	16	46	–	62
·5	3	1	4	1	–	1	114	24	65	13	102	22	11	–	33	40	35	–	75
11	3	1	4	2	–	2	56	41	37	14	92	20	2	–	22	43	22	–	65
·5	4	1	5	2	–	2	26	45	15	11	71	11	7	–	18	25	12	–	37
12	6	3	9	1	–	1	9	19	3	11	33	10	7	–	17	16	23	–	39
·5	7	4	11	3	4	7	8	11	3	5	19	6	6	–	12	8	45	–	53
13	4	4	8	4	10	14	10	3	2	5	10	1	7	–	8	10	57	–	67
·5	1	1	2	16	10	26	19	–	3	5	8	6	7	–	13	15	66	–	81
14	2	–	2	17	6	23	27	1	3	7	11	10	7	–	17	23	55	–	78
·5	1	4	5	23	10	33	30	–	1	17	18	11	3	–	14	21	45	–	66
15	–	11	11	13	15	28	21	–	–	8	8	13	6	–	19	34	40	–	74
·5	–	5	5	5	25	30	20	–	–	14	14	15	3	–	18	38	22	–	60
16	3	5	8	8	14	22	14	–	–	8	8	12	1	–	13	41	12	–	53
·5	2	3	5	11	15	26	16	–	–	16	16	14	–	–	14	49	4	–	53
17	2	1	3	10	10	20	12	–	–	7	7	20	2	–	22	46	2	–	48
·5	1	1	2	5	9	14	21	–	–	8	8	14	1	–	15	39	–	–	39
18	3	1	4	8	2	10	11	–	–	8	8	12	–	–	12	41	2	–	43
·5	3	1	4	10	1	11	9	–	–	16	16	10	–	–	10	31	1	–	32
19	3	1	4	9	1	10	11	–	–	7	7	11	1	–	12	21	1	–	22
·5	6	–	6	11	1	12	5	–	–	6	6	9	–	–	9	17	–	–	17
20	2	–	2	1	–	1	5	–	–	5	5	4	–	–	4	11	–	–	11
·5	1	–	1	4	–	4	5	–	–	5	5	5	–	–	5	4	–	–	4
21	–	–	–	2	–	2	4	–	–	9	9	2	–	–	2	7	–	–	7
·5	–	–	–	1	–	1	2	–	–	4	4	1	1	–	2	2	–	–	2
22	1	–	1	–	–	–	1	–	–	2	2	2	–	–	2	4	–	–	4
·5	–	–	–	2	–	2	1	–	–	2	2	2	–	–	2	–	–	–	–
23	–	–	–	1	–	1	–	–	–	2	2	–	–	–	–	1	–	–	1
·5	–	–	–	–	–	–	1	–	–	1	1	–	1	–	1	1	–	–	1
24	–	–	–	–	–	–	–	–	–	1	1	–	1	–	1	1	–	–	1
·5	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
25	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–
·5	–	–	–	–	–	–	1	–	–	–	–	–	2	–	2	1	–	–	1
26	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
	58	48	106	174	138	312	705	162	234	302	698	274	153	84	511	624	516	57	1197

XVII.—TURBOT.

Col. I. Aberdeen Bay, 18th September 1901. Push-net on beach.
,, II. Annan, 27th November 1900. Shrimp-net.
,, III. ,, 23rd April 1904. Shrimp-net.
,, IV. Montrose, May 1891. Stake-net.
,, V. ,, June ,, ,,
,, VI. ,, July ,, ,,
,, VII. Aberdeen Bay, October 1901. Small-meshed net.
,, VIII. Burghead Bay, Moray Firth, 9th, 10th November 1903.
,, IX. ,, ,, ,, 26th December 1903.
,, X. ,, ,, ,, 21st, 29th November 1904.
,, XI. ,, ,, ,, 6th, 12th December 1904.
,, XII. Totals of X. and XI.
,, XIII. Burghead Bay, Moray Firth, 6th, 7th February 1905.

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.
4·5	1	–	–	–	–	–	–	–	–	–	–	–	–
5	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	1	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	1	–	–	–	–	–	–	–	–	–	–
10	–	–	–	3	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	3	1	–	–	–	–	–	–	–	–
12	–	1	–	1	1	–	–	–	–	–	–	–	–
·5	–	–	–	5	1	–	–	–	–	–	–	–	–
13	–	–	–	–	1	–	–	–	–	–	–	–	–
·5	–	–	–	1	–	–	–	–	–	–	–	–	–
14	–	–	–	3	2	–	–	–	–	–	–	–	–
·5	–	–	–	2	–	–	–	–	–	–	–	–	–
15	–	–	–	7	–	1	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
16	–	–	–	1	2	–	–	–	–	–	–	–	–
·5	–	–	–	–	3	–	–	–	–	–	–	–	–
17	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
18	–	–	–	–	3	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	1	–	–	–	–	–	–	–
19	–	–	–	2	–	2	–	–	–	–	–	–	–
·5	–	–	–	–	1	–	–	–	–	–	–	–	–
20	–	–	–	2	2	1	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
22	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
23	–	–	–	1	–	–	–	–	–	–	–	–	–
·5	–	–	–	1	–	–	–	–	–	–	1	1	–
24	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
25	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	1	–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
27	–	–	–	1	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	2	–	–	–	–	–	–
28	–	–	–	1	–	–	1	–	–	–	–	–	–
·5	–	–	–	–	–	–	1	–	–	–	–	–	–
29	–	–	–	–	–	–	2	–	–	–	–	–	–
·5	–	–	–	–	–	–	2	–	–	–	–	–	–
30	–	–	–	–	–	–	2	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
31	–	–	–	–	–	–	1	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–

XVII.—TURBOT—*continued.*

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.
32	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
33	–	–	–	–	–	–	–	–	–	–	1	1	–
·5	–	–	–	–	–	–	–	1	1	1	–	1	–
34	–		–	–	–	–	–	1	–	1	1	2	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–
35	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	1	–	1	–
36	–	–	–	–	–	–	–	–	1	3	2	5	–
·5	–	–	–	–	–	–	–	–	1	2	1	3	–
37	–	–	–	–	–	–	–	–	–	3	2	5	1
·5	–	–	–	–	–	–	–	1	–	1	–	1	1
38	–	–	–	–	–	–	–	2	–	–	2	2	–
·5	–	–	–	–	–	–	–	2	–	1	1	2	1
39	–	–	–	–	–	–	–	1	–	1	–	1	2
·5	–	–	–	–	–	–	–	–	–	2	–	2	–
40	–	–	–	–	–	–	–	–	–	–	–	–	1
·5	–	–	–	–	–	–	–	–	–	2	–	2	1
41	–	–	–	–	–	–	–	–	–	–	–	–	2
·5	–	–	–	–	–	–	–	–	–	1	1	2	–
42	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	2
43	–	–	–	–	–	–	–	–	–	1	–	1	–
·5	–	–	–	–	–	–	–	–	–	1	–	1	–
44	–	–	–	–	–	–	–	1	–	1	2	3	–
·5	–	–	–	–	–	–	–	–	–	2	–	2	–
45	–	–	–	–	–	–	–	–		4	3	7	4
46	–	–	–	–	–	–	–	–	–	–	–	–	2
47	–	–	–	–	–	–	–	–	–	1	–	1	1
48	–	–	–	–	–	–	–	–	–	1	–	1	–
49	–	–	–	–	–	–	–	–	–	2	–	2	–
50	–	–	–	–	–	–	–	–	–	1	–	1	2
51	–	–	–	–	–	–	–	–	–	–	–	–	–
52	–	–	–	–	–	–	–	–	–	–	1	1	–
53	–	–	–	–	–	–	–		–	–	–	–	–
54	–	–	–	–	–	–	–	–	–	–	–	–	–
55	–	–	–	–	–	–	–	–	–	–	–	–	–
56	–	–	–	–	–	–	–	–	–	–	–	–	–
57	–	–	–	–	–	–	–	–	–	–	–	–	–
58	–	–	–	–	–	–	–	–	–	–	–	–	–
59	–	–	–	–	–	–	–	–	–	–	–	–	–
60	–	–	–	–	–	–	–	–	–	–	–	–	–
61	–	–	–	–	–	–	–	–	–	–	–	–	1
62	–	–	–	–	–	–	–	–	–	–	–	–	–
63	–	–	–	–	–	–	–	–	–	–	–	–	–
64	–	–	–	–	–	–	–	–	–	–	–	–	–
65	–	–	–	–	–	–	–	–	–	–	–	–	1
66	–	–	–	–	–	–	–	–	–	–	–	–	–
67	–	–	–	–	–	–	–	–	–	–	–	–	–
68	–	–	–	–	–	–	–	–	–	–	–	–	–
69	–	–	–	–	–	–	–	–	1	–	–	–	–
70	–	–	–	–	–	–	–	–	–	–	1	1	–
71	–	–	–	–	–	–	–	–	–	–	–	–	–
72	–	–	–	–	–	–	–	–	–	–	–	–	–
73	–	–	–	–	–	–	–	–	–	–	–	–	–
74	–	–	–	–	–	–	–	–	–	–	–	–	–
75	–	–	–	–	–	–	–	–	–	–	–	–	–
76	–	–	–	–	–	–	–	–	–	–	–	–	–
77	–	–	–	–	–	–	–	–	–	–	–	–	–
78	–	–	–	–	–	–	–	–	–	–	–	–	–
79	–	–	–	–	–	–	–	–	–	–	–	–	–
80	–	–	–	–	–	–	–	–	1	–	–	–	–
	3	1	1	30	17	5	11	9	5	33	19	52	22

XVIII.—BRILL.

Col. I. Aberdeen Bay, 18th September 1901. Push-net on beach.
,, II. Annan, 30th April 1900. Shrimp-net.
,, III. Montrose, May. Stake-nets.
,, IV. ,, June. ,,
,, V. ,, July. ,,
,, VI. Burghead Bay, Moray Firth, 9th, 10th November 1903.
,, VII. ,, ,, ,, 25th, 26th December ,,
,, VIII. ,, ,, ,, 21st-27th November 1904.
,, IX. ,, ,, ,, 6th-12th December 1904.
,, X. Totals of VIII. and IX.
,, XI. Burghead Bay, Moray Firth, 6th and 7th February 1905.
,, XII. Dornoch Firth, ,, 9th November 1901.
,, XIII. ,, ,, 10th, 11th November 1903.
,, XIV. ,, ,, 25th, 26th December ,,
,, XV. Aberdeen Bay, 6th, 7th June 1901.

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.
3	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–		–	–
4	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–
12	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	4	1	1	–	–	–	–	–	–	–	–	–	–
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14	–	–	2	1	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
15	–	–	5	4	1	–	–	–	–	–	–	–	–	–	–
·5	–	–		–	–	–	–	–	–	–	–	–	–	–	–
16	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	2	1	–	–	–	–	–	–	–	–	–	–	–
17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18	–	–	2	1	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–
21	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
·5	–	–	1	–	–	–	–	1	2	3	–	–	–	–	–
22	–	–	–	–	–	–	–	–	1	1	1	–	–	–	–
·5	–	–	1	–	–	–	–	1	1	2	–	–	–	–	–
23	–	–	2	2	–	–	–	1	3	4	–	–	–	–	–
·5	–	–	2	–	–	–	–	1	1	2	1	2	–	–	–
24	–	–	2	1	1	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–		–	1	–	–	–
·5	–	–	–	–	–	–	–	1	–	1	1	–	–	–	–
26	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–
·5	–	–	–	–	–	1	1	1	–	1	–	–	1	–	–
27	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–
·5	–	–	–	–	–	1	–	1	1	2	–	2	–	1	–
28	–	–	–	–	–	3	1	–	–	–	–	–	–	1	–
·5	–	–	1	–	–	3	–	2	2	4	1	–	–	2	–
29	–	–	–	–	–	6	–	1	2	3		–	–	1	–
·5	–	–	–	–	–	1	1	–	–	–	1	–	–	1	–

XVIII.—BRILL—*continued.*

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.
30	–	–	–	–	–	4	1	1	1	2	–	–	1	1	–
·5	–	–	–	–	–	2	1	–	2	2	1	–	1	3	–
31	–	–	–	–	–	5	–	3	1	4	3	–	–	4	–
·5	–	–	–	–	–	6	1	–	–	–	–	2	–	3	–
32	–	–	–	–	–	5	–	2	2	4	1	1	–	6	1
·5	–	–	–	–	–	5	1	2	1	3	4	1	–	2	–
33	–	–	–	–	–	3	2	–	–	–	1	1	1	2	–
·5	–	–	–	–	–	1	1	–	1	1	–	–	1	2	–
34	–	–	–	–	–	1	–	1	1	2	–	1	–	–	–
·5	–	–	–	–	–	–	1	1	2	3	–	–	1	2	–
35	–	–	–	–	–	–	1	2	1	3	1	–	–	–	2
·5	–	–	–	–	–	1	–	3	3	6	1	1	–	1	1
36	–	–	–	–	–	2	–	6	2	8	1	3	–	–	1
·5	–	–	–	–	–	5	–	6	4	10	1	1	–	2	–
37	–	–	–	–	–	1	–	12	9	21	5	2	1	–	2
·5	–	–	–	–	–	3	–	17	6	23	5	1	–	1	1
38	–	–	–	–	–	2	–	15	9	24	12	2	–	–	5
·5	–	–	–	–	–	2	–	17	8	25	13	1	–	1	–
39	–	–	–	–	–	3	–	17	6	23	14	2	–	1	1
·5	–	–	–	–		3	–	10	18	28	8	–	–	–	2
40	–	–	–	–	–	3	1	12	13	25	13	1	–	–	–
·5	–	–	–	–	–	1	–	17	9	26	11	2	–	–	–
41	–	–	–	–	–	2	–	10	6	16	15	–	–	–	–
·5	–	–	–	–	–	1	1	12	8	20	12	–	–	1	–
42	–	–	–	–	–	2	–	2	1	3	9	–	–	1	1
·5	–	–	–	–	–	2	2	5	7	12	5	–	–	–	–
43	–	–	–	–	–	2	–	3	4	7	11	2	1	1	–
·5	–	–	–	–	–	1	1	3	2	5	2	–	–	–	–
44	–	–	–	–	–	–	–	2	3	5	4	–	–	–	–
·5	–	–	–	–	–	–	–	2	3	5	2	–	–	1	–
45	–	–	–	–	–	–	1	3	2	5	4	–	–	–	–
46	–	–	–	–	–	–	–	5	2	7	–	–	–	2	–
47	–	–	–	–	–	1	–	1	3	4	2	–	–	–	–
48	–	–	–	–	–	–	–	1	1	2	1	–	–	1	–
49	–	–	–	–	–	–	–	4	–	4	–	1	–	1	–
50	–	–	–	–	–	–	2	1	–	1	2	–	–	–	1
51	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–
52	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
53	–	–	–	–	–	–	–	1	–	1	1	–	–	–	–
54	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
55	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
56	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
57	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
58	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
59	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
60	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–
61	–	–	–	–		–	–	–	–	–	–	–	–	–	–
62	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–
	6	1	30	16	7	85	20	212	156	368	171	30	8	47	18

XIX.—COD—ABERDEEN BAY.

Col. I. 15th January 1902.
,, II. 11th February 1905.
,, III. 29th March 1905.
,, IV. 13th May 1902.
,, V. 13th June 1901.
,, VI. 28th June 1901.
,, VII. 30th July 1901.
,, VIII. 31st July 1901.
,, IX. VII. and VIII. combined.
,, X. 21st August 1901.
,, XI. 3rd September 1901.
,, XII. 4th September 1901.
,, XIII. 4th September 1901.
,, XIV. 4th September 1901.

Col. XV. XII.-XIV. combined.
,, XVI. 10th September 1901.
,, XVII. 18th October 1901.
,, XVIII. 31st October 1903.
,, XIX. 5th November 1901.
,, XX. 6th November 1901.
,, XXI. XIX. and XX. combined.
,, XXII. 28th November 1901.
,, XXIII. 29th November 1901.
,, XXIV. XXII. and XXIII. combined.
,, XXV. 12th December 1904.
,, XXVI. 16th December 1901.
,, XXVII. 29th December 1903.

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV	XXVI.	XXVII.
5	–	.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	1	–	–	6	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	6	2	–	–	–	–	–	1	1	–	–	–
8	–	3	–	–	–	–	–	–	–	7	–	–	–	1	1	6	9	1	–	1	1	–	5	5	–	2	–
9	2	6	1	–	–	–	–	–	–	–	–	–	–	–	–	8	10	4	–	26	26	–	7	7	–	3	–
10	2	5	–	–	–	–	–	–	–	–	–	–	–	–	–	3	4	2	–	36	36	–	10	10	–	3	–
11	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	5	10	4	–	50	50	–	6	6	–	3	–
12	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	2	12	2	–	47	47	–	1	1	–	2	–
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	6	2	–	39	39	–	1	1	–	–	1
14	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	1	10	2	–	38	38	–	–	–	–	1	–
15	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	1	4	3	–	21	21	–	1	1	–	2	2
16	1	–	2	1	2	–	1	1	2	–	–	–	–	–	–	–	5	–	–	22	22	–	–	–	–	–	–
17	–	1	–	–	5	–	1	–	1	–	–	–	–	–	–	–	1	–	–	11	11	–	1	1	–	–	1
18	–	–	–	–	8	–	–	1	1	2	1	–	–	–	–	1	–	–	–	9	9	1	2	3	–	–	–
19	–	–	2	1	6	3	1	7	8	3	1	–	–	1	1	–	2	–	–	1	1	–	1	1	–	1	–
20	–	–	–	1	3	3	5	1	6	2	1	–	1	1	2	–	–	–	–	–	–	–	1	1	–	1	–
21	–	–	–	–	2	6	3	4	7	15	7	–	3	4	7	–	–	–	–	–	–	–	2	2	–	–	–
22	–	–	–	–	2	2	7	1	8	19	6	1	1	–	2	1	1	1	–	–	–	–	2	2	–	–	–
23	–	–	–	–	1	2	7	6	13	15	9	1	2	3	6	–	2	2	–	–	–	1	1	2	–	1	–
24	–	–	–	–	–	2	7	2	9	8	11	2	2	3	7	2	–	–	–	–	–	1	1	2	–	1	1
25	–	–	–	–	–	–	4	4	8	12	20	4	6	5	15	–	2	2	–	–	–	1	1	2	–	5	–
26	1	–	–	–	–	1	4	3	7	3	12	1	3	2	6	–	8	2	2	–	2	–	4	4	–	7	–
27	1	–	–	1	–	–	2	2	4	2	10	1	2	5	8	1	6	2	2	–	2	1	9	10	–	5	–
28	1	–	–	–	–	–	1	–	1	1	9	1	3	4	8	1	3	–	2	–	2	4	6	10	–	6	–
29	2	–	–	–	–	1	1	–	1	2	4	1	1	1	3	1	3	1	3	–	3	3	14	17	–	6	–
30	3	–	–	1	–	–	3	–	3	–	–	–	–	–	–	–	4	–	5	–	5	1	15	16	–	8	–
31	–	–	–	2	–	–	3	–	3	–	1	1	–	–	1	–	1	–	2	–	2	6	20	26	1	4	–
32	1	–	–	–	–	–	–	1	1	1	1	1	–	–	1	–	2	1	2	–	2	6	16	22	–	11	–
33	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	–	–	5	16	21	1	4	–
34	1	–	–	1	–	–	1	–	1	–	–	–	–	–	–	–	1	–	1	–	1	3	9	12	–	3	–
35	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	1	–	1	5	7	12	1	1	–

XIX.—COD—ABERDEEN BAY—*continued.*

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.	XXVI.	XXVII.
36	1	–	–	–	–	1	1	–	1	1	–	–	–	–	–	–	–	1	–	–	–	4	5	9	2	3	–
37	1	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	5	6	1	–	–
38	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	2	3	3	3	–
39	–	–	–	–	–	–	–	–	–	1	3	–	–	–	–	–	–	1	–	–	–	1	3	4	2	–	–
40	1	–	–	–	–	–	5	–	5	1	–	–	–	–	–	–	–	–	–	–	–	1	2	3	2	–	–
41	–	–	–	–	1	–	7	–	7	1	1	–	–	–	–	–	–	–	–	–	–	1	2	3	2	2	–
42	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	1	2	1	–	–
43	–	–	–	–	–	–	2	–	2	1	1	–	–	–	–	–	–	–	–	–	–	1	4	5	1	–	–
44	–	–	–	–	–	–	1	–	1	–	2	–	–	–	–	–	–	1	–	–	–	1	2	3	2	–	–
45	–	–	–	–	–	–	–	–	–	3	1	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–
46	–	–	–	–	–	–	1	–	1	2	–	–	–	–	–	–	–	–	1	–	1	–	–	–	4	–	–
47	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	2	1	1	2	2	–	–
48	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	1	–	1	1	4	–	–
49	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	2	3	4	–	–
50	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	1	2	–	–
51	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	3	1	–
52	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	1	2	–	2	4	–	–
53	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1	1	2	4	–	–
54	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
55	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–
56	–	–	–	–	–	1	–	–	–	–	1	–	–	–	–	–	1	–	1	–	1	–	1	1	–	–	–
57	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	1	1	–	–	–
58	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
59	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
60	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
61	–	–	–	–	–	–	–	–	–	1	3	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
	25	16	6	10	32	27	72	33	104	120	107	14	24	30	68	48	114	40	27	301	328	56	193	249	51	89	5

XX.—COD.

DORNOCH FIRTH.

Col. I. 9th February 1905.
,, II. 22nd October 1903.
,, III. 9th, 10th November 1901.
,, IV. 12th November 1903.
,, V. 7th December 1904.
,, VI. 19th December 1901.

SMITH BANK.

Col. I. 1st April 1904.
,, II. 23rd October 1903.

SMITH BANK—*continued.*

Col. III. 8th November 1901.
,, IV. 27th December 1903.

BURGHEAD BAY.

Col. I. 7th September 1901.
,, II. 20th October 1903.
,, III. 6th December 1904.
,, IV. 20–25th December 1901.
,, V. 29th December 1903.

Cm.	Dornoch Firth.						Smith Bank.				Burghead Bay.				
	I.	II.	III.	IV.	V.	VI.	I.	II.	III.	IV.	I.	II.	III.	IV.	V.
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	2	–	–	2	–	–	–	–	–	–	–
8	1	–	–	–	3	–	–	1	–	–	–	–	–	–	–
9	2	2	–	–	5	–	–	–	1	–	–	–	–	–	–
10	2	–	5	–	2	–	–	–	1	–	1	1	–	1	–
11	–	–	13	–	1	–	–	–	–	–	–	1	–	3	–
12	–	–	18	1	–	–	1	1	1	–	–	1	–	8	–
13	1	–	15	–	–	–	1	–	1	–	–	–	–	8	–
14	–	–	8	–	–	–	–	–	–	–	–	–	–	13	–
15	–	–	9	1	–	–	1	–	–	–	–	1	–	22	–
16	1	–	3	–	–	–	–	–	–	–	–	–	–	10	–
17	–	–	2	1	–	–	–	–	–	–	–	–	–	11	–
18	–	–	1	–	–	–	–	–	–	–	–	–	–	6	–
19	–	–	1	–	–	–	–	–	–	–	–	–	–	2	–
20	–	–	1	1	–	–	1	–	–	–	1	1	–	3	–
21	–	1	2	–	–	–	–	–	–	–	–	2	2	4	–
22	–	–	4	–	–	–	–	–	–	–	2	–	–	1	–
23	–	–	8	–	–	–	2	1	–	–	5	–	3	5	–
24	–	–	12	–	–	–	2	–	–	–	7	2	4	13	–
25	–	–	18	1	1	1	2	1	1	2	8	2	5	10	–
26	–	–	10	–	–	1	–	1	3	3	3	3	4	22	1
27	–	–	10	–	1	1	4	–	2	3	1	–	4	21	2
28	–	–	8	1	–	2	5	–	3	4	3	3	4	13	1
29	–	–	9	1	–	2	1	–	7	3	1	2	2	19	2
30	–	–	14	–	–	6	–	1	5	5	1	–	1	17	–
31	–	1	4	1	–	5	1	–	5	3	1	–	–	11	–
32	–	–	4	–	–	4	1	–	5	4	1	–	2	5	–
33	–	–	2	1	–	8	–	–	5	2	–	–	1	8	–
34	–	–	4	1	–	4	1	–	1	2	–	–	–	7	–
35	–	–	1	–	–	2	–	–	1	1	–	–	–	10	–
36	–	–	2	–	–	1	2	1	1	–	–	–	–	7	–
37	–	–	–	–	–	–	–	–	1	1	–	–	–	4	–
38	–	–	–	–	–	–	1	–	–	–	–	–	–	4	–
39	–	–	–	–	–	2	–	1	1	–	–	–	–	2	2
40	–	–	–	–	–	1	–	–	1	–	–	–	–	1	–
41	–	–	–	–	–	1	–	–	–	–	–	–	–	2	–
42	–	1	–	–	–	–	–	–	–	–	–	–	–	2	–
43	–	–	1	–	–	–	–	–	–	–	–	–		3	1
44	–	–	–	1	–	–	–	–	–	–	–	–	–	3	1
45	–	1	–	–	–	–	–	–	–	1	–	1	–	2	1
46	–	–	–	–	–	1	1	–	–	1	–	–	–	3	–
47	–	1	–	–	–	–	1	–	–	–	–	–	–	1	–
48	–	–	–	1	–	3	1	–	–	–	–	1	–	3	–
49	–	–	1	2	–	3	–	–	1	–	–	–	–	3	–
50	–	–	1	–	–	–	–	–	–	1	–	–	–	1	–
51	–	–	–	1	–	1	–	–	–	–	–	–	–	2	–
52	–	–	1	3	–	1	1	–	–	–	–	–	–	2	–
53	–	–	–	1	–	1	–	–	–	–	–	–	–	3	–
54	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
55	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–
56	–	–	–	1	–	1	–	–	–	–	–	–	–	3	–
57	–	–	–	1	–	2	1	–	–	–	–	–	–	1	–
58	–	–	–	1	–	–	1	–	–	–	–	–	–	1	–
59	–	–	–	1	–	–	1	–	–	–	–	–	–	1	–
60	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
61	–	–	–	2	–	–	–	–	–	–	–	–	–	2	–
62	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
	7	8	192	26	15	56	33	10	47	36	35	21	32	311	11

XXI.—COD.

Cromarty Firth.
7th January 1901.

Sinclair Bay.
4th June 1901.

Off Lybster.
Col. I. 22nd October 1903.
,, II. 8th November 1901.

Off Dunbeath.
Col. I. 17th January 1902.
,, II. & III. 18th January 1902.
,, IV. I.-III. combined.

Firth of Forth.
Col. I.—Station III. 13-16th May 1901.
,, II. ,, 23rd July 1901.
,, III. ,, 22nd August 1901.
,, IV.—Station V. 16th August 1901.

Off Shetland.
19-22nd May 1901.

Cm.	Cromarty Firth.	Sinclair Bay.	Off Lybster.		Off Dunbeath.				Firth of Forth. Stations III.			Firth of Forth. V.	Off Shetland.
			I.	II.	I.	II.	III.	IV.	I.	II.	III.	IV.	
4	–	–	–	–	–	–	–	–	–	1	–	–	–
5	–	–	1	–	–	–	–	–	–	14	1	–	–
6	–	–	1	–	–	–	–	–	–	7	10	5	–
7	–	–	–	–	–	–	–	–	–	5	14	5	–
8	1	–	–	–	–	–	–	–	–	2	8	–	–
9	1	–	2	–	–	–	–	–	2	–	7	–	–
10	–	–	1	–	–	–	–	–	6	–	2	–	–
11	–	–	–	–	–	–	–	–	13	–	1	–	–
12	–	–	–	–	–	–	–	–	21	–	1	–	–
13	–	–	–	–	–	–	1	1	24	–	2	–	–
14	–	–	1	–	–	–	–	–	21	–	–	–	–
15	1	–	–	–	–	–	–	–	18	2	–	–	–
16	–	–	–	–	–	–	1	1	9	1	1	–	–
17	1	–	–	–	–	–	–	–	5	6	1	–	–
18	1	–	–	–	1	1	–	2	8	6	1	2	1
19	3	–	–	–	–	–	2	2	6	10	6	–	–
20	2	–	–	–	2	1	–	3	4	11	3		1
21	5	–	–	–	1	–	3	4	3	9	13	–	–
22	1	–	–	–	–	3	1	4	3	7	3	6	–
23	–	–	–	–	1	2	1	4	1	6	3	3	1
24	–	–	1	–	2	3	5	10	–	4	5	1	–
25	1	–	–	–	7	2	6	15	1	3	4	2	2
26	–	1	–	1	12	2	10	24	1	2	2	3	1
27	1		–	–	8	2	11	21	1	3	4	–	5
28	2	4	–	2	6	8	18	32	–	4	1	1	19
29	3	3	–	6	4	4	13	21	–	2	–	1	23
30	–	2	–	13	5	1	22	28	–	1	–	–	25
31	2	1	1	20	6	2	26	34	–	–	–	–	33
32	3	1	1	26	5	5	10	20	–	1	–	–	38
33	1	3	–	23	3	–	11	14	–	1	–	–	33
34	1	3	–	9	9	–	7	16	–	–	–	–	33
35	3	1	–	8	4	1	3	8	–	–	–	–	19
36	1	1	–	5	1	–	7	8	–	–	–	–	14
37	1	–	–	1	3	–	4	7	–	–	–	–	5
38	2	–	–	–	1	–	3	4	–	–	–	–	6
39	1	–	–	–	3	–	5	8	–	–	–	–	8
40	–	1	–	–	3	–	3	6	–	–	–	–	2
41	–	–	–	–	1	–	–	1	–	–	–	–	4
42	–	1	–	–	2	–	1	3	–	–	–	–	6
43	–	1	–	–	2	–	–	2	–	–	–	–	6
44	–	–	–	–	1	–	1	2	–	–	–	–	10
45	–	2	–	–	1	–	1	2	–	–	–	–	4
46	–	1	–	–	–	–	–	–	–	–	–	–	8
47	–	–	–	–	2	–	–	2	–	–	–	–	7
48	–	–	–	–	–	–	1	1	–	–	–	–	10
49	–	–	–	–	–	–	–	–	–	–	–	–	7
50	–	1	–	–	3	–	–	3	–	–	–	–	10
51	–	2	–	–	1	–	–	1	–	–	–	–	9
52	–	1	–	–	1	–	–	1	–	–	–	–	8
53	–	1	–	–	7	–	–	7	–	–	–	–	7
54	–	–	–	–	3	–	–	3	–	–	–	–	7
55	–	1	–	–	–	–	–	–	–	–	–	–	9
56	–	1	–	–	1	–	–	1	–	–	–	–	6
57	–	–	–	–	1	–	–	1	–	–	–	–	6
58	–	–	–	–	3	–	1	4	–	–	–	–	6
59	–	–	–	–	3	–	–	3	–	–	–	–	2
60	–	–	–	–	–	–	1	1	–	–	–	–	6
61	–	–	–	–	–	–	1	1	–	–	–	–	4
62	–	–	–	–	2	–	–	2	–	–	–	–	1
	38	33	9	114	121	37	180	338	147	108	93	29	412

XXII.—HADDOCK.

ABERDEEN BAY.

Col. I. 15th January 1902. (Doghole) 57 fms.
,, II. 29th March 1905.
,, III. 13th May 1902. (Doghole) 55 fms.
,, IV. 29th December 1903.
,, V. 31st October 1903.

SMITH BANK.

Col. I. 1st April 1904. (22 fathoms.)
,, II. 22nd October 1903.
,, III. 14th November 1903.
,, IV. 12th December 1904. (19–22 fathoms.)

DORNOCH FIRTH.

Col. I. 22nd October 1903.
,, II. 13th November 1903.
,, III. 27th December 1903.

WITCH GROUND, OFF KINNAIRD HEAD.

23rd January 1904. (40–50 fathoms.)

BURGHEAD BAY.

Col. I. 20th October 1903.
,, II. 29th December 1903.

OFF LYBSTER.—22nd October 1903.

Cm.	Aberdeen Bay.								Smith Bank.				Dornoch Firth.			Witch Ground.	Burghead Bay.		Off Lybster.
	I.	II.	III.	IV.	V.				I.	II.	III.	IV.	I.	II.	III.		I.	II.	
					F.	M.	?	Total											
10	–		–	–	–	–	–	–	–	–	–	–	1	–	–	–	3	–	–
11	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	4	–	–
12	–	–	–	–	–	–	–	–	–	2	–	–	1	–	–	–	10	–	2
13	–	1	–	–	–	–	2	2	–	–	–	2	2	–	–	–	3	–	2
14	–	4	1	4	–	–	14	14	–	3	1	6	2	–	–	–	5	–	–
15	26	43	1	10	–	–	67	67	1	1	–	83	1	1	–	12	4	3	–
16	96	82	7	17	–	–	122	122	3	–	–	256	–	3	–	20	1	2	–
17	241	104	31	24	–	–	94	94	5	–	–	262	–	–	–	8	–	1	–
18	248	61	95	23	–	–	41	41	8	–	–	128	–	1	–	2	–	1	–
19	139	15	163	14	–	–	15	15	2	–	–	14	–	–	–	–	–	1	–
20	24	4	147	2	–	–	5	5	1	1	–	4	–	–	–	–	–	1	–
21	1	–	87	3	–	–	3	3	8	2	–	–	1	–	–	2	–	–	1
22	–	–	25	2	–	–	8	8	20	17	–	–	–	–	–	5	–	–	2
23	–	–	9	1	1	–	13	14	40	49	–	–	–	–	–	27	13	8	6
24	1	–	1	12	9	3	30	42	125	58	1	–	1	–	–	28	26	13	33
25	–	–	4	7	17	9	29	55	126	59	4	–	7	–	1	31	41	20	60
26	4	–	1	9	52	17	17	86	108	32	4	1	12	3	1	12	43	27	78
27	2	–	3	3	65	22	5	92	51	19	5	–	21	6	3	5	40	32	67
28	8	–	3	5	65	26	–	91	33	9	5	–	12	1	–	5	13	10	47
29	4	–	3	5	43	17	–	60	30	10	7	–	8	1	1	3	11	6	39
30	2	–	2	1	39	16	–	55	46	11	9	–	4	1	6	2	6	3	54
31	2	–	2	2	28	12	–	40	66	8	7	–	3	1	10	1	5	2	74
32	1	–	1	4	46	14	–	60	57	7	7	–	2	–	8	5	11	4	86
33	1	–	2	3	56	26	–	82	44	6	3	–	4	–	3	6	5	2	77
34	–	–	1	3	47	26	–	73	48	4	2	–	3	1	2	5	2	2	77
35	1	–	2	1	47	13	–	60	21	1	1	–	4	1	1	5	–	–	48
36	–	–	2	–	27	12	–	39	12	1	–	–	1	1	3	3	–	–	10
37	1	–	1	–	11	5	–	16	8	1	2	–	1	–	1	3	1	–	13
38	–	–	1	–	2	2	–	4	10	–	–	–	–	–	1	3	–	–	8
39	–	–	–	–	1	–	–	1	6	2	1	–	–	–	–	3	1	–	11
40	–	–	1	1	3	–	–	3	4	1	–	–	1	–	–	–	–	–	5
41	–	–	–	3	–	–	–	–	2	–	–	–	–	–	–	1	–	–	4
42	–	–	–	2	1	1	–	2	–	–	1	–	–	–	1	1	–	–	1
43	–	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1
44	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–
45	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
46	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
47	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
48	–	–	–	–	1	–	–	1	–	–	–	–	1	–	–	1	–	–	–
49	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
51	–	–	–	–	1	–		1	–	–	–	–	–	–	–	–	–	–	
52	–	–	–	–	1	–	–	1	–	–	1	–	1	–	–	–	–	–	–
53	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
	802	314	596	162	563	221	465	1249	885	306	62	756	95	21	42	199	248	138	807

XXIII.—WHITING.

ABERDEEN BAY.

Col. I. 31st October 1903.
,, II. 29th December 1903.
,, III. 11th February 1905.
,, IV. 29th March 1905.
,, V. 13th May 1902 (Doghole).

BURGHEAD BAY.

Col. I. 20th October 1903.
,, II. 14th November 1903.
,, III. 28th December 1903.
,, IV. 23rd January
,, V. 29th December 1903.

SMITH BANK.

Col. I. 1st April 1904.
,, II. 23rd October 1903.
,, III. 12th December 1904.
,, IV. 27th December 1903.

DORNOCH FIRTH.

Col. I. 22nd October 1903.
,, II. 11th November 1903.
,, III. 7th December 1904.
,, IV. 27th December 1903.
,, V. 28th December 1903.
,, VI. 9th February 1905.

OFF FINDHORN.—1st April 1904.

Cm.	Aberdeen Bay.					Burghead Bay.					Smith Bank.				Dornoch Firth.						Off Findhorn.
	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	I.	II.	III.	IV.	V.	VI.	
5	5	–	–	–	–	–	–	–	–	–	–	–	–	–	3	1	–	–	–	–	–
6	9	–	–	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	1	–	–
7	9	–	1	–	–	2	–	5	1	–	–	–	1	–	7	3	1	–	19	–	–
8	3	–	–	–	–	4	4	15	4	–	–	2	–	–	16	21	5	1	51	1	–
9	5	–	1	–	–	11	11	29	8	–	–	2	–	–	24	25	15	1	106	7	–
10	16	–	1	–	–	11	18	21	11	–	–	7	–	–	46	39	15	17	179	25	–
11	60	5	15	2	–	10	32	50	12	3	1	41	1	3	52	82	31	43	254	49	–
12	67	34	28	13	1	3	43	67	18	4	2	71	8	12	47	95	69	90	310	119	–
13	106	138	39	96	10	4	49	82	15	6	2	47	20	27	19	52	133	107	177	192	–
14	88	168	28	144	7	2	20	56	16	7	–	20	27	3	5	35	124	81	64	139	–
15	40	106	19	88	11	–	12	31	3	3	2	8	29	13	3	32	70	62	30	70	–
16	17	30	5	16	9	–	4	6	2	1	8	1	17	2	1	18	25	36	12	19	–
17	8	11	2	3	8	–	–	8	–	1	8	–	10	2	2	10	6	19	5	6	1
18	3	1	1	–	9	2	–	1	–	1	5	–	6	1	–	5	1	13	–	–	1
19	6	–	1	–	9	2	–	–	–	–	4	–	1	–	–	2	–	6	–	–	2
20	9	–	1	–	26	1	3	1	–	–	14	21	1	7	–	–	–	6	–	1	8
21	28	–	6	1	29	7	2	1	–	2	51	46	–	7	1	–	1	1	–	–	11
22	26	–	–	1	41	9	2	1	4	1	108	52	–	10	1	–	–	6	–	–	21
23	24	–	–	–	31	3	6	3	5	–	155	35	1	15	–	–	–	–	–	–	37
24	28	–	–	–	26	4	12	3	7	–	145	26	1	15	–	–	–	2	–	–	40
25	17	–	–	–	22	7	14	5	3	–	129	18	1	14	–	–	–	2	–	–	46
26	17	–	–	–	10	4	9	–	8	–	123	10	–	5	–	–	–	–	–	–	31
27	33	–	–	–	9	4	14	–	–	–	74	7	–	5	–	1	–	–	–	–	26
28	25	–	–	–	5	1	29	–	4	–	49	4	–	2	–	–	–	–	–	–	22
29	13	1	–	–	2	2	24	1	3	–	29	2	–	1	–	–	–	–	1	–	10
30	16	–	–	–	4	–	14	–	1	–	15	–	–	2	–	–	–	–	–	–	14
31	8	–	–	–	2	–	13	–	3	–	12	–	–	–	–	–	–	–	–	–	7
32	7	1	–	–	1	1	6	–	1	–	2	–	–	–	–	–	–	–	–	–	7
33	3	–	–	–	2	–	6	–	1	–	4	–	–	–	–	–	–	–	–	–	3
34	2	–	–	–	–	–	3	–	1	–	–	–	–	–	–	–	–	–	–	–	1
35	–	–	–	–	–	–	2	–	–	–	1	–	–	1	–	–	–	–	–	–	2
36	1	–	–	–	1	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–
37	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	2
38	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
39	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
41	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
42	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
43	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
44	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
45	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
46	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
47	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	701	498	148	364	275	94	355	386	131	29	955	420	124	147	233	421	496	494	1209	628	293

XXIV.—GURNARD.

Aberdeen Bay.

Col. I. 11th February 1905.
,, II. 30th May 1901.
,, III. 13th June 1901.
,, IV. 5th July 1901.
,, V. 30th July 1901.
,, VI. 31st July 1901.
,, VII. 1st September 1904.
,, VIII. 4th September 1901.
,, IX. 20th September 1900.
,, X. 13th October 1900.
,, XI. 8th October 1901.
,, XII. 31st October 1904.
,, XIII. 5th November 1901.
,, XIV. 17th December 1900.

Dornoch Firth.

Col. I. 9th February 1905.
,, II. 3rd June 1901.
,, III. 8th June 1903.
,, IV. 3rd July 1901.
,, V. 5th August 1901.
,, VI. 22nd October 1903.
,, VII. 5th November 1900.
,, VIII. 11th November 1901.
,, IX. VII. and VIII. combined.
,, X. 7th December 1904.
,, XI. 27th December 1903.

Smith Bank.

Col. I. 5th June 1901.
,, II. 8th November 1901.
,, III. 12th December 1904.

Cm.	Aberdeen Bay.														Dornoch Firth.											Smith Bank.		
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	I.	II.	III.
3	–	–	–	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
5	–	–	–	–	–	–	9	–	1	2	1	–	–	–	–	–	–	–	–	–	–	1	1	3	–	–	2	–
6	–	–	–	–	–	–	3	–	1	3	1	–	–	–	2	–	–	–	–	–	–	5	5	–	–	–	1	–
7	1	–	–	–	–	–	1	–	–	3	1	–	–	–	2	–	–	–	–	–	5	8	13	–	2	–	1	1
8	1	–	–	–	–	–	–	–	–	1	1	1	–	–	1	–	–	–	–	–	9	18	27	–	2	–	–	4
9	–	–	–	1	–	–	–	–	3	–	–	2	–	–	–	–	–	–	–	–	4	17	21	–	1	–	–	4
10	–	–	1	12	–	–	–	–	–	–	1	1	–	–	2	–	2	–	2	–	2	8	10	–	–	–	–	–
11	–	–	1	49	–	1	–	–	1	1	–	2	–	–	–	–	–	–	1	–	–	5	5	–	2	–	1	–
12	–	–	–	39	–	3	–	–	2	2	2	1	–	–	–	–	–	–	1	1	3	1	4	–	–	–	–	–
13	–	–	–	8	–	2	–	–	11	3	3	4	–	–	–	–	6	–	–	11	1	–	1	–	–	–	1	–
14	–	–	1	4	–	5	–	–	17	5	2	4	–	–	–	–	7	–	–	2	–	–	–	–	–	–	5	1
15	–	–	4	10	–	1	–	–	17	4	4	5	–	–	–	1	4	–	–	3	–	2	2	–	–	2	3	1
16	–	1	6	16	–	1	–	–	4	4	2	3	–	–	–	1	8	1	1	1	1	–	1	–	1	3	15	4
17	–	2	9	24	–	6	–	–	4	–	1	2	–	–	–	1	8	3	–	4	1	1	2	–	–	4	8	2
18	–	2	2	3	–	16	–	1	3	–	–	–	–	–	–	1	4	4	–	3	1	–	1	–	–	1	2	1
19	–	2	4	4	–	5	–	–	9	1	–	–	–	–	–	3	6	1	–	2	2	–	2	–	–	3	3	2
20	–	5	5	1	2	4	–	–	12	–	–	1	–	–	–	5	1	–	1	–	4	–	4	–	–	4	5	1
21	–	6	2	–	3	1	–	1	9	–	4	2	1	–	–	10	2	2	–	–	3	1	4	–	–	5	8	–
22	–	2	1	–	–	2	–	1	4	1	1	–	1	1	–	17	1	1	2	2	–	–	–	–	–	11	4	–
23	–	2	1	1	1	2	–	–	3	–	–	1	2	–	–	21	1	4	–	–	–	–	–	–	–	3	2	–
24	–	–	–	1	–	2	–	–	2	–	1	–	1	2	–	12	–	2	–	–	–	–	–	–	–	9	4	–
25	–	–	–	–	1	–	–	–	1	–	–	–	1	3	–	17	–	2	1	–	–	–	–	–	–	8	5	–
26	–	–	–	–	–	1	–	–	1	–	–	–	1	2	–	15	–	1	–	1	–	–	–	–	–	12	2	–
27	–	–	–	–	1	–	–	–	2	–	1	–	1	4	–	11	–	3	1	–	1	–	1	–	–	7	5	–
28	–	–	–	–	–	1	–	–	2	–	–	1	1	–	–	14	–	1	–	–	1	–	1	–	–	7	2	–
29	–	–	–	–	–	–	–	–	1	–	–	–	3	–	–	7	–	2	1	–	1	–	1	–	–	3	5	–
30	–	1	–	–	–	1	–	–	–	–	–	–	4	–	–	1	–	–	1	–	–	–	–	–	–	–	3	–

XXIV.—GURNARD—*continued.*

Cm.	Aberdeen Bay.														Dornoch Firth.											Smith Bank.		
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	I.	II.	III.
31	–	–	–	–	–	2	–	–	2	–	–	–	3	–	–	8	–	–	1	1	–	–	–	–	–	1	2	–
32	–	–	–	–	–	–	–	1	2	–	–	–	4	–	–	3	–	–	2	–	1	1	2	–	–	1	2	–
33	–	1	–	–	–	–	–	–	–	–	–	–	4	1	–	3	–	–	–	2	–	–	–	–	–	3	1	–
34	–	–	–	–	–	1	–	1	–	–	–	–	2	–	–	8	–	1	–	–	–	–	–	–	–	1	2	–
35	–	–	1	–	–	–	–	–	–	–	–	–	2	–	–	10	–	–	–	1	–	–	–	–	–	–	1	–
36	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	8	–	1	2	–	–	–	–	–	–	–	3	–
37	–	–	–	–	–	1	–	–	1	–	–	–	1	–	–	4	–	2	3	–	1	–	1	–	–	–	–	–
38	–	–	1	–	–	–	–	–	–	–	–	–	1	–		2	–	1	1	–	2	–	2	–	–	1	2	–
39	–	–	1	–	–	–	–	–	–	–	–	–	2	–	–	2	–	1	–	–	–	–	–	–	–	–	–	–
40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–	–
41	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	1	–	–	–	–	–	–	–	–
42	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–
43	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
44	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	1	–	–	–	–	–
45	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
46	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
47	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
48	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
49	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
	2	24	40	173	8	60	17	6	115	32	26	30	35	13	7	190	50	33	24	35	44	68	112	4	8	92	100	21

XXV.—GURNARD.

Burghead Bay.

Col. I. 1st June 1901.
,, II. 6th, 7th September 1901.
,, III. 20th October 1903.
,, IV. 14th November 1903.
,, V. 25th December 1901.

Moray Firth.

Col. I. Several Hauls, October 1900.
,, II. Several Hauls, November 1900.
,, III. Off Lossiemouth, 3rd November 1901.
,, IV. Station VII., 12th June 1900.
,, V. Witch Ground, off Burghead, 14th November 1903.

Sinclair Bay.

3rd and 4th June 1901.

Firth of Forth.

Col. I. 9th, 13th May 1901, Station III.
,, II. 23rd July 1901, do.
,, III. 19th August 1901, do.
,, IV. 10th May 1901, Station V.
,, V. 16th, 21st August 1901, do.

Clyde.

Off Ailsa Craig, 4th October 1901.

Off Shetland.—October 1900.

Cm.	Burghead Bay.							Moray Firth.					Sinclair Bay.												Firth of Forth.								Clyde.	Off Shetland.
	I.	II.			III.	IV.	V.	I.	II.	III.	IV.	V.	3rd June 1901.			3rd June 1901.			4th June 1901.			Total (3 Hauls).			Station III.						Stn. V.			
		F.	M.	Tl.																					I.				II.	III.	IV.	V.		
													F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	Tl.	F.	M.	?	Tl.						
6	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	1	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-	-	1	-
8	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-	1	-	1	-
9	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	-	-	4	-	-	-
10	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-	-
11	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	7	2	1	2	-	-
12	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	16	17	2	6	1	-
13	-	1	-	1	-	1	-	5	4	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	9	18	-	9	3	-
14	1	1	-	1	1	-	-	7	15	1	10	-	1	-	1	-	-	-	-	-	-	1	-	1	-	1	1	2	5	13	3	5	6	-
15	1	2	2	4	1	-	-	11	49	2	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	12	2	1	1	12	-
16	1	1	2	3	1	2	-	12	54	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5	9	34	1	-	3	27	-
17	2	3	4	7	2	-	-	7	22	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	6	-	7	27	2	1	4	27	-
18	1	15	12	27	2	6	-	1	29	9	-	1	-	-	-	-	-	-	1	-	1	1	-	1	2	-	1	3	20	4	-	1	39	-
19	1	33	21	54	2	9	-	7	31	21	-	1	-	-	-	-	-	-	-	1	1	-	1	1	-	2	-	2	7	4	2	1	45	-
20	3	36	12	48	1	4	-	10	51	32	-	1	2	2	4	1	-	1	1	-	1	4	2	6	3	-	-	3	2	3	-	4	33	-
21	5	27	3	30	1	5	-	4	45	44	-	2	2	-	2	2	-	2	1	3	4	5	3	8	5	1	-	6	2	-	2	4	25	-
22	4	17	7	24	1	8	-	8	36	37	-	2	12	2	14	7	2	9	4	2	6	23	6	29	1	2	-	3	4	-	1	3	12	3
23	5	16	6	22	1	6	-	4	31	21	-	3	25	1	26	6	2	8	15	3	18	46	6	52	1	-	-	1	2	1	-	3	13	6
24	1	26	11	37	3	4	-	1	28	44	-	1	27	9	36	10	2	12	16	5	21	53	16	69	1	-	-	1	2	1	-	4	13	7
25	3	23	16	39	1	1	-	1	27	47	-	2	45	13	58	11	4	15	27	10	37	83	27	110	3	-	-	3	1	2	1	2	8	1
26	5	29	4	33	1	5	-	-	23	36	-	2	63	10	73	8	1	9	27	5	32	98	16	114	1	-	-	1	1	-	1	-	11	4
27	7	29	5	34	2	2	-	1	27	41	-	2	66	10	76	10	1	11	30	9	39	106	20	126	2	2	-	4	-	-	1	2	5	10
28	6	16	6	22	-	1	-	3	19	25	-	5	73	14	87	8	3	11	42	5	47	123	22	145	2	1	-	3	-	1	-	1	4	4
29	6	17	2	19	2	-	-	4	20	4	-	1	63	8	71	12	-	12	32	2	34	107	10	117	2	-	-	2	-	1	-	-	1	4
30	3	20	3	23	3	1	-	3	11	8	-	7	54	4	58	6	1	7	25	1	26	85	6	91	3	2	-	5	-	-	-	-	3	4
31	3	16	3	19	3	4	-	8	14	3	-	2	38	6	44	9	2	11	35	2	37	82	10	92	3	-	-	3	3	-	-	1	3	2
32	2	9	-	9	2	4	-	10	7	3	-	2	31	5	36	7	-	7	19	-	19	57	5	62	3	-	-	3	-	2	-	3	3	7
33	10	10	1	11	2	2	-	15	10	3	-	5	29	2	31	2	2	4	20	3	23	51	7	58	-	-	-	-	-	-	-	-	3	2
34	5	2	-	2	3	-	-	9	9	4	-	6	29	2	31	9	-	9	22	-	22	60	2	62	1	-	-	1	-	1	-	-	1	4
35	8	6	-	6	4	-	-	9	9	3	-	1	24	1	25	4	-	4	17	-	17	45	1	46	2	-	-	2	-	-	-	-	1	5
36	6	7	1	8	4	1	-	6	7	8	-	-	17	-	17	2	-	2	13	-	13	32	-	32	-	-	-	-	-	-	-	-	1	2
37	2	9	-	9	4	-	-	2	11	1	-	-	15	-	15	1	1	2	10	-	10	26	1	27	-	-	-	-	-	1	-	-	-	2
38	5	5	-	5	1	-	-	-	18	1	-	-	11	-	11	3	-	3	10	-	10	24	-	24	-	-	-	-	-	-	-	-	-	1
39	3	7	-	7	-	1	-	-	9	3	-	-	6	-	6	-	-	-	7	-	7	13	-	13	-	-	-	-	-	-	-	-	-	-
40	7	5	-	5	-	-	-	-	7	4	-	1	8	-	8	1	-	1	3	-	3	12	-	12	-	-	-	-	-	-	-	-	-	-
41	1	4	-	4	-	-	-	-	6	1	-	-	7	-	7	-	-	-	1	-	1	8	-	8	-	-	-	-	-	-	-	-	-	-
42	1	1	-	1	-	-	-	-	12	3	-	-	3	-	3	1	-	1	1	-	1	5	-	5	-	-	-	-	-	-	-	-	-	-
43	1	-	-	-	1	-	-	-	4	1	-	-	1	-	1	-	-	-	2	-	2	3	-	3	-	-	-	-	-	-	-	-	-	1
44	-	-	-	-	1	-	-	-	2	-	-	-	3	-	3	-	-	-	-	-	-	3	-	3	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-
46	1	1	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	110	394	121	515	51	67	1	149	671	415	18	49	655	89	744	121	21	142	381	51	432	1157	161	1318	37	22	19	78	154	76	22	134	302	69

Fig. 2.

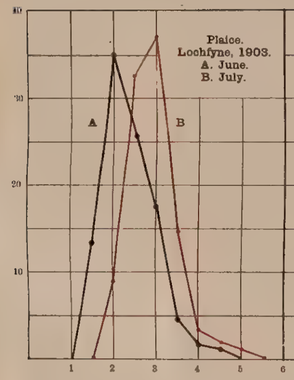


Fig. 3.

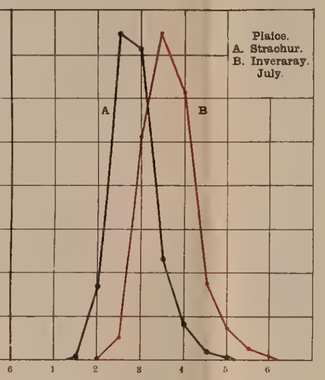


Fig. 4.

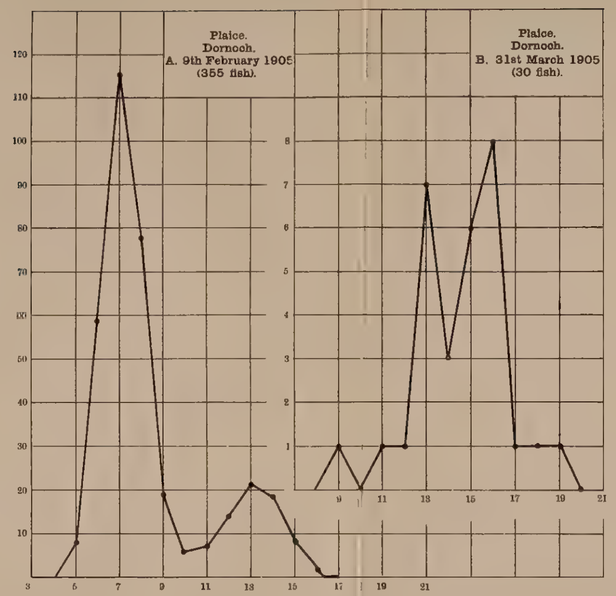


Fig. 5.

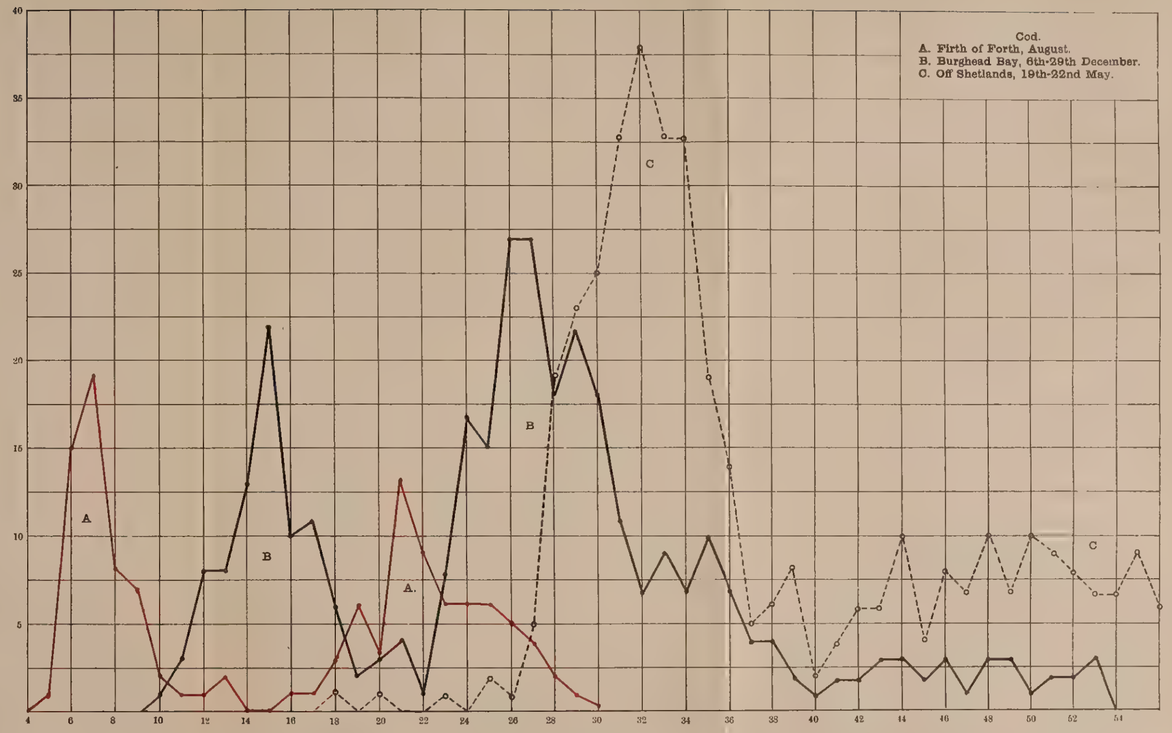


Fig. 1.

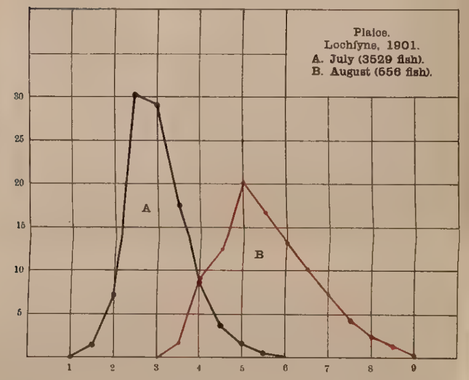


Fig. 7.

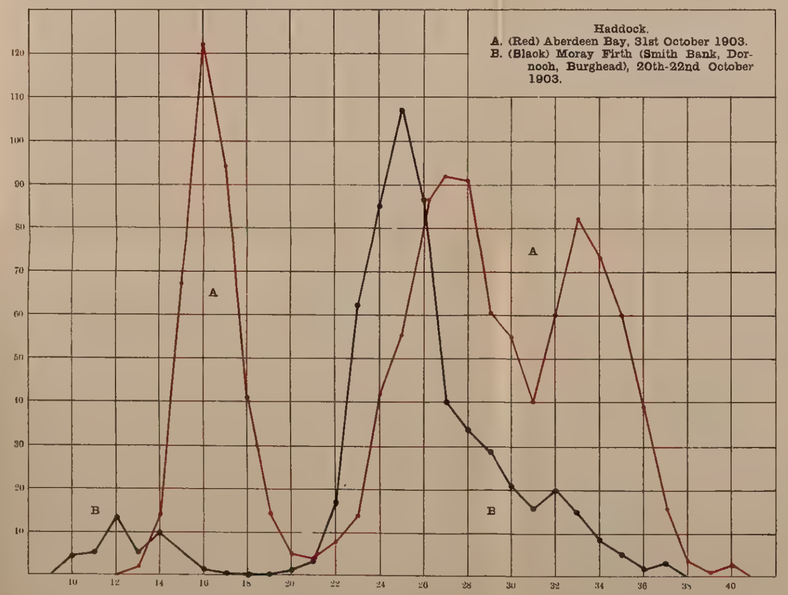
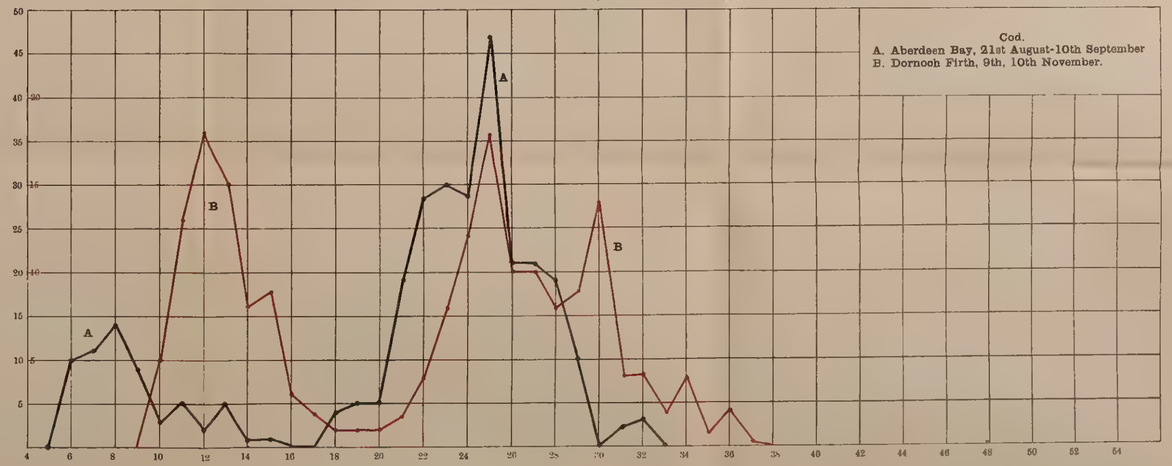
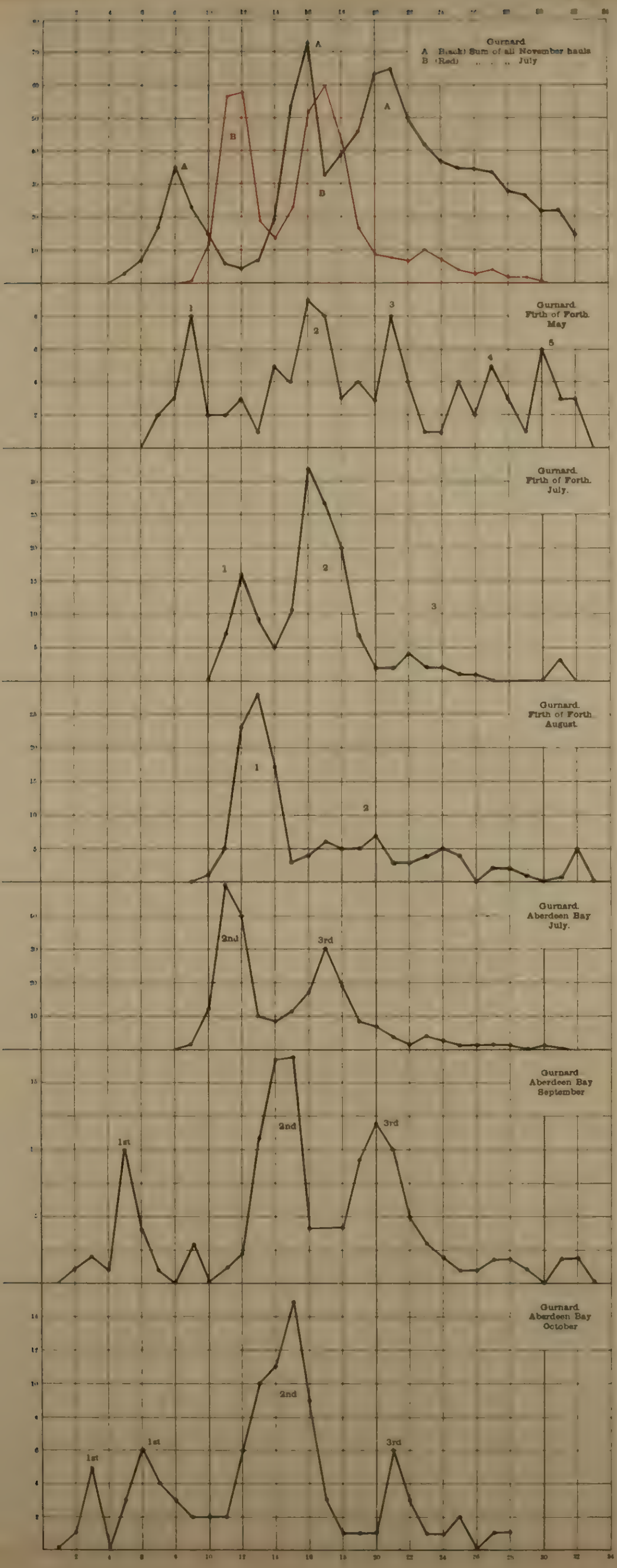


Fig. 6.




Gurnard
A (Black) Sum of all November hauls
B (Red) .. . .. July
Gurnard
Firth of Forth
May
Gurnard
Firth of Forth.
July.
Gurnard
Firth of Forth
August.
Gurnard
Aberdeen Bay
July.
Gurnard
Aberdeen Bay
September
Gurnard
Aberdeen Bay
October

IX.—NOTES ON NEW AND RARE COPEPODA FROM THE SCOTTISH SEAS.

By Thomas Scott, LL.D., F.L.S., Mem. Soc. Zool. de France.

(Plate XIV.)

Preliminary Note.

The following are a few notes and drawings of rare Entomostraca that have been held over from previous papers on Scottish Crustacea, published from time to time in the Reports of the Fishery Board for Scotland.

I am indebted to my son, Mr. Andrew Scott, A.L.S., for the drawings with which these notes are illustrated.

Genus *Amphiascus*, G. O. Sars (1895).

Amphiascus Catharinæ, T. Scott, sp. n. Pl. xiv., figs. 1–9.

Description of the female:—Body robust, somewhat similar to *Amphiascus minutus* (Claus); Rostrum moderately elongated (fig. 1); length, ·74mm. ($\frac{1}{33}$ of an inch).

Anterior antennæ slender, reaching to about the end of the cephalothoracic segment, and composed of eight joints; the first, fourth, and last joints of moderate length, the others small, as shown by the formula (*see* also fig. 2).

Proportional length of the joints,	16	18	9	14	4	7	6	1
Numbers of the joints, - -	1	2	3	4	5	6	7	8

Posterior antennæ stout, two-jointed, and furnished with a moderately elongated and three-jointed outer ramus (fig. 3).

Mandibles tolerably stout, apex truncated and armed with several teeth of unequal length; palp well developed, basal part moderately stout and setiferous, and provided with two small branches, as shown in the drawing (fig. 4).

Second maxillipeds small, second joint moderately narrow and fringed with minute setæ; the end joint very small but armed with a tolerably large terminal claw (fig. 5).

First pair of thoracic legs slender, both branches triarticulate, inner branch with first joint narrow, considerably elongated, and apparently with only a few minute setæ near the proximal end of the inner margin and a small hair near its distal extremity; the two end joints very short and armed with a stout terminal claw and a tolerably large seta; there are also a few smaller setæ, as shown in the drawing. Outer branch about two-thirds the length of the first joint of the inner, the middle joint is rather longer than the first and fully twice as long as the third; these joints have the outer margin setiferous and are also furnished with long spines on the outer distal angles (fig. 6).

Both branches of the other three pairs are also three-jointed, elongated and slender, the inner branches being rather shorter than the outer, as shown in the drawing which represents the fourth pair (fig. 7).

Fifth pair tolerably large and foliaceous; basal joint somewhat triangular in outline, the distal half of the inner margin which slopes towards the apex is provided with three stout setæ, the inner margin is nearly straight and terminates in an angle, and immediately posterior to this angular tooth are two apical setæ, which are separated from the lowermost of the three on the inner margin by a *distinct hiatus*, as in the drawing. Secondary joint subquadrangular, its width being equal to nearly two-thirds of the length, the outer and inner margins are *nearly parallel at the proximal end*, but they taper from about the middle of the joint towards the apex and there are three setæ on the outer margin, one on the lower inner margin and two on the apex, as shown in the drawing (fig. 8).

Furcal joints very short (fig. 9). Principal tail setæ slender. Two ovisacs. Male unknown.

Habitat.—Granton, Firth of Forth; dredged in an old quarry to which the tide has access. Apparently rare.

Remarks.—In some respects *Amphiascus Catherinæ* comes very near *Amphiascus* (*Dactylopus*) *minutus*, Claus., as described and figured by G. O. Sars,* but the form and armature of the fifth pair of thoracic feet are totally different. Other but less obvious differences are also noticeable, as, for example, in the form and armature of the mandible-palp, the armature of the outer and inner branches of the fourth pair of thoracic legs and in the hirsute character of the first two abdominal segments. Unfortunately I have been unable to obtain the male of this form, but owing to the differences mentioned I prefer meantime to regard this as a distinct form from *A. minutus*.

Genus *Dactylopusia*, A. M. Norman (1903).

Dactylopusia brevicornis (Claus). Pl. xiv., figs. 10–18.

1866. *Dactylopus brevicornis*, Claus., Die Copepoden-fauna von Nizza, p. 29, Taf. iii., figs. 20–25.

1905. *Dactylopusia brevicornis*, G. O. Sars, Crust. of Norway, vol. v., p. 130, pl. lxxx.

The female of this species, like that of some others of the same group, has the cephalothorax depressed and broadly ovate, but the abdomen is comparatively narrow (fig. 10). Rostrum short, with a broadly rounded apex. Length ·77mm. ($\frac{1}{32}$ of an inch).

Anterior antennæ composed of five joints, very short and stout; the first three are more robust than the remaining two joints, the end joint is fully twice as long as the penultimate one (fig. 11). The formula shows the proportional lengths of the various joints as follows:—

Proportional lengths of the joints, -	18	12	16	6	17
Numbers of the joints, - - -	1	2	3	4	5

Posterior antennæ stout, two-jointed, with a short three-jointed outer ramus (fig. 12).

Mandibles stout, with an obliquely truncate apex, which is armed with a few large and several small teeth. Mandible palp with a dilated basal part bearing two very short uniarticulate branches (fig. 13).

* Crustacea of Norway, vol. v., p. 154, pl. xcvi. (March 1906).

Second maxillipeds short, stout, with a strong terminal claw (fig. 14).

The first pair of thoracic legs stout, both branches three-jointed; the first joint of the inner branch is as long as the entire outer branch, while the second and third joints are very short; a long plumose seta springs from near the middle of the inner margin of the first joint, but the outer margin is fringed with small spines, the inner branch bears two strong, but unequal, terminal claws; the first and second joints of the outer branch are subequal, and are each furnished with a stout elongated spine near the outer distal angle, the second joint being also provided with a long plumose seta on the inner margin, the end joint is tolerably short and is armed as shown in the drawing; a stout spine also springs from both the outer and inner angles of the second basal joint (fig. 15).

The next three pairs of thoracic legs have also both branches three-jointed, the inner being the shorter one; both branches have their outer margins fringed with spines. In the fourth pair (fig 16.) the inner margin of the first joint of the inner branch caaries one seta. The second two setæ, and the end joint four setæ. A short spine also springs from the outer distal angle of the third joint.

The fifth pair foliaceous, basal joint broadly triangular, with a truncated and broadly but irregularly rounded apex which bears five stout setæ of various lengths. Secondary joint broadly subquadrangular, proximal half of the outer margin nearly parallel with the inner, but the distal half tapers towards the apex and carries three setæ, other three setæ spring from the apex and lower part of the inner margin (fig. 17).

Furcal joints very short; the inner of the two principal tail setæ with the base slightly dilated (fig. 18).

Habitat.—Collected in an old quarry, open to the sea, at Granton, Firth of Forth.

Remarks.—The form described here under the name of *Dactylopusia brevicornis*, Claus, undoubtedly belongs to that species. The drawings, though only now published, were prepared a number of years ago from specimens collected in an old quarry at Granton, Firth of Forth, to which the tide has access.

The abbreviated length and massive structure of the antennules; the structure of the mandibles, the stout first pair of thoracic feet, and the form of the fifth pair are sufficiently characteristic of this particular species.

The following list of some of the rare and interesting species that have been obtained in the old quarry at Granton just referred to may be of interest, as indicating the remarkable variety of organisms present in this small body of water. The species are arranged alphabetically:—

Acartia bifilosa, Giesb.
Ameira longicaudata, T. Scott.
Beatricella mimica, T. Scott.
Canthocamptus parvus, T. Scott.
Canuella perplexa, T. and A. Scott.
Cletodes similis, T. Scott.
Dactylopusia brevicornis, (Claus).
,, *finmarchicus*, (T. Scott).
,, *vulgaris*, G. O. Sars.
Ectinosoma curticorne, Boeck.
Enhydrosoma incurvatum (B. & R.).
Euryte longicauda, Philippi.
Halicyclops æquoreus (Fischer).
Harpacticus obscurus, T. Scott.
Idya furcata, Baird.
,, *gracilis*, T. Scott.

Idya minor, T. Scott.
Laophonte curticauda, Boeck.
,, *gracilis*, T. Scott.
,, *hispida*, B. & R.
,, *inopinata*, T. Scott.
,, *intermedia*, T. Scott.
,, *littorale*, T. and A. Scott.
,, *longiremis*, T. Scott.
,, *thoracica*, Boeck.
Longipedia Scotti, G. O. Sars.
Nannopus palustris, G. S. Brady.
Parathalestris hibernica (Brady & Robertson)
Platychelipus littoralis, G. S. Brady.
Pontopolites typicus, T. Scott.
**Pseudothalestris major*, T. and A. Scott.
Stephos Scotti. G. O. Sars.
Tachidius dicipes, Giesb.
,, *littoralis*, Poppe.
Zaus spinatus, Goodsir.

Genus *Pseudodiosaccus*, T. Scott (1906).

Pseudodiosaccus propinquus (T. and A. Scott). Pl. xiv., figs. 19–29.

1893. *Diosaccus propinquus*, T. and A. Scott. Ann. and Mag. Nat. Hist., sev. 6, vol. xii. (Oct., 1893), p. 237, pl. xi., figs. 1–6.

1906. *Pseudodiosaccus propinquus*, T. Scott. Ann. and Mag., May, 1906, p. 465.

This species was obtained in the Moray Firth, a few miles to the northward of Kinnaird Head, where the water is very deep; the particular part where this species was obtained gave a sounding of 130 fathoms (240 metres), the dredge line hanging free, and straight up and down. As the species appears to be rare, and as the number of drawings used to illustrate the description were only sufficient for its identification, I propose to supplement the original description with some additional remarks and drawings, especially as it has been considered necessary to remove the species from the genus to which it was first ascribed.

* Professor G. O. Sars. in Vol. V. of his great work on the Crustacea of Norway, at present in course of publication, deals with what is probably the most difficult as well as the most interesting group of the Copepoda, viz.:—the Harpacticoida. In this volume, at p. 142, the learned author is inclined to regard *Pseudothalestris major*, T. and A. Scott, as identical with *Westwoodia minuta*, Claus. The description and figures of this form given by Dr. Claus are meagre—they are not only limited and indefinite, but it is only the male that he describes. On the other hand, Professor Sars' description and figures of what he believes to be the female of Claus' species are full and clear, like all that author's work, and they no doubt show a certain close resemblance to the female of *Pseudothalestris major*. But there is at least one point where an important difference occurs. The author describes the antennules of the female as composed of six joints, whereas those of the female of *Pseudothalestris major* are eight-jointed, the first four being moderately elongated and the other four shorter. There appears also to be some difference in the structure of the posterior antennæ.

It may also be noted that the same author makes *Pseudothalestris* Brady, a synonym of *Westwoodia*, Baird, but as the small group of species that have been arranged under the genus name *Pseudothalestris* are clearly distinguishable from *Westwoodia* by the difference in the structure of the first pair of thoracic feet, I prefer to keep them separate under the genus instituted by Dr. Brady. The fact that *all* the species belonging to the group hitherto arranged together under *Pseudothalestris* are similarly characterised by the peculiarity in the structure of the first pair of feet that distinguishes them from the typical *Westwoodia* is, I think, a valid reason for keeping them separate from that genus.

The female of this species, as already described, resembles to some extent that of *Diosaccus tenuicornis*, Claus, in its general appearance, but is probably somewhat larger. It measures about 1mm. (or $\frac{1}{25}$ of an inch) in length, exclusive of the tail setæ (fig. 19).

The antennules (anterior antennæ) are moderately elongated, and composed of eight joints; the first four joints are moderately large, and are together considerably longer than the entire length of the last four. The fifth joint is little more than half the length of the preceding one and about two-thirds of the length of the sixth joint. The end joint is about equal in length to the fifth, but the penultimate one is considerably shorter, as shown in the drawing (fig. 20).

The outer and inner rami of the posterior antennæ are both of them biarticulate. The outer ramus, which has the joints subequal, is short, and furnished with about three short setæ. The inner ramus is moderately stout (fig. 21).

The mandibles are stout, and possess a broad and somewhat obliquely truncated biting edge, which is irregularly but distinctly dentated. Mandible palp of moderate size, and provided with a single terminal uniarticulate branch (fig. 22).

The maxillæ are moderately stout and compact, and the masticatory lobe, which is short, and obliquely truncated, is armed with a number of tolerably strong spines of varying lengths; the palp is fairly well developed (fig. 23), and consists of several lobe-like processes as shown.

Second maxillipeds robust, and armed with a stout elongated terminal claw (fig. 24).

The first pair of thoracic legs have both branches three-jointed; the first joint of the inner branch is considerably elongated, but the second and third are very short and subequal, and the end one is armed with two terminal claw-like spines, one being moderately long and one short; a small seta also springs from near the distal end of the inner margin of the first joint. The outer branch is little more than half the length of the inner one; the first two joints are subequal, but the third is short, and furnished with several spiniform setæ, as shown in the drawing (fig. 25).

The second and third pairs, which have also both branches three-jointed, are moderately stout, and the outer and inner branches are of nearly equal length. In the second pair the first joint of the inner branch is rather shorter than the second, and it carries a single seta on the inner margin; the second joint carries three setæ, and the end joint one seta, on the inner margin; the end joint is also provided with three terminal setæ, but the outer one is short. The outer branch has the end joint rather longer than the preceding one, and furnished with two elongated setæ on the inner margin, two moderately long spines on the outer margin, and three apical setæ of different lengths; the first and second joints are each furnished with a moderately long spine on the outer distal angle, and an elongated seta on the inner margin (fig. 26).

In the fourth pair the outer branch resembles that of the second pair in stoutness and armature, but the inner branch is slender and short, and composed of only two joints; the first joint, which is narrow and shorter than the second, bears a seta on the inner margin; the second joint scarcely reaches beyond the end of the middle joint of the outer branch, and carries five setæ round its distal extremity (fig. 27).

In the fifth pair the outer and inner margins of the basal joint are nearly parallel; the distal end is obliquely truncated and slightly convex, and bears four moderately long marginal setæ, so arranged as to be nearly equidistant from each other. The secondary joint is broadly oval in outline, and extends considerably beyond the end of the basal joint; it

is provided with six setæ, which are arranged as follows:—One small seta on the upper half and another on the lower half of the outer margin and situated considerably apart, and four setæ round the distal extremity; the outermost and innermost seta is moderately large and plumose, but the two intermediate ones are small and close together (fig. 28)

Furcal joints as long as the last abdominal segment (fig. 29). Ovisacs two. Only three specimens—all females—were obtained.

Remarks.—This species, as already stated, has some resemblance to *Diosaccus tenuicornis*, Claus, but the structure and armature of the mandibles, maxillæ, and fourth pair of thoracic legs are so distinctly different that though the species was at first ascribed to that genus it cannot be retained there, and a new genus, *Pseudodiosaccus*, has therefore been instituted for its reception, as indicated above. This genus appears to partake of the characters of both *Diosaccus* and *Amphiascus*, but in the structure of the fourth pair of thoracic legs it agrees with neither of these two genera.

It resembles *Diosaccus* in the structure of the posterior antennæ, of the mandible palp, and to some extent in the structure of the first and fifth pairs of thoracic legs; while in the maxillæ, second maxillipeds, and the second and third pairs of legs it resembles *Amphiascus*.

PLATE XIV.

Amphiascus Catharinæ, T. Scott.

Fig. 1. Female, side view.
Fig. 2. Antennule.
Fig. 3. Antenna.
Fig. 4. Mandible.
Fig. 5. Posterior foot jaw.
Fig. 6. Foot of first pair.
Fig. 7. Foot of fourth pair.
Fig. 8. Foot of fifth pair.
Fig. 9. Abdomen and furcal joints.

Dactylopusia brevicornis, Claus.

Fig. 10. Female, dorsal view.
Fig. 11. Antennule.
Fig. 12. Antenna,
Fig. 13. Mandible.
Fig. 14. Posterior foot-jaw.
Fig. 15. Foot of first pair,
Fig. 16. Foot of fourth pair.
Fig. 17. Foot of fifth pair.
Fig. 18. Abdomen and furcal joints.

Pseudodiosaccus propinquus, T. Scott.

Fig. 19. Female, side view.
Fig. 20. Antennule.
Fig. 21. Antenna.
Fig. 22. Mandible.
Fig. 23. Maxilla.
Fig. 24. Posterior foot-jaw.
Fig. 25. Foot of first pair.
Fig. 26. Foot of second pair.
Fig. 27. Foot of fourth pair.
Fig. 28. Foot of fifth pair.
Fig. 29. Abdomen and caudal furca.

PLATE XIV.

SCOTT. *del ad nat.*

FIGS. 1–9. *Amphiascus Catharinæ.* FIGS. 10–18. *Dactylopusia brevicornis.* FIGS. 19–29. *Pseudodiossacus propinquus.*

X.—ON THE SPAWNING AND FECUNDITY OF THE PLAICE (*PLEURONECTES PLATESSA*). By T. Wemyss Fulton, M.D., F.R.S.E., Superintendent of Scientific Investigations.

The spawning period of the plaice has been very well determined for various parts of the North Sea. On the east coast of Scotland it extends from the end of December in some years, but more usually from the early part or middle of January, to the early part or middle of May, the chief spawning taking place in March.

The records of the Marine Hatchery at Aberdeen furnish some details of interest as to the length of the spawning season and the intensity of spawning in the various months. Thus last year eggs were obtained from the spawning pond for 117 days, from 20th January till 16th May. The number of eggs obtained in the various months during the last three years, and the percentages of the total, are as follows:—

	Number of Eggs.	Percentage.
January, .	1,980,000	1·5
February, .	31,402,000	22·3
March, . .	78,595,000	53·5
April, . .	31,911,000	21·3
May, . .	1,762,000	1·2

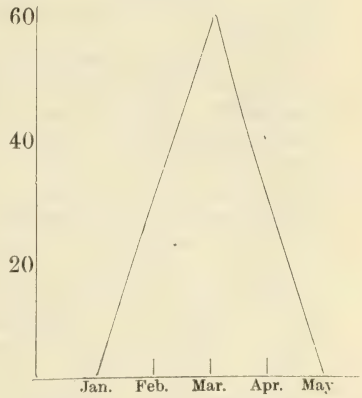


Fig. 1.

The curve (Fig. 1) formed by these figures is very regular, and, as will be seen, the spawning is at its height about the middle of March.

It has not yet been shown, however, over what part of the period a single female continues to discharge her eggs. It is well known that most or all fishes producing isolated pelagic eggs do not get rid of them at once. They are spawned in relatively small quantities at a time and over a longer or shorter period. As I have elsewhere shown,* this is a physical necessity, since a female cannot hold all the eggs at the size they possess when mature, and they must ripen gradually and in succession.

It was in order to determine the duration of the spawning in a single female, and some other points in connection with spawning, that the following experiments were chiefly made. But another object I had in view was to ascertain the number of eggs actually shed into the water, *i.e.*, the real fecundity. This has been approximately determined for the

* "The Comparative Fecundity of Sea Fishes," *Ninth Annual Report*, Part III., p. 242; "On the Growth and Maturation of the Ovarian Eggs of Teleostean Fishes," *Sixteenth, Ibid.*, p. 88.

plaice already in one of the papers above alluded to, but by a different method, viz., by counting the eggs in a given portion of the ovary after the death of the fish, and then computing the total numbers.

The experiment consisted in keeping two female plaice, which were nearly ready to spawn, in separate tanks, with one or more mature males with each of them, until spawning was quite concluded; to collect all the eggs daily and ascertain their numbers.

The tanks in which the experiments were made are similar in all respects. Each is 6 feet 4 inches in length, 4 feet 3 inches in breadth, and 3 feet 6 inches high, and the water was kept at a level of 28 inches throughout the period. The quantity of water was thus about 62 cubic feet, or 385 gallons (1749 litres). The flow through it amounted to about 80 gallons per hour. The glass front of the tank was covered over with an old sail, and light was admitted from the top, but it was not very strong. The water entering the tanks was filtered through close and thick flannel to obviate the chance of eggs getting into them in that way; and no other fish or organisms were in the tanks—nothing but the plaice.

The overflow from each tank was carried into two boxes, each about a foot square, the bottoms of which were covered with fine silk-netting, so that all eggs might be retained; these were partly immersed in order to keep the eggs living, and the water passed from one of the boxes into the other, being thus twice filtered, an arrangement adopted lest the fine apertures in the silk gauze in the first box should get clogged up during the night.

The method of dealing with the eggs was as follows:—Each collection, daily, or, usually, twice a day, was preserved in sea-water with a little formaline. The eggs were then strained off and spread on blotting paper, and as much of the water and moisture as possible removed. They were then added to a long burette, graduated to tenths of a cubic centimetre, in which a certain measured quantity of water had been placed. The difference between the readings before and after the eggs were introduced gave the volume of the eggs in cubic centimetres. Some were also weighed on a Sartorius balance. A portion of the eggs in each collection were treated in a similar way and, after the volume had been determined, were counted. The number of eggs per cubic centimetre, and the total quantity of eggs in the collection, were thus estimated.

Two suitable female plaice were selected from those in the spawning pond (used in connection with the hatchery), *i.e.*, which had swollen ovaries and obviously would soon spawn, but which contained no ripe eggs. This was ascertained by pressure in the ordinary way. On the other hand, males were taken from which spermatic fluid was already oozing, in order to provide that the eggs should be fertilised, and to furnish such psychological stimulus to the female as might be necessary and natural.

On the 19th February the following plaice were put into the tanks:—In No. 5 a female measuring 47cm. ($18\frac{1}{2}$ inches) and weighing 1324 grammes (2 lbs. $14\frac{3}{4}$ ounces), and a male of 43cm. (17 inches) and weighing 842 grammes (1 lb. $13\frac{3}{4}$ ounces). In tank No. 2 the female measured 46·5cm. ($18\frac{1}{4}$ inches) and weighed 1536 grammes (3 lbs. $6\frac{1}{4}$ ounces), and was thus heavier than the other. Two males were put in with her, measuring respectively 38·6cm. and 40cm.

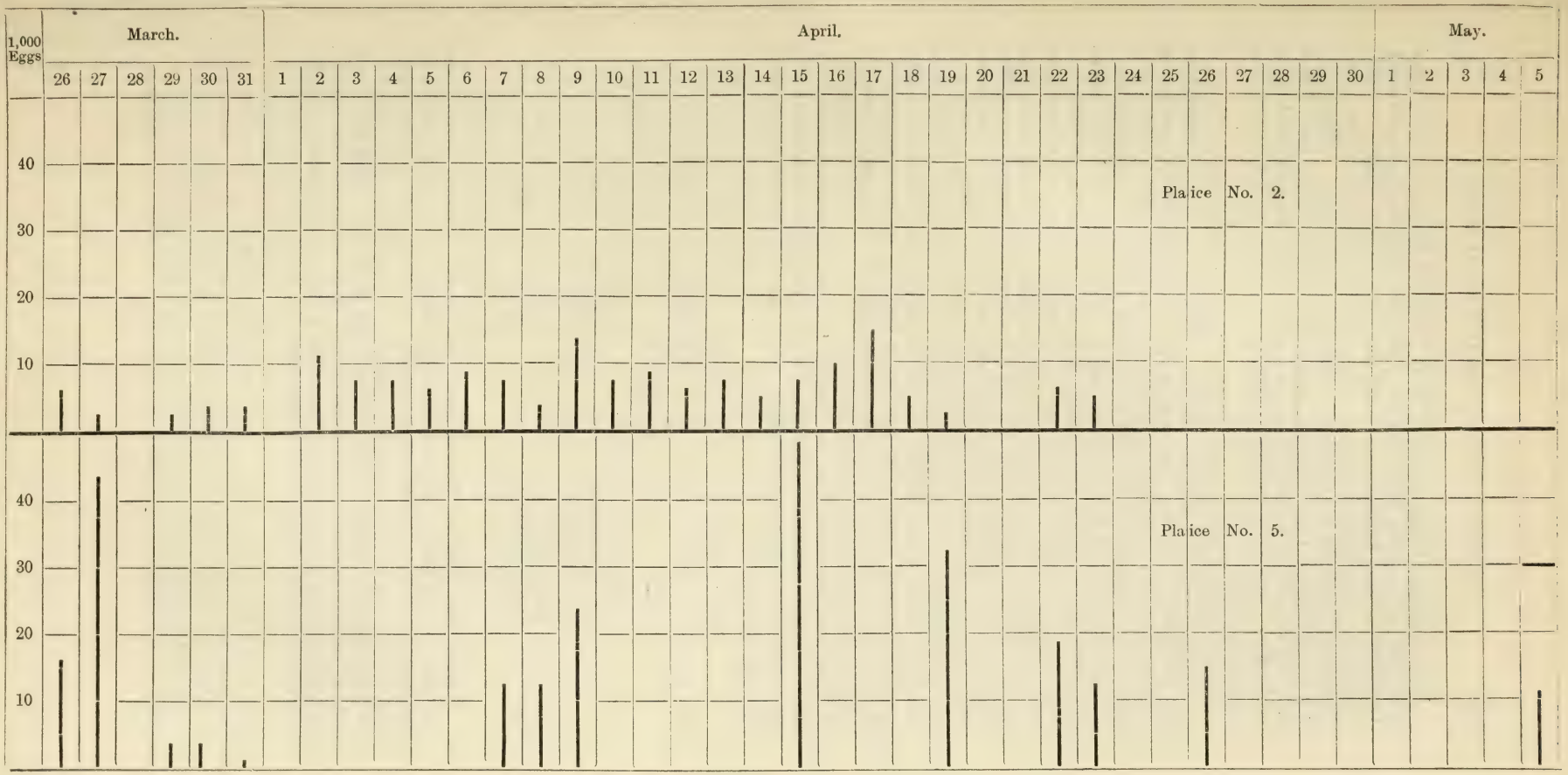
In the course of the experiment, when a pause occurred in spawning, the males were sometimes replaced by fresh ones taken from the pond, as mentioned later.

No eggs were obtained from either tank until 19th March. During the interval the males and females lay quiet in a corner of the tank. In No. 5, for example, the female lay with her snout as far as possible into the

corner, the male snuggling up close beside her, between her and the wall. They were never observed swimming about, and only rarely shifted their position. They did not take any food; the mussels thrown in one day were removed on the following day. The male in No. 2 was curiously coloured. Along the sides, near the base of the fins, there were six equidistant and subequal spots of chalky white, from $\frac{1}{2}$–$\frac{3}{4}$ inch in diameter; there was a similar spot at the root of the tail and another near the base of the pectoral fin. Between these were single dullish-red spots, by no means conspicuous; white rings were not observed around them. Similar red spots were scattered over the surface. The female was dull-coloured and her spotting not very noticeable.

The particulars as to the spawning of each female from day to day are given in the following Table, and also in the diagram on the opposite page, the numbers in the first column representing 1000's of eggs.

Time of Collection.		Eggs Collected.		Quantity taken for Computation.				Number per C.C.		Estimated Total Number.		Temperature of Water.	
		C.C.		C.C.		Number.							
Day.	Hour.	2	5	2	5	2	5	2	5	2	5	2	5
Mar. 19	...	18	...	18	...	3003	...	166·9	...	3,003	...	...	...
,, 20	...	...	...	...	...	...	...	...	...	...	...	...	...
,, 21	...	...	...	...	...	...	...	...	...	...	...	...	...
,, 22	...	...	...	...	...	...	...	...	...	...	...	...	...
,, 23	...	...	...	..	...	...	...	...	...	...	...	...	...
,, 24	...	...	...	...	...	...	...	...	...	...	...	...	...
,, 25	...	...	...	...	...	...	...	...	...	...	...	...	...
,, 26	...	28·98	*62·8*	1·08	*4·3*	237	*1085*	219·4	*252·3*	6,359	*15,846*	...	...
,, 27	7.10a	8·5	*22·5*	8 5	*22·5*	1796	*5542*	211·3	*243·6*	1,796	*5,542*	...	...
	2.20	7-1	*158·7*	7·1	*8·8*	1316	*2155*	185·35	*244·8*	1,316	*38,863*	...	...
,, 28	...	...	...	. .	...	...	...	...	...	...	...	...	...
,, 29	2.30p	11·09	*10*	2·38	*10*	542	*2608*	227·7	*260·8*	2,525	*2,608*	...	...
,, 30	3.30p	16·15	*9·2*	1·45	*2·2*	324	*611*	223·4	*277·7*	3,609	*2,555*	...	...
,, 31	1.15p	15.58	...	1·2	...	274	*155*	228·3	...	3,557	*155*	...	...
April 1	...	...	...	...	...	...	...	...	...	...	...	...	...
,, 2	10a	49·0	...	2·15	...	490	*88*	227·9	...	11,167	*88*	...	...
,, 3	2·30p	28·9	...	1·6	...	385	...	240·6	...	6,954	...	...	...
,, 4	3p	28·87	...	1·77	...	422	...	238·4	...	6,883	...	...	...
,, 5	3p	24·8	...	1·2	...	285	...	237·5	...	5,890	...	...	...
,, 6	3p	38·45	...	1·65	...	381	...	230·9	...	8,878	...	...	...
,, 7	9.30a	30·45	*45·5*	1·45	*2·4*	335	*626*	231·8	*260·8*	7,035	*11,868*	...	...
,, 8	10a	10·86	*39·4*	0·66	*1·5*	185	*458*	280·3	*305·3*	3,044	*12,030*	...	...
,, 9	7.30a	50·35	*92·15*	3·15	*3·1*	808	*804*	256·5	*259·4*	12,915	*23,899*	...	...
	4·50p	3·8	...	0·99	...	236	...	238·4	...	906	...	...	...
,, 10	7.10a	24·89	...	1·69	...	427	...	252·7	...	6,288	...	...	...
	4.45p	3·5	...	3·5	...	702	...	200·6	...	702	...	...	...
,, 11	7.15a	22·9	...	1·0	...	255	...	255	...	5,840	...	45·4	*44·8*
	4.45p	6·95	...	0·75	...	199	...	265·3	...	1,844	...	...	...
,, 12	7·15a	21·56	...	1·21	...	316	...	261·1	...	5,629	...	45·4	*45·1*
	11a	...	...	...	...	...	...	...	...	...	...	...	...
	4.45p	...	...	...	...	...	...	...	...	...	...	...	...
,, 13	7.10a	22·85	...	4·75	...	1231	...	259·2	...	5,922	...	46·8	*46·4*
	4.45p	3·91	...	1·21	...	280	...	231·4	...	905	...	...	...
,, 14	7.10a	15·98	...	1·63	...	482	...	265·0	...	4,235	...	46·2	*45·7*
	3.20p	2·77	...	2·77	...	766	...	276·5	...	766	...	...	...
,, 15	2p	24·3	*134·75*	1·7	*3·25*	489	*1186*	287·6	*364·9*	6,989	*49,170*	47·1	*46·1*
,, 16	7.10p	38·1	...	2·0	...	507	...	253·5	...	9,658	...	48	*46·2*
	4.45p	...	...	...	...	...	...	...	...	...	...	...	...
,, 17	7.10a	53·35	...	2·1	...	586	...	279	...	14,887	...	...	...
	4.45p	·90	...	·90	...	308	...	342	...	308	...	44·2	*44·2*
,, 18	7.10a	15·35	...	1·55	...	503	...	324·5	...	4,981	...	45·3	*45·0*
	4.45p	...	...	...	...	...	...	...	...	...	...	...	...
,, 19	7·10a	9·7	*104·35*	·75	*6·85*	159	*2155*	212	*314·6*	2,056	*32,828*	40·8	*41·2*
	4.45p	...	...	...	...	...	...	...	...	...	...	...	...
,, 20	7.15a	..	...	...	...	...	...	...	...	...	...	42·3	*42·1*
	4.30p	...	..	...	...	...	...	...	...	...	...	...	...
,, 21	7.10a	...	...	...	...	...	...	...	...	...	...	45·7	*45·3*
,, 22	9.15a	23·6	*54·2*	2·0	*2·7*	462	*941*	231	*348·5*	5,452	*18,888*	45·0	*45·0*
,, 23	7.15a	10·8	*38·0*	1·1	*2·1*	434	*660*	394·5	*314·3*	4,261	*11,943*	42·8	*42·8*
	4.45p	...	...	...	...	...	...	...	...	...	...	...	...
,, 24	7.15a	...	...	...	...	...	...	...	...	...	...	40·6	*41·0*
,, 25	7.10a	...	...	...	...	...	...	...	...	...	...	40·6	*41·2*
	4.45p	...	...	...	...	...	...	...	...	...	...	...	...
,, 26	7.15a	...	*50·94*	...	*3.34*	...	*1022*	...	*306*	...	*15,587*	42·3	*42·4*
	4.45p	...	..	...	...	...	...	...	...	...	..	...	...
,, 27	7.15a	...	...	...	...	...	...	...	...	...	...	43·9	*43·5*
	4.45p	...	...	...	...	...	...	...	...	...	...	...	...
,, 28	7.30a	...	...	...	...	...	...	...	...	...	...	44·2	*43·9*
,, 29	,,	...	...	...	...	...	...	...	...	...	...	44·6	*44·2*
,, 30	7.20a	...	...	...	...	...	..	...	...	...	...	45·5	*45·0*
	4.45p	...	...	...	...	...	...	...	...	...	...	...	...
May 1	7a	...	...	...	...	...	...	...	...	...	...	44·6	*44·6*
, 2	7.15a	...	...	...	...	...	...	...	...	...	...	44·4	*44·8*
,, 3	7.15a	...	...	...	..	...	...	...	...	...	...	46·8	*46·0*
,, 4	7.10a	...	...	...	...	...	...	...	...	...	...	47·8	*47·1*
,, 5	12p	...	*3 4*	...	*4.0*	...	*1272*	...	*318*	...	*10,907*	46·9	*46·8*


1,000 Eggs
March.
April.
May.
26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5
40
30
20
10
Plaice No. 2.
Plaice No. 5.

The quantity of eggs obtained from No. 2 on 19th March was small, and there was a pause until the 26th, when the spawning began in reality. In the case of this fish the emission of eggs went on very steadily until the 19th April, eggs being got daily. From 19th to 22nd April spawning was interrupted, and the last eggs were obtained on 23rd April. The spawning of this female thus extended over a period of 36 days from first to last, but was chiefly limited to the interval from 26th March to 23rd April, or 28 days; only on three days in that time were no eggs found to have been spawned.

The characters of the spawning of this fish were a regular, small or moderate, quantity of eggs on each day. The average number emitted per day for the 25 days that they were emitted was 6542; the largest on any one day was 15,195 on 17th April, the next largest being 13,832 on 17th April; the smallest was 2056 on 19th April, and 2525 on 29th March.

The other female, in tank 5, offered a striking contrast to the above. Its spawning extended over a period of 41 days, viz., from 26th March to 5th May; but eggs were spawned on only 16 days during that time. There were thus long intervals without any eggs being obtained; as much as nine days. As the Table shows, it spawned most regularly at first, each day from 26th March to 2nd April (no collection was taken on the 28th or 1st). It will be noticed that the quantity of spawn emitted on the second day was very large, and it then diminished, only 155 eggs being found on the 31st March, and only 88 on 2nd April. The ovaries were greatly distended when spawning began, and the figures show that the fully mature eggs which had collected were got rid of in about five days, after which a rest for some days occurred.

This female spawned again on the 7th April, and for the next two days; then not again until the 15th; then on the 19th, 22nd, and 23rd; then on the 26th, and finally on 5th May. The seven "bursts" of spawning were as follows:—

	Dates.	Number of Eggs Spawned.	Ratio per 1 C.C.
1	26th March–2nd April, .	65,657	255·64
2	7th–9th April, . . .	47,797	272·2
3	15th April, . . .	49,170	364·9
4	19th April, . . .	32,828	314·6
5	22nd, 23d April, . .	30,831	331·4
6	26th April, . . .	15,587	306·0
7	5th May, ...	10,907	318·0

The largest numbers on any one day was 49,170 on 15th April, and 44,405 on 27th March; the smallest daily amount was 88 and 155, which might almost be considered accidental, the next being 2555. The average per day for the 15 days on which spawning occurred was 16,852 eggs.

The aggregate quantiiy of spawn from No. 2 over the whole period was 654·29 cubic centimetres, and the estimated number of eggs was 163,557.

The aggregate from No. 5 was 856·79 cubic centimetres, and the estimated number of eggs was 252,777.

[TABLE.

The quantity and numbers for each month were:—

	No. 2.		No. 5.	
	C.C.	No.	C.C	No.
March, .	71·82	15,605	263·2	65,414
April, .	582·47	147,952	559·29	176,456
May, .	–	–	34·30	10,907

The quantities taken for enumeration were 84·94 cubic centimetres for No. 2 and 77·04 for No. 5, or about 13 and 9 per cent. of the totals; and the numbers of eggs counted were 19,075 of No. 2 and 21,400 of No. 5, the total being 161·98 cubic centimetres, and 40,475 eggs.

With regard to the fecundity of the fishes, these results agree very well with those deduced previously from weighing part of the ovary and enumerating the eggs. Thus, in the paper referred to in the *Ninth Annual Report*, I describe a female of 17½ inches, and weighing 2 lbs. 10 ounces, with an estimated number of 148,470 eggs, and another of the same size and weighing 3 lbs. 0¼ ounces, with 223,497; the average for the five plaice there dealt with being 19·9 inches in length, 3 lbs. 10¾ ounces (1664 grammes) in weight, and 301,394 eggs.

Before referring further to the facts brought out in the Table, I may describe some of the occurrences in regard to the fishes and their treatment.

On 31st March a fresh male quite ripe was put into tank No. 5. The female was observed to be lying apart from the males, all of which had conspicuous red spots, but not nearly so bright as one often sees on plaice brought to deck at the fishing grounds at other times of the year. The ovaries were sometimes enormously swollen, so much so that I was afraid that the "egg-bound" condition was about to supervene. It appears, however, to be natural, and a certain distension occurred before the eggs were allowed to run from the oviduct. After a "burst" of spawning they were notably reduced in size.

On the 6th April, a fresh ripe male was put with No. 5, and the spawning, which had been interrupted, began on the same night. On the occasions when No. 5 stopped spawning, she was usually observed to be lying away from the males. The latter, it may be remarked, appeared to have no contests for the privilege of fertilising the eggs, as with the lumpsuckers in an adjoining tank. They were always lying quietly, and often, or even usually, together.

The ovaries of No. 2 were, as a rule, more swollen than those of the other female.

On 13th April two ripe males were put into No. 5, and she spawned again on the 15th.

With regard to food, mussels were only occasionally eaten, probably by the males; only on one occasion was any slimy matter which might have come from the intestines observed in the overflow, and in pressing the plaice taken from the tank to select those for the experiment, no excrements were pressed out.

After No. 5 stopped spawning on the 26th, she was observed to be adhering to the vertical side of the tank, a position she occupied for a day or two, as if desiring to be freed from the attention of the males.

Spawning was never actually observed, but the Table shows that it takes place usually at night, though it does not always do so (see 27th

March). As a rule, however, very much less spawn was collected in the afternoon than in the morning, and part may have been derived from the spawning during the night.

The difference between the two females was not confined to the spawning. There was a noteworthy difference in the eggs, not merely as to quantity but as to size. After some experience in the enumeration, it was possible to tell whether a collection was from No. 2 or No. 5, owing to this difference. Those from No. 5 were smaller.

Thus the mean number per cubic centimetre of the eggs from No. 2 was 250 (249·98), while the mean number from No. 5 was 245 per cubic centimetre, a difference of 45 per cubic centimetre. In other words, the eggs of one plaice were about 18 per cent. smaller than those of the other. With one exception (23rd April) the number per cubic centimetre was always greater in the second plaice, No. 5, that is to say, its eggs were smaller.

The ratio of number of eggs to 1 cubic centimetre in No. 2 was 185·35 at the beginning of spawning, and 394·5 at the close; in No. 5 it was 243·6 at the beginning, and over 300 later, the highest being 364·9 on 15th April.

This difference was partly due to the fact that in No. 2 there was in almost every collection a proportion of the eggs much larger than others; in some of the collections this was very noticeable. They graduated from very large ones, swollen, and, it might be said, hydropic, to small ones; the range of size being considerable from the smallest to the largest.

The eggs spawned by the other female (No. 5) were much more uniform in size. Whether differences of this kind occur under natural conditions I do not know, but such large hydropic eggs of the plaice are sometimes taken from the spawning pond, and on one or two occasions led to the suspicion that they might belong to some other species. They appear to be produced by an excessive imbibition of the watery saline solution that enters the egg at the last stage of maturation.* Whether they are fertilised and behave like the normal egg was not determined. Now and again a single egg was got stained bright yellow, no doubt from the bile; and several were blue, for what reason I did not discover.

It may be seen from the Table, moreover, that as spawning proceeded the size of the eggs tended to become smaller.

The fact may be seen from the averages for No. 5 given in the Table printed above; and, taking the mean of the first five averages (number per cubic centimetres) and the mean of the last five averages, we have the following:—

	No. 2.		No. 5.
26th–30th March,	213·43	26th–30th March,	255·84
17th–23rd April,	297·17	19th April–5th May,	320·28

The increase in the number with the first female was thus 83·74 per cubic centimetre, and in the second, 65·04 per cubic centimetre, the reduction in size amounting to 39·2 and 25·4 per cent. respectively.

The fact is of some interest, and is in all probability due to the comparative exhaustion of the water-secreting function of the ovary, water being, so far as volume is concerned, the chief product of that organ. It might, however, be owing to the eggs spawned later containing less yolk; a less probable explanation, for several reasons.

I may add that the mean of a number of fertilised plaice eggs taken from the large spawning pond at the same time was 307 per cubic centimetre, two samples varying from 312·27 to 301·63.

* *Vide Sixteenth Annual Report*, Part III., p. 89.

I have elsewhere shown* that at the last stages of the maturation of plaice eggs in the ovary the absorption of water by the eggs is enormous, amounting to at least two-thirds of the volume of the contents. Thus, in the 654 cubic centimetres of eggs produced by the female, No. 2, at least 536 cubic centimetres is represented by water absorbed not long before the eggs are extruded, and which is secreted by the fish. So in the other case; about 572 cubic centimetres of the 857 cubic centimetres of eggs represents water absorbed.

Both the plaice were kept in the tanks after the conclusion of spawning. On 9th May, no further eggs having come from the plaice in No. 2 since the 23rd of April, and spawning being clearly over, she was killed and examined. The length was the same, 46·5cm., and the weight was 2lbs. 8¼oz. (1139·8 grammes), showing a loss of 14oz., or 396 grammes.

At the same time, the other plaice (No. 5) was also weighed. It was 2lbs. 6¼oz. (1083 grammes), showing a loss of 8¼oz., or 234 grammes. The measurement was a little less, viz., 46·7cm.

This fish was put back with the males into the tank, but no further spawning occurred. On 13th May she weighed 1119 grammes, and was still 46·7cm.; on 21st May the weight and length were the same, so that recovery was slow.

The loss in weight above referred to does not represent anything like the weight of the eggs spawned. Among those of No. 2 it was found that 56 cubic centimetres weighed 53 grammes, so that the total weight of the 654 cubic centimetres spawned would be about 619 grammes, or 223 grammes more than the loss of weight of the fish.

In the other plaice (No. 5) 6·7 cubic centimetres of eggs weighed 6·65 grammes, and the total weight of the whole quantity of 857 cubic centimetres would be about 850 grammes, or 616 grammes in excess of the loss of weight of the fish.

The difference is accounted for by the water secreted and absorbed as the eggs mature; also, no doubt, by the absorption of water by the muscles and tissues of the fish after spawning, the increase of weight in No. 5 after the 9th May being probably due to this, since no food was eaten.

When the first plaice (No. 2) was killed, on 9th May, the ovaries were found to contain a large quantity of spawn. When put into sea-water all went to the bottom within a few minutes, and the disc was chalky white, and in many cases wrinkled and irregular. They represent the eggs which the fish is unable to get rid of at the end of spawning, and which disintegrate and are absorbed. The quantity amounted to 43·95 cubic centimetres, of which 3·75 cubic centimetres contained 1482 eggs, or 395·2 per cubic centimetre. The estimated number of eggs thus retained in the ovaries and destroyed was 17,369, or over 10 per cent. of the number spawned, which indicates a very considerable loss.

The ovaries of the other plaice were in the same condition, slightly swollen, tumid, and soft.

* *Ibid.*, p. 14. *See* also p. 145.

XI.—ON TWO CASES OF HERMAPHRODITISM IN THE COD (*GADUS CALLARIAS*).

By H. Charles Williamson, M.A., D.Sc., Marine Laboratory, Aberdeen.

(Plates XV., XVI.)

Several cases of Hermaphroditism were noticed among the cod landed in Aberdeen during March, 1906. Two of these were secured from local fish-curing yards for the Marine laboratory. A third was reported to the Fishery Board from Whitehills; and a fourth is known to have been observed in Aberdeen.

The specimens here described were examined after having been two months in formaline solution; they exhibit two different arrangements of the ovaries and testes. In one case, fig. 1, pl. xv. and xvi., a fully developed female reproductive organ bears at the anterior extremity of each ovary a small testis, forming a symmetrical hermaphrodite organ. The other example (fig. 2, pl. xv. and fig. 4, pl. xvi.) shows a single roe of large size united to a full-sized testis. The organ on the right side is female, that on the left is male.

The symmetrical roe weighed about $5\frac{1}{2}$ lb. It contained transparent eggs, showing that the roe was nearly ripe. The testis contained some ripe sperms, but there were none in the *vas deferens*. The testis, though well developed, was considerably short of being ripe. The main blood-vessel, *b.v.*, of the ovary reaches that organ at its anterior extremity. It is continued over the dorsum of the ovary along the base of the mesentery (after giving off a large branch to pass down on the inner surface of the ovary) to unite at the junction of the two ovaries with the corresponding vessel of the opposite organ. Before it reaches the ovary this large vessel gives off two branches $b^1.v^1$. and $b^2.v^2$., one to each end of the loop-formed testis (fig. 2, pl. xvi.). Between the branch blood-vessels and the frill of the testis lies the *vas deferens*. This duct is closed at one end of the testis loop, viz., at *VD*, and it opens by its other extremity, V^1D^1, into the ovary, by three small openings. These openings were not so guarded as to prevent the eggs from getting out into the *vas deferens*, but the eggs found there were small yoked eggs, and they may have been forced out by the handling to which the roe was subjected. A fully ripe egg would probably not pass through the apertures. The general form of the testis is that of a loop; it is shown diagrammatically in fig. 3. The great development of the testis-frill on so short an extent of *vas deferens* has formed it into a compact mass, wherein the *vas deferens* is not to be seen until the folds are forced apart. The large blood-vessel of the ovary is accompanied by a thick walled vessel (*v.*) having a very small lumen.

The asymmetrical organ weighed $3\frac{3}{4}$ lb. The ovary contained transparent eggs. Some ripe sperms were present in the testis; but there were none in the *vas deferens*. In this case a normal ovary is accompanied by a normal testis (fig. 4). The two unite in the anal region just as two ovaries or two testes do, and their ripe products escape by the

one genital aperture (*g.-ap.*). In the cod each ovary or testis is supported to the roof of the abdominal cavity by a mesentery, which is attached longitudinally to the swim-bladder. The stomach and gut are similarly supported by a mesentery that hangs between the genital mesenteries. All three mesenteries are together connected to the union of the two ovaries (or testes). The rectum is supported by mesentry to the inferior part of the united ovaries. The two ovarian mesenteries are continued posteriorly as a single mesentery joined superiorly to the roof of the abdominal cavity, and extending to the hind extremity of the post-abdomen, where it unites with the peritoneum. The hind lobes of the ovary are attached, one on each side, to the mesentery. This mesentery also includes the ureter and urinary bladder, and binds them to the floor of the post-abdomen. The post-abdomen is thus divided longitudinally into two quite separate compartments.

This arrangement was found to hold exactly in the case of the second hermaphrodite specimen. The mesenteries were arranged quite normally. Since they are similarly arranged in both sexes, the substitution of one half of the ovary by a testis did not involve any obnormal arrangement of the mesenteries.

When the wall of the ovary near the genital aperture was dissected off it was seen (fig. 5) that the *vas deferens* from the hind part of the testis, viz., $V^1.D^1$., and that from the main testis, *V.D.*, opened into a common chamber, marked *sm.* in the drawing. The wall of this chamber is smooth; it is open below to the eggs in the ovary. Alongside the base of the ventrally descending portion of the testis the tissue is deeply honeycombed, and divided up with a network of stout fibres (*h.-c.*). The passage of the sperms to the exterior appears to be as follows:—They pass from the upper smooth part to the honeycombed region, which probably acts as a sort of seminal receptacle, and from thence pass out along the smooth lower wall to the genital opening (*g.ap.*). The wall of the ovary near the genital aperture is smooth on the inside, whereas all the remaining wall bears the ovarian folds. The smooth part forms a gathering place for the ripe eggs, where they may collect away from the developing eggs, and when they may lie ready to be expelled. The smooth part of the skin of the ovary is shown in fig. 1, *sm.* In fig. 5, which shows the dissection of the hermaphrodite roe, the deflected sides are shown to be on one side partly smooth and in part covered with ovarian folds (*ov.f.*), and on the anterior side smooth (*sm.*). The smooth parts are the oviducal part.

It is clear that in the asymmetrical hermaphrodite both male and female organs will be functional, but it is also evident that they will not be simultaneously ripe. In this case the testis is much further from ripeness than is the ovary. Even although they should be ripe simultaneously, it is possible that the elements might not mix much, because there is room for the ripe eggs to collect on the opposite side of the ovary to that on which the testis is.

In the first case, where the testis is attached to the anterior end of the ovary, the former was farther from being ripe than was the ovary. It is not likely that the sperms would be able to penetrate the ovary so long as the ovary is large and distended. And as the facts indicate that the ovary will be ripe first, it is conceivable to regard the ovary as functioning later in the spent condition as a *vas deferens.*

Masterman* described two cases of hermaphroditism in the cod in the *Thirteenth Annual Report of the Fishery Board for Scotland*, Pt. III., p. 297. He also cites a number of other cases. In none of these was a condition found similar to either of the specimens described above. In

only one case was the hermaphrodite organ symmetrical—that was a case described by Weber, in which a testis was attached to the posterior end of each ovary. In no case was the united organ composed equally of one testis and one ovary. The connection of the *vas deferens* with the ovary was similar in Howe's, Masterman's, and the present instance, except that in Howe's a well-marked valve structure prevented the back passage of ova into the *vas deferens*. A somewhat similar arrangement appeared in Masterman's specimen.

Kyle† describes a case of hermaphroditism in the ling (*Molva vulgaris*). The testis was in four parts; a very large part much larger than the ovary was attached to the anterior end of each ovary, and a smaller part was connected with the hind end of each ovary, that connected to the right ovary being very small. A small portion of the left ovary was separated from the ovary posteriorly. Anteriorly each testis opened into the ovary by a small aperture guarded against the issue of the eggs by a valve-like fold of fibrous tissue. Posteriorly the left testis opened by its *vas deferens* into the oviduct. In this specimen, then, we have a combination of the two conditions described above—viz., (1) the ovary functioning as a *vas deferens*, and (2) the common use of the oviduct for the issue of both eggs and sperms. The eggs were nearly ripe, and the testis was well developed. The specimen was secured in May.

Plate XV.

Fig. 1.—Symmetrical hermaphrodite reproductive organs of *Gadus callarias*.

Fig. 2.—Asymmetrical hermaphrodite reproductive organs of *Gadus callarias*.

Plate XVI.

The Figures are not drawn to Scale.

Fig. 1.—Symmetrical hermaphrodite reproductive organs of *Gadus callarias*.

Fig. 2.—Dissection of connection between the testis and the anterior end of the ovary in the symmetrical organ.

Fig. 3.—Diagrammatic sketch of structure of testis of preceding.

Fig. 4.—Asymmetrical hermaphrodite reproductive organs of *Gadus callarias*.

Fig. 5.—Dissection showing connection between *vas deferens* and the oviduct in the asymmetrical organ.

Letters Used.

a.—anus.
b.v.—blood vessel.
gn.ap.—genital aperture.
gn.me.—genital mesentery.
gt.me.—gut mesentery.
h.c.—honeycombed region
me.—mesentery.
ov.—ovary.
ov.f.—ovarian folds.
ov.int.—interior of ovary.
sm.—smooth area.
T.—testis.
ur.—ureter.
ur.bl.—urinary bladder.
v.—vessel.

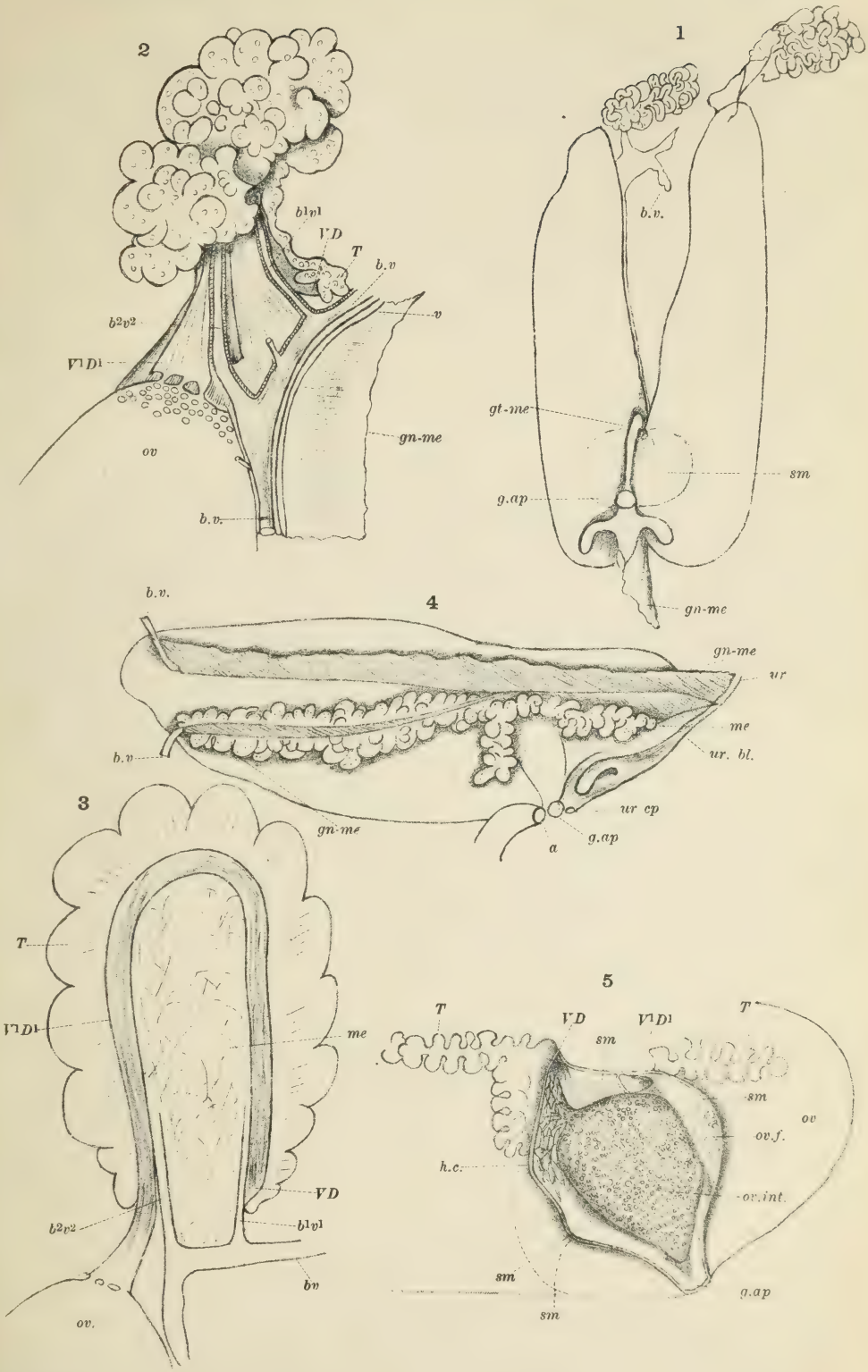
*Masterman: "On Hermaphroditism in the Cod." *Thirteenth Annual Report of the Fishery Board for Scotland*, Part III., for the year 1894, p. 297.

† Kyle: "Note on the Reproductive Organs of an Hermaphrodite Ling." *Fifteenth Annual Report of the Fishery Board for Scotland*, Part III., for the year 1896, p. 396.

Fig. 1.

Fig. 2.

Hermaphrodite reproductive organs of *Gadus callarias*. Fig. 1.—Symmetrical Condition. Fig. 2.—Asymmetrical Condition.



H.C.W. HERMAPHRODITE REPRODUCTIVE ORGANS OF *Gadus callarias*.

XII.—ON THE GROWTH AND AGE OF THE HERRING (*CLUPEA HARENGUS*). By Dr. T. Wemyss Fulton, F.R.S.E., Superintendent of Scientific Investigations.

(Plates XVII–XIX.)

CONTENTS.

	PAGE.
1. Previous Opinions and Observations, ...	293
(*a*) English Authors, ...	293
(*b*) Scandinavian and Dutch, ...	294
(*c*) Meyer and Jenkins, ...	295
(*d*) Masterman and Cunningham, ...	298
2. The Size of the Herring when it first attains Maturity, ...	299
3. The Maximum Size attained by the Herring, ...	301
4. The Spawning-Periods of the Herring, ...	302
5. The Duration of Embryonic Development: Relation to Temperature, ...	303
6. A Criticism of Meyer's Conclusions and Observations, ...	304
7. The Scottish Collections, ...	307
(*a*) Larval and Post-larval Stages, ...	308
(*b*) The Annual Groups, ...	323
8. Conclusions, ...	334
9. Literature, ...	338
10. Description of Plates, ...	338

1.—Previous Opinions and Observations.

The investigation of the rate at which the herring grows is more difficult than similar investigations with other fishes. The fact that herrings spawn twice in the year, and that spawning may take place, more or less, over many or most of the months of the twelve, offers one difficulty, and a great one, since the post-larval and young stages derived from one spawning cannot readily be distinguished from those derived from the other, though metamorphosis may occur at a different length. The conditions are complicated by the circumstance that the early stages of the sprat, which spawns in early summer, can hardly be separated with any certainty from the corresponding stages of the herring.

Many writers have expressed their opinion as to the rate of growth of this fish and the size and age it attains when it first becomes mature and reproduces; and authors are by no means in agreement on these points. It is probable that the divergence of view is in part explained by the herrings of widely-separated localities growing at a different rate, and coming to maturity at a different size; partly from the very smallest and exceptionally mature individuals having been fixed upon; many of the opinions, moreover, are based upon general considerations rather than on definite evidence.

(*a*) *English Authors.*

Huxley, in the report of a Commission on the Scottish herring fishery (l. p. 27) stated that it was difficult to obtain satisfactory evidence on the point, some fishermen believing that the herring took three years and others that it took seven years to reach maturity. His own view was

that there was no good evidence against the supposition that it reaches the spawning condition in one year, a view which was also held by the old Dutch naturalist Leuwenhoek. But it might be well, he said, to leave the question whether the herring attains its maturity at 12, 15, or 18 months open, in the tolerably firm assurance that the period last named is the maximum. Later, he modified his opinion, agreeing rather with Mitchell (2, p. 30) and Yarrell (3, ii., p. 190), that it attained maturity when about one year and a half old—a somewhat odd conclusion, since it implies that the summer-spawners of one year give rise to the winter- or spring-spawners of the next year but one, and *vice versa.*

De Caux, who wrote a book on the herring and its fishery, stated his belief that herrings arrived at maturity well within twelve months (4, p. 50).

Mr. George Sim did not agree with the supposition that the herring grew so fast. From the examination of large numbers of herrings, he thought that it grew in its first year six or seven inches, and that it did not spawn until the end of its second year (5, p. 46).

(*b*) *Scandinavian and Dutch.*

On the Continent, and especially in Sweden and Norway, much attention has been given to the question.

Ljungmann (6, 6*a*), as the result of the measurement of a large number of herrings in May from the west coast of Sweden, came to the conclusion that the herring grew much more slowly than the above statements would indicate.

On the coast of Bohuslän, where the small herrings come in May, they grow rapidly with the high temperature, and measure 80mm. to 100mm. He measured a great many herrings in the latter part of November on the northern part of the Swedish coast, and found that the length of these one-year-old fish varied from 78mm. to 109·5mm. In the latter part of spring he also measured many herrings on the Bohuslän coast, and came to the conclusion that the majority could be divided into three groups, (1) about 120mm. ($4\frac{3}{4}$ inches), or one year old; (2) 170mm. to 175mm. ($6\frac{3}{4}$–$6\frac{7}{8}$ inches), or two years old; (3) 200mm. to 210mm. ($7\frac{7}{8}$–$8\frac{1}{4}$ inches), or, presumably, three years old, and with fully-developed reproductive organs.

Ljungmann occasionally found herrings as small as 18·5cm. ($7\frac{1}{4}$ inches) with fully ripe eggs; on the other hand, many herrings from this size up to 20cm. ($7\frac{7}{8}$ inches) could not possibly spawn the same season. While he thinks the herring spawns first at three years of age, he says some may not do so until four years old. Fish of about 23·5cm. ($9\frac{1}{4}$ inches) he regards as four years old.

Widegren (7), who assigned a length of 75mm. (3 inches) to a one-year-old herring, and a length of 150mm. (6 inches) to one two years of age, stated that herrings two months old had a length of 25mm. (1 inch) and at three months a length of 37mm. ($1\frac{7}{16}$ inches). The size at maturity he placed at 20cm. (8 inches) and the age at three years.

Axel Boeck (8), with special reference to the Norwegian spring herring, puts the average length when maturity is reached at 25cm. ($9\frac{7}{8}$ inches), and the average age at three to four years; while Sundevall (9), dealing with the strömling of the eastern coast of Sweden, supposed them to attain maturity when three or four years old, and about 20cm. (8 inches) in length. He states that the young herring reach a length of 25mm. in about two months; 36mm. in three months; 50mm. in four months; 75mm. (3 inches) when one year of age, and from 125mm. to 150mm. (5–6 inches) when two years old.

The opinion of Ekström (10, 10*a*) was that herrings 10–12 inches in length were about 4–5 years of age. He found young herrings on the coast at Mörkö to reach a length of 25mm. in one month, 50mm. in three months, 75mm. to 100mm. in December, when they were nearly one year old, and about 100mm. (4 inches) when one year of age. He believes that maturity is reached at a length of 7 to 8 inches.

Nilsson (11) states that the young of the autumn-spawning herring measure about 75mm. (3 inches) in the following May; and, according to the views of the fishermen on the Bohuslän coast, the young of the spring herring reach a length of 25mm. in May, 50mm. about the middle of August, and in the autumn of the following year, when they are about one year and a half old, they are from 75mm. to 100mm. (3–4 inches). It was held, moreover, that the herring did not spawn until it was five or six years of age.

G. O. Sars (12) followed Nilsson in believing that the herring reaches a considerable age before it reproduces, fixing it first at 4 to 5 years, and later at 5 to 6 years.

Another author specially qualified to speak of the herrings of the Bohuslän coast assigns to them a very slow growth. A. W. Malm (13) states that those of 85mm. to 95mm. ($3\frac{3}{8}$–$3\frac{3}{4}$ inches) are almost two years old, and he thinks that herrings from 19cm. to 22cm. ($7\frac{1}{2}$–$8\frac{3}{4}$ inches) are in their fourth year, and those of 30cm. ($11\frac{3}{4}$ inches) upwards of six years of age.

Hoek (14), who carried on a series of careful observations on the herrings of the Zuiderzee, which spawn in April and May, states that the ripe herrings measure between 24mm. and 27cm. ($9\frac{1}{2}$–$10\frac{5}{8}$ inches) their weight being from 110 grammes to 143 grammes, and the weight of the reproductive organs from 23 grammes to 27 grammes.

He gives a number of measurements of the post-larval and young herrings taken at various periods throughout the year. In July the smallest ones were 37mm. to 42mm. (about $1\frac{1}{2}$ inches), and there were others between 57mm. and 80mm. or even above 90mm. In the following February most measured between 88mm. and 95mm. ($3\frac{7}{16}$–$3\frac{3}{4}$ inches), in March between 85mm. and 95mm., while others were 49mm. to 75mm. ($1\frac{5}{16}$–3 inches), others 70mm. to 78mm., and some 83mm. to 114mm. In April a few specimens were taken which measured about 90mm. ($3\frac{1}{2}$ inches). He thinks that when one year old they are about 115mm. ($4\frac{1}{2}$ inches); but his Tables allow a smaller size to be inferred, especially as young herrings are known to enter the Zuiderzee from the North Sea.

In another work (14*a*, p. 298) Hoek describes the characters of young herrings of the Hollandsch Diep and Haringvliet. Large numbers were found in the Hollandsch Diep at the end of March, measuring 45mm. to 48mm. ($1\frac{3}{4}$–$1\frac{7}{8}$ inches), which he assigns to the North Sea so-called winter herring, which spawns from the beginning of August on; others from 21mm. to 28mm. ($\frac{13}{16}$–$8\frac{1}{8}$ inches), found in the latter part of June, he attributes to the coast herrings which spawn in spring.

(*c*) *Meyer and Jenkins.*

A series of observations on the growth of the herring of Kiel Bay was carried on by Dr. H. A. Meyer (15, 15*a*), whose results are well-known and have to a very large extent guided opinion subsequently as to the rate at which the herring grows. In 1874 he found numerous larval herrings at the mouth of the Schlei, where spawning takes place in March, and especially in April and May, measuring 25mm. to 29mm. On 10th June they measured up to 33mm.; on 23rd June up to 43mm.,

but the great bulk of them had at this time a length of 25mm. to 28mm. (1–1$\frac{1}{8}$ inches); they could not be older than three months, showing a rate of growth of at least 13mm. a month, while the majority could scarcely be older than six weeks. By the end of July they were transformed, and then measured 45mm. to 55mm. (1$\frac{3}{4}$–2 $\frac{3}{16}$ inches).

It is important in considering these results to note the temperature prevailing in the locality, and I append here a table compiled from those in Meyer's paper, for the ten months given; up to and including July they refer to Schliewasser, and are the mean of three years, 1875–77; for the rest they refer to Kiel Bay and are the mean of two years, 1875–76. They are all surface temperatures, and are in F.

	Mean.	Maximum.	Minimum.
March, ...	35·6	41·9	32·0
April, ...	44·2	50·0	39·2
May, ...	51·2	57·2	42·8
June, ...	62·2	70·9	51·8
July, ...	66·2	72·3	57·2
August, ..	67·1	72·7	58·1
September, ..	61·5	66·9	52·5
October, ..	54·5	59·7	44·2
November, ..	43·3	50·7	34·9
December, ..	36·9	44·2	32·9

On 11th June, 1874, Meyer put into a floating box at Kiel a number (not stated) of transparent post-larval herrings, measuring 25mm. to 28mm., the growth of which is shown as follows:—

Date.	No. of Days.	Length.	Increase.	Mean Approximate Growth per Day.
		Mm.	Mm.	Mm.
June 24,	13	31–33	4–7	·42
July 6,	25 (12)	37–38	5–6	·46
,, 21,	40 (15)	41–43	4–5	·30
August 1,	50 (10)	45–46	3–4	·35

The transformation of these spring herrings was completed when they were 41mm. long; and the total growth in the 50 days was about 15mm. to 17mm. ($\frac{5}{8}$–$\frac{11}{16}$ of an inch), or about 10mm. a month.

This experiment was a good one, and it would have been improved if the numbers at the different sizes had been noted. It will be seen that growth became somewhat slower towards the end of the experiment. A growth of about 10mm ($\frac{3}{8}$ of an inch) per month at this period, and with high temperatures prevailing, is not perhaps excessive.

At the end of August and beginning of September, Meyer also measured the young herrings in the neighbouring bays, after they had left the mouth of the Schlei and were mixed with other and larger

herrings. To obviate as far as possible the risk of confusion, he measured only the smaller herrings at the various periods (the numbers are not stated) with the following results .—

	Mm.	Inches.	Increase.
			Mm.
14th November 1876, ...	84	$3\frac{5}{16}$	
End of November 1876, ...	90	$3\frac{9}{16}$	6
,, December 1876, ...	100	$3\frac{12}{16}$	10
,, January 1877, ...	110	$4\frac{5}{16}$	10
,, February ,, ...	114	$4\frac{1}{2}$	4
,, March ,, ...	135	$5\frac{5}{16}$	21
,, April ,, ...	138	$5\frac{7}{16}$	3
	...	...	54

Thus, the total growth in about 167 days, over the winter, according to these observations, was approximately 54mm. ($2\frac{1}{8}$ inches), or at the rate of ·32mm per day, or about 9·6mm. per month; that is to say, at about the same rate as the average growth of the smaller forms in the height of summer.

This does not agree with my experience as to the growth of other fishes, in which growth is much retarded or completely arrested, it may be, in winter, and which grow fastest in the younger stages.

Some experiments were made by keeping herrings in confinement. Two, taken on 12th August among a lot which measured from 50mm. to 55mm., were respectively 106mm. and 96mm. $4\frac{1}{2}$ months later. The growth thus amounted to about 48mm., or about 10·7mm. per month.

Three of a medium size of 75mm. on the 24th October, kept in an aquarium, measured 100mm. on 28th December, 65 days later, or an increment of nearly ·4mm per day ; at the end of January they measured 110 mm. (an increase at the rate of almost ·3mm. daily), the total increase in a little over three months being 35mm., or approximately 11mm. per month.

Meyer concluded that the spring herring of the western part of the Baltic reach a length of from 130mm. to 140mm. ($5\frac{1}{8}$–$5\frac{1}{2}$ inches) at the end of their first year; that a month after the fertilisation of the eggs the mass of larvæ, in water over 12°C. (53·6°F.), measure from 17mm. to 18mm. ; in two months, from 34mm. to 36mm., and in three months from 45mm. to 50mm., growth thereafter for the remaiming months of the twelve being approximately at a similar rate of 10mm. or 11mm. per month.

Ripe herrings, both spring and autumn, were found at 20cm. ($7\frac{7}{8}$ inches); these were the smallest, more commonly the size at first-maturity was 210mm. to 220mm. ($8\frac{1}{4}$ to $8\frac{5}{8}$ inches), and he states that they are got in the Baltic from 160mm. to 200mm. His conclusion is that the herring does not reach sexual maturity before the end of the second year, but this conclusion is pieced together from various considerations that appeared to him probable, and was not attained by direct evidence.

A few years later, Meyer made a number of observations on the growth of young herrings from artificially fertilised eggs (15*a*). The eggs were fertilised on 26th April, and before hatching they were placed in a wooden vat supplied with fresh supplies of water daily. Hatching occurred in from 14 to 15 days, the temperature being 51·8° to 53·6°F.; later in the summer the temperature of the water was about 68°F. After a few days some showed a considerable increase in size, measuring

9·2mm. and 9·3mm. Counting from the fertilisation of the egg, the sizes at different ages were as follows:—

	Mm.	Increase.	Sizes of Schlei Specimens.
		Mm.	Mm.
One Month, ...	10–11	–	17–18
Two Months, ...	17–19	7–8	34–36
Three ,, ...	30–35	13–16	45–50
Four ,, ...	48–54	18–19	55–61
Five ,, ...	65–70	17–16	65–72

The small growth in the early stages was ascribed to deficient food, and when the arrangements were modified growth was quicker; and at the end of the five months those artificially reared were of the same size as those under natural conditions.

Another work dealing with the growth of the herring, especially of the Baltic, is by Travis Jenkins, (16), and his conclusions were founded on the examination of the otoliths of over 300 herrings, almost all from Kiel Bay, like those of Meyer. These conclusions are as follows:—

Age.	Total Length.	Weight.	Growth in Each Year.	
	Mm.	Grammes.	Mm.	Gm.
One Year, ...	113–121	8	117	8
Two Years, ...	156–164	30	43	22
Three ,, ...	190–198	50	34	20
Four ,, ...	217–225	70	27	20
Five ,, ...	237–245	90	20	20

With regard to the age at which the herring attains maturity, Jenkins places it at three years, when it has a length of 190mm. to 198mm. ($7\frac{1}{2}$ to $7\frac{13}{16}$ inches). Jenkins found that in the Windebyer Noor, a small piece of water at Eckernförde, which has scarcely any communication with the sea, and is very brackish, the mature herrings were remarkably small, though three years of age, according to the otoliths. They measured from 127mm. to 150mm. (5–6 inches), and furnish good examples of the probable effect of diminished salinity on growth, although there are other conditions in this case which may have an important influence.

(*d*) *Masterman and Cunningham.*

Another paper on the growth of the herring must be referred to, viz., by Masterman (17), who assigns a very moderate rate of growth to the early stages, but comes nearer the truth than some of the others whose conclusions have been quoted.

His investigation was made on a very large collection of young herrings from newly-hatched larvæ and upwards, accumulated by Professor M'Intosh at St. Andrews. They comprised both spring and autumn spawners. Enormous numbers of young herrings, just emerged from the egg, occur in St. Andrew's Bay at the beginning of March, sometimes a little earlier and sometimes a little later, and last in great abundance through April and May. Their average length is about 7mm.; when about 10mm. long they leave the bottom for mid-water, and when some 20mm. to 25mm. in length reach the surface or near it, and then migrate shorewards, frequenting the mouths of rivers. They can be traced in the same localities till mid-winter, when they have a length of some

50mm. They are not found in the spring or summer, but recur in the autumn, with a length of about 80mm., which is increased to 100mm. by the end of the year. When one year old Masterman thinks they are probably about 60mm. ($2\frac{3}{5}$ inches) long.

In the case of the autumn herrings, the occurrence of newly-hatched larvæ extends over August and September, the spawning period being thus of shorter duration. The larvæ are somewhat shorter than the spring ones, averaging between 5mm. and 6mm.

The following Table gives Masterman's estimate of the growth from month to month of the spring and autumn herrings, after hatching:—

Month.	Spring.	Autumn.	Month.	Spring.	Autumn.
	Mm.	Mm.		Mm.	Mm.
1	15	14	8	47	43
2	20	19	9	50	47·5
3	27	23	10	54	52
4	30	27	11	58	57
5	35	30	12	62	61
6	40	34	18	87	88
7	44	38	20	98	—
			24	...	113

Thus, according to Masterman, the autumn herring at two years of age is rather smaller than the one-year old spring herring of the Baltic, as Meyer has determined it. The rate of growth of the spring series is about 4mm. to 5mm. per month, while in the winter months the growth of the autumn herring in the early stages is retarded (3mm. to 4mm. per month). The largest specimen in the collection measured 134mm. ($5\frac{1}{4}$ inches), which would be about $27\frac{1}{2}$ months old and belong to the autumn brood. In his later work in conjunction with M'Intosh (17*a*, p. 422) rather a different opinion is expressed. It is there supposed that the herring attains sexual maturity at a length of 8–9 inches and probably during the third year; and it is stated that 3 inches and 5 inches may be taken to represent a rough average of the size of a herring when one year and two years of age respectively.

The growth of the herring on the Scottish coast has also been considered by Cunningham (18, p. 162). He is of opinion that the herrings $3\frac{1}{4}$–$5\frac{1}{4}$ inches long (82mm. to 133mm.) taken in considerable numbers in December, in the sprat fishery in the Firth of Forth, are derived from the spring herrings that spawn at the Isle of May, which would give them an age of about nine months.

At Plymouth, a large number of small herrings from 4·3 to 5·5 inches long, taken in May, are supposed by Cunningham to be year-old fish, derived from the spawning in February and March in the previous year.

From the above review, it is apparent that very different opinions are held as to the rate of growth of the herring and the size and age when it reaches the mature condition.

2.—The Size of the Herring when it first attains Maturity.

The observations made by myself as to the size when maturity is attained lead to the conclusion that the herring on the coast of Scotland does not spawn until it has reached a larger average size than most of those given above.

Mature herrings, both male and female, are indeed occasionally taken which have a length of about 8 inches (20cm.), or even slightly under that size. I have found a few of this size at Ballantrae Bank in March with fully developed reproductive organs, but they were exceedingly exceptional. They were not quite so rare between 8 and 9 inches (20·3cm to 22·8cm.),but the great majority of these small herrings were immature.

Matthews (19, p. 96) records ripe herring from Lochfyne in February, between 19cm. and 20cm. ($7\frac{1}{2}$ to 8 inches), and he mentions one that he examined (place and date not stated), which measured only $7\frac{1}{4}$ inches (18·4cm.); it was the smallest among about 3000 young herrings he examined over a period of two years.

Among several thousands examined by myself, the smallest fully ripe herring measured 21·1cm. ($8\frac{1}{4}$ inches). There were two of this size among 2178 landed in February and March, 1904, at Anstruther, in the Firth of Forth. They were thus spring herrings, and formed part of the spawning shoals which habitually visit the mouth of the Firth in spring to spawn. They were all mature fish, the spawn and milt flowing from them in February (16th), when none among the 1023 measured were spent; but on this occasion the smallest were:—Males, one at 21·8cm., three at 22·3cm., two at 25cm., two at 26cm., and altogether from 22·5cm. to 22·9cm.—21 males; females, one at 22·5cm., one at 22·6cm., three at 22·7cm., and altogether between 22·5cm. and 22·9cm. ($8\frac{7}{8}$ to 9 inches)—there were 15 females.

In March, when 1155 were measured, 40 of the females and 43 of the males were spent; the smallest of these was a female measuring 21.5cm. ($8\frac{1}{2}$ inches), the next spent female being 22·8cm.; the smallest male was 23cm. Among the fish still spawning, the number of each sex at the smallest measurements were these:—

	211	212	213	214	215	216	217	218	219	220	221	222	223	224
Male	1	–	1	1	1	3	3	3	3	3	8	10	9	11
Female ...	1	–	–	–	1	2	1	–	2	5	5	7	8	7

Moreover, among many hundreds of autumn spawners from various parts of the east coast, examined in July and August, the smallest ripe female in the latter month was 9 inches, or 23cm., the weight of the fish being 92·3 grammes, and the ovaries 13·1 grammes. It was quite an exception. The smallest male that was mature measured also 9 inches, the testes weighing 12·5 grammes.

Other particulars regarding these small herrings may be summarised. A male at 9 inches (23cm.), and weighing 110·3 grammes, was approaching ripeness, the testes weighing 9·2 grammes. One at $9\frac{3}{10}$ inches (23 6cm.) was fully mature, as were other two at 23·5cm. and 23·8cm. One male at $8\frac{1}{2}$ inches (21·5cm.), weighing 90 grammes, had testes which weighed 9·5 grammes, and was judged to be about half ripe.

Among small female herrings, some measuring 23·9cm. (102 grammes), 25cm. (106 grammes), 24·1cm. (128·4 grammes), 24cm. (105 grammes), and with roes weighing from 16 to 22·6 and 25 grammes, were judged to be approaching maturity. On the other hand, some females from $8\frac{1}{4}$ to 10 inches (21cm. to 25·5cm.) were immature, their weights ranging from 93 to 133·7 grammes, and the weight of the ovaries from 2·3 grammes (in the one at 10 inches) to 1·6 and 6·4 grammes.

Besides these, there were many whose sex could not be distinguished by the naked eye. They ranged from $7\frac{3}{4}$ to $10\frac{1}{4}$ inches (19·5cm. to 26cm.) and from 55·5 grammes upwards, with reproductive organs from under 1 gramme in weight to 2·7 grammes.

Almost all the autumn herrings which were above 10 inches in length were ripe or approaching maturity; and it must be remembered that this was the chief spawning time.

Some particulars of other cases may be given. In the collection from the Dornoch Firth on 12th November, 1903, thirteen were examined. They ranged from 176mm. to 197mm. (7–7¾ inches), and their weight from 37.5 to 57 grammes. In all cases the reproductive organ was extremely minute and immature, the heaviest (from a male) weighing 0·03 grammes. These herrings were extremely fat, and there was a large quantity of fat in the abdominal cavity. This fat, as I have elsewhere suggested, is probably used up, not only in connection with the development of the reproductive organs, but also for the production of energy, in tiding over the winter, when growth, and even the power of digestion, is to a large extent in abeyance.

Other herrings, taken in Aberdeen Bay on 29th December, measuring 148 and 153mm. (6 inches) were quite immature and were also full of fat.

In the spring herring from the Forth, as will be seen later, two series are represented, the average size of the smaller, but fully mature, fish being about 9⅜ inches, and the range from 8½ to about 10 inches.

I think there is little doubt that these herrings represent shoals spawning for the first time, and that the average size of the winter or spring spawner on this part of the coast, when maturity is first reached, is about 23·5cm. (9¼ inches), while some may spawn when about 21cm. to 22cm. (8¼ to 8¾ inches), and others probably not till they are 26·5cm. or 28cm. (10 inches), agreeing in respect of variation in size with what obtains in the first mature group among other fishes. In all cases the fish in a group of the same year exhibit considerable variations in length, and it is the average rather than the extremes that have to be considered.

The mean size I have assigned to the spring herrings when they first spawn is nearly the same as has been given by Hoek for the herrings of the Zuider-zee (*supra*), viz, 24cm. to 27cm., and by Boeck for the Norwegian herring, viz., 25cm.

It is of some importance to establish the size at first maturity in connection with the consideration of the growth of the fish and the number of annual series which precede the reproductive one.

3.—Maximum Size attained by the Herring.

It is also desirable to say something as to the size to which herrings grow. In our waters few are caught over 12 inches (30·5cm.) in length. In those examined at Anstruther, above referred to, two were 12¾ inches (324mm. and 325mm.), and only 33 were above 11 inches. The largest herring that came under the observation of Huxley during the enquiry in Scotland measured 12$\frac{6}{10}$ inches (32cm.), and the smallest full, it may be said, was 10⅖ inches (26·5cm.); but he mentions that the Fishery Officer stated that it was not uncommon to get Orkney herrings that measured 14 or 15 inches long, and he had got one of 17 inches (43·2cm.), a size mentioned by Buckland as the largest for a herring on record.

At Aberdeen the longest observed by Sim was 12¼ inches (31·2cm.), its weight being 9¾ oz.; Matthews (19) got one 33·5cm. long, and another, 33·3cm.; while Brook (20) states that in Lochfyne he has seen herrings in August "quite 15 inches long," or 37cm.

De Caux (4) records one of 15½ inches (39·4cm.), and Murie (21) another of 14¼ inches (36·1cm.) The largest obtained by Ljungmann (6)

measured 37·5cm., the largest mentioned by Collett was 36·4cm., and a herring measuring 34·4cm. was the largest found by Lundberg (22) in the Royal Museum.

Specimens of a very large size were obtained by Trybom in the course of investigations on the west coast of Sweden, and he gives very full and detailed measurements of them (23, 23*a*). Samples were selected from the catches of various kinds of net, and from his Tables the following are extracted. In the catches of set-nets (*sättgarnsfangst*) the largest measured 38·5, 37·0, 35·2, 34·8cm., *i.e.*, up to 15⅛ inches. Here are the sizes of ten herrings from such a catch obtained at a place near Marstrand on 11th November, the meshes of the net being 35mm. (1⅜ inches) from knot to knot:—38·5, 35·2, 33·4, 33·4, 32·8, 32·7, 32·6, 32·5 32·2, 32·0cm., none being under 12⅝ inches. With mackerel nets the sizes of the larger herrings were 36, 35·8, 35·3, and 35·2cm.; with seines (*vadfangst*) the larger measured 37·2, 35.8, 33·8cm; with purse-seines (*snörpvadsfangst*) the largest were 34·4, 34, and 33·8cm; with drift nets, (*drifgarnsfangst*) the meshes going up to 33mm. (1 5/16 inches), herrings of the following dimensions were caught:—35·8, 35·5, 35·1, 35, 34·8cm., &c.

The largest herring of which I have found a record (24) is one which was said to have been taken by a Dutch herring boat (*De Dankbaarheid*) in the North Sea, about 57°23′ N. Lat., on 23rd October 1863. This giant measured 48·5cm. (a trifle over 19 inches); but it was probably a shad, specimens of which are not uncommonly recorded by the uninstructed as extraordinarily large herrings.*

The largest obtained by me in Lochfyne measured 13½ inches (33·4cm.), but many were 13¼ inches. I have also received a herring from the Firth of Forth of this size.

From general considerations I think it very probable that herrings of 14 and 15 inches represent the usual maximum size attained, and it must be borne in mind that on our east coast the herrings are all taken by drift-nets, which is selective, and that the size of mesh is small compared with those used by Trybom. In Lochfyne and the Clyde they are taken mostly by seine-nets.

4.—The Spawning Periods.

There are two well-marked periods of spawning on the coast of Scotland, one in spring and one in autumn. The former is chiefly in March and February, as at Ballantrae Bank in the Clyde, and at the mouth of the Firth of Forth; the latter is chiefly in August and September.

Mr. Jeffrey, the Fishery Officer at Peterhead, who has had great experience, tells me that on this part of the east coast (Aberdeenshire) the autumn and summer spawning season varies very little, and that the principal time may be safely set down as extending from the middle of August to the end of the first week in September, though small shoals may spawn a little before and a little after the period stated. With regard to the winter or spring fishing, very little is done on the Aberdeenshire coast, but the fishermen agree that the herrings taken in January and February are well developed, and that they spawn in March.

This is also the experience at Ballantrae and the Firth of Forth, and I think March may be set down as the chief spring month for spawning, though it extends from the latter part of January into April. It is probable that the height of the spring spawning is separated from the height of the autumn spawning by something less than six months,

* Dr. Redeke, Scientific Adviser on Fisheries to the Dutch Government, kindly informs me there is no evidence that the fish was examined by a competent person, and he does not attach any value to the record.

and the latter from the spring spawning in the following year by rather more than six months.

Too much stress perhaps is laid on the fact that spawning herrings may be obtained in most months of the year. There is evidence to show that among several other fishes individuals may be found fully mature at times more or less remote from the spawning period. On some parts of the coast, moreover, the limits of the normal spawning period of the herring may be earlier or later than what I have stated. But that the spawning season is a brief one, both in spring and autumn, is shown by the separation of the age-groups, contrasting in this respect with most other species.

5.—The Duration of Embryonic Development: Relation to Temperature.

The period of "incubation," from the deposition and fertilisation of the eggs until the young herrings hatch out, varies according to the temperature of the water, which appears to be by far the most mportant factor. It is desirable to consider the point, because it furnishes a clue to the period when the mass of the larvæ escape into the water and begin independent life and growth.

Many observations have been made as to the hatching of the eggs of the herring at different temperatures, and I append a Table in which I have set down a number of them.

Place.	Season.	Temperature. F.	Number of Days to Hatch.	Authority.
Firth of Forth, .	February, March, .	(40–41)	25–30	Allman.
Clyde, . . .	March, . . .	41–44	18–22	Ewart.
,, . . .	March–April, .	(40-45·5)	26	Dannev'g.
Plymouth, . .	January, . .	48	12–14	Cunningham.
Zuiderzee, . .	April, . . .	48·9	12	Hoffmann.
Bohuslän, . .	Spring, . . .	—	24	Malm.
Norway, . .	Spring, . . .	—	24	Boeck.
Stockholmlän, . .	—— . . .	—	14	Sundevall.
Mörkö, . . .	—— . . .	—	14	Ekström.
Northumberland, .	August, . .	52–58	8 9	Cunningham.
Denmark, . .	—— . . .	—	8–10	Kröyer.
Clyde, . . .	September, . .	54	8–10, 13	Ewart.
Stockholmlän, .	August, . . .	57–59	6–8	Sundevall.
Kiel, . . .	Autumn, . .	50–51	11	Meyer.
, . . .	Spring April, .	64·4–68	8–10	,,
,, . . .	,, ,, .	51·8–53·6	11	,,
,, . . .	,, ,, .	35·6	28–34	,,
,, . . .	,, ,, .	32	47	,,

The last entries refer to experiments by Meyer.

It is obvious from the Table that the period of "incubation" varies greatly, and that in the case of spring or winter spawners the duration is much longer than with the autumn-spawning fish.

At the spawning-grounds near the mouth of the Firth of Forth the temperature of the bottom water in the various months is as follows:—

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Surface, .	41·6	**40·9**	**40·1**	**43·1**	46·8	51·2	54·1	**55·1**	**54·1**	**51·3**	47·8	44·4
Bottom, .	42·8	**41·0**	**39·9**	41·9	44·8	46·6	50·0	**52·9**	**53·1**	51·4	48·6	45.2

It has been mentioned by Huxley (1) as a point of interest that he met with no case of full or spawning herrings during the solstitial months, viz., June and December; but it is perhaps of more interest to note that

the spring herrings spawn when the bottom water is the coldest of the year and the autumn spawners when it is the warmest of the year.

The effect of the difference on the rate of development in the eggs must be considerable. From the Table given above it may be inferred that the eggs of the spring fish take from about 25 to 30 days to hatch in February and March, while the eggs of the autumn spawners hatch in 9 or 10 days, or approximately in a third of the time. One must therefore add these numbers to the date fixed for the maximum spawning in order to determine the period when most of the larval herrings appear in the water. In the case of the spring fish the period is about the middle of April, and in the case of the autumn fish it is about the second week of September.

The advantage to the autumn herring in respect of the quicker development in the egg is, however, compensated by the difference in the temperature to which the young growing herrings are soon exposed. With the spring fish the temperature is a rising one, favourable to growth, for many subsequent months, while with those hatched in autumn, the temperature is a falling one, especially at the surface, and thus less favourable to growth.

How long it may take in some instances for the young of the spring herring to reach even a small size is shown by an experiment of Mr. Harald Dannevig. On 13th–14th March he fertilised some herring eggs and brought them to the Marine Laboratory at Aberdeen, where they hatched on 9th April, after an "incubation" period of 26 or 27 days. The larvæ then measured 8mm. in length. The yolk was not absorbed until 9 days later, and 23 days after hatching the post-larvæ measured only 10mm. In this case 49 or 50 days elapsed (viz., 13th–14th March–2nd May) before the young herring measured $\frac{3}{8}$-ths of an inch, thus offering a great contrast to the results of Meyer, but in the latter case the temperature during the experiment was not the same as at Aberdeen. Much stress cannot be put upon the experiment, but Mr. Dannevig is skilful in rearing post-larval fishes, as his success with the plaice shows.

The difference in temperature between the bottom and surface water, above shown, no doubt explains the fact that the larvæ in spring soon seek the upper layers, while in autumn they do this to a very small extent, the later larvæ, as Masterman says, appearing never to leave the bottom, but to migrate shorewards at once, without an intermediate journey through the mid-water and surface layers.

The young herring when it is hatched is of a length ranging from 5·2mm. to 8·8mm. ($\frac{1}{5}$–$\frac{3}{8}$ inch), and the yolk disappears in from three or four days to a week; traces may be found in larvæ measuring over 9mm.

It may be mentioned that the larva of the sprat is 3–3·7mm. when hatched, and, according to Ehrenbaum, the length when the yolk is absorbed (in about a week) is 4·7mm. They may thus be easily separated in some collections.

6.—A Criticism of Meyer's Conclusions and Observations.

Before dealing with the collections of herrings given in the Tables appended to this report, it may be well to consider some general results as to the growth of fishes deduced from my researches with a number of other species, and how they bear upon the statements concerning the growth of the herring above quoted, and more especially those of Meyer and Jenkins.

Meyer, as we have seen, came to the conclusion that the herring at the end of about six months reached a length of approximately 70mm. to 80mm.; at the end of the first complete year a length of 130mm. to 140mm., and at the end of the second complete year, when he supposed it to attain to maturity, a length of 160mm. to 170mm.

The amount of growth in length in the first year was thus 130mm. to 140mm. ($5\frac{1}{8}$–$5\frac{1}{2}$ inches), while in the second, and, be it noted, before sexual maturity, it was only 30mm. ($1\frac{3}{16}$ inches). In other words, about 82 per cent. of the growth in the period anterior to sexual maturity is represented as occuring in the first half of the period and only 18 per cent. in the second half, a result totally opposed to what happens with other fishes.

Jenkins, as we have seen, also working on the herrings of Kiel Bay, by studying their otoliths, reduces somewhat the rapidity of growth as brought out by Meyer. He makes the sizes of the annual groups somewhat less than Meyer, and puts the period of maturity at the third year instead of the second, increasing the size at first maturity by some 3·0cm. He also gives the annual sizes up to the fifth year, when the herrings are between 9 and 10 inches in length. Thus, taking the average sizes as given by Jenkins, we have the following increments per annum before maturity.

Year.	Mean Size.	Increment.	Percentage Increase on Total Length at Maturity.
	Mm.	Mm.	
1, . . .	117	117	60·3
2, . . .	160	43	22·2
3, . . .	194	34	17·5

Again, if we consider the growth each year as related to the total growth in the five years as given by Jenkins, we have the following:—

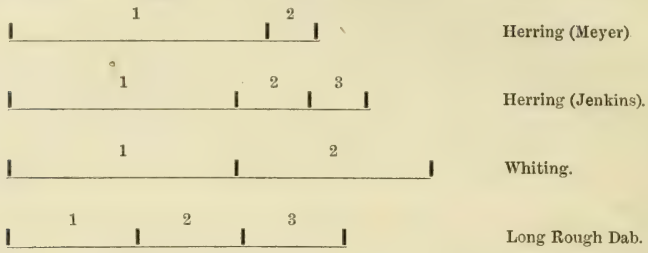
Year.	Mean Length.	Annual Increment.	Percentage Increase on Total Length at 5 Years of Age.
	Mm.	Mm.	
1, . . .	117	117	48·5
2, . . .	160	43	17·8
3, . . .	194	34	14·1
4, . . .	221	27	11·2
5. . . .	241	20	8·3

Thus, according to these results, the herring grows in its first year (though not sexually mature till its third year) almost half of the total length it attains at the end of its fifth year.

The conclusion, I think, is obvious, that both Meyer and Jenkins have jumped at least a year, and that the herring at 135mm. or 117mm. is much more than one year old.

We are now tolerably well acquainted with the growth of several species of fish, and in all of them the growth in each year *anterior to the occurrence of sexual maturity* is fairly comparable in extent; very often the amount of growth in the first year is somewhat greater than in the others, and it diminishes slightly with each successive year; though observers do not always agree about this.

The difference referred to may be brought out by the following diagram, showing in proper relation the annual growth of the long rough dab and whiting up to sexual maturity, and of the herring according to Meyer and Jenkins up to the same period.



Meyer's methods of determining the size of the herrings living naturally in the sea were unsatisfactory, and were unlikely to furnish a just estimate of the average size or of the true rate of growth, and his experiments are subject to important reservations, since only selected results are given, and not full details or numbers; and, moreover, too much stress was laid on the amount of growth in the summer months as a factor in computing the amount of growth for the whole year.

Thus, the growth of the herrings in the Schlei, as determined by him for comparison with his later rearing experiments, amounted to only 48–54mm. ($1\frac{7}{8}$–$2\frac{1}{8}$ inches) over the five summer months, or an average of just 10mm. per month, and the herrings which he reared grew to a similar extent over the period. But the temperature in these months is the highest in the year, the means ranging from 51·2 F. for May to 67·2 F. for August, and in no other month, except May, was it under 61·5 F. Then, again, in the best of his experiments, in which the young herrings were kept in a floating box for 50 days, the growth was at the mean rate of 9·6mm. ($\frac{3}{8}$ of an inch) per month, but the months were at the end of June and July, the mean temperature in the latter month being 66·2 F.

Compare these reasonable results with his results in winter, derived from the comparison of herrings from the sea, as shown in another Table. We find that from the end of November to the end of March (when with many fishes growth is quite arrested and always very slow) the indicated growth in the four months, December to March, amounted to 48mm., or 12mm. a month, which is higher than in summer, a result that is obviously fallacious. And yet the average size when a year old is placed at 135mm., a size which appears to have been inferred from five months' growth at 10mm. per month and seven months' growth at 12mm. per month.

In point of fact, as shown in my various papers on the rate of growth of fishes, as in the one in the present report, growth in summer greatly exceeds the growth during the rest of the year, while it is extremely small in the period from October–November to February–March.*

* Here are a few examples. The growth of young haddocks from 31st July to 10th September (41 days) amounted to 38·6mm., or at a rate of ·94mm. per day, or 29mm. per month; from 31st July to the 18th October (79 days) they increased by 61·1mm., or at a rate of ·77mm. per day, or about 24mm. per month; over part of winter, from 28th November to 15th January (48 days) the increase was 3·7mm., or at a rate of ·08mm. per day, or 2·4 per month. Another series increased by 28·6mm. in the 41 days from 24th July to 3rd September, the rate being ·7mm. per day, or 21mm. per month. Over winter and spring another series increased in 164 days, from 18th December to 30th May, by 33·9mm., or at a rate of ·2mm. per day, or 6·4mm. per month, and the period included April and May, which is one of the most favourable months.

With the young whiting, whose habitat more nearly resembles that of the young herring, the retardation in winter and the rapid growth in summer are marked. From June to the middle of September one set of observations shows a growth of ·5mm. per day, or 15·8mm.

In the shallow waters on the beach, it may be entirely arrested, as with small flat-fishes, while the growth of young whiting is very greatly diminished—it grows at least fifteen times faster in the summer months. Young herring inhabit the same coastal waters, and must be affected in a similar way; and an estimate of the average size of the one-year old herring from Meyer's own observations above referred to, qualified by these facts, would reduce the size very materially.

I think there is little doubt, at all events, that Meyer's conclusions as to the rate of growth of the herring, which have so long held the field, are fallacious.

Jenkin's results are based on a study of the otoliths, which, as he says, cannot tell the precise age of a fish, but only within certain limits. So far as my somewhat limited experience goes as to the utility of the markings on the otoliths of the herring as a clue to the age of the fish, it has led me to the belief that there is considerable scope for erroneous conclusions, especially with the younger forms. It appears to me probable, on the above grounds alone, that Jenkins has not succeeded in separating the first year's fish from the second year's, and that the size he gives as approximately that of a one-year-old (117mm.) is nearer the size of a two-year-old herring.

His observations on the older herrings are valuable, and it is of interest to note that he makes a herring of 21·7cm. to 22·5cm. ($8\frac{1}{2}$ to $8\frac{7}{8}$ inches) approximately four years old, and one of 23·7cm to 24·5cm ($9\frac{3}{8}$ to $9\frac{5}{8}$ inches) approximately five years old

He gives an interesting diagram (16, p. 95) of the curves based on the determinations of different observers. The point alluded to, the exaggeration of the first year's growth, is well indicated, and the curve exhibiting Meyer's results shows a deflection at the end of the first year which would not apply to any other fish.

The curves of Ljungmann (who calculated the year-old herring to be from 65cm. to 90cm in length) are devoid of this, except between the second and third year,† and it is noteworthy that the prolongation of the curve of Ljungmann and of the curve showing Masterman's conclusions meet Jenkin's curve in the fourth year.

7.—The Scottish Collections.

The collections have been made during the last five or more years at various seasons, and mostly in Aberdeen Bay, the Moray Firth, and the Firth of Forth.

The measurements arranged in ·5 centimetre groups are given in Tables I.–III., appended to this paper.

per month; another from 30th May to the early part of October show increments of ·5mm. per day, or 15·8 per month; another in July and August show increments of ·9mm. per day, or 28·5 per month; a fourth set show increments in June and July of ·66mm. per day, or 20·5 per month. On the other hand, in the winter and spring, we have the following:—From 21st December to end of May an increase of 17·1mm., or at a rate of ·107mm. per day, or 3·4mm. per month—most of this, no doubt, in May; 18th October to 15th January, ·045mm. per day, or 1·4mm. per month; 6th November to 17th December, 1·5mm., or ·037 per day, and 1·1mm. per month; 29th November to 15th January, 2·3mm., or ·048mm. per day, or 1·4 per month. These observations are based on the measurements of many thousands of fish.

In the deeper water it may be shown that the growth in the early months is less retarded, as with haddock, whiting, and witches, and no doubt also with mackerel and other fishes, which withdraw to the deeper and warmer layers in winter, but, as elsewhere remarked, there are not yet sufficient temperature observations with which to correlate the observations on growth, those taken on the Quarterly Cruises in the International Investigations being useless for fishery investigations such as these.

† Due to misapprehension of his measurements, a mistake also made by Meyer, who took Ljungmann's measurements as measurements of the total length, whereas they excluded the caudal fin.

(a) *Larval and Post-Larval Stages.*

Considerable collections of larval and small post-larval clupeoids and herrings were obtained by the "Garland" during the years she was engaged in the Forth and adjoining waters, which have been tabulated in the Board's Reports* by various workers. In Professor M'Intosh's tables† referring to the pelagic fauna of St. Andrews Bay, various young clupeoids are tabulated, and a large number also in the paper by Masterman previously mentioned.

It is important to determine the rate of growth of the herring in the early stages, first of all, and I have therefore brought together in the table subjoined most of the measurements contained in the lists referred to, those given by Masterman in his paper and by M'Intosh in his tables, as well as those in the later collections of the Fishery Board. M'Intosh states that towards the end of March myriads of young clupeoids, apparently herrings, throng the lower part of the water in St. Andrews Bay. They had probably only escaped from the eggs, though the absence of the yolk-sac in many, and the presence of well-marked embryonic fin-rays, showed that they were some days old. He also states that in this month numerous young sprats, from $1\frac{3}{8}$ to $1\frac{3}{4}$ inches (34mm. to 45mm.), were captured in the mid-water net.

A précis of the collections examined by Masterman shows the following:—

In *January* (19th, 20th) eleven herrings measured from 42mm. to 56mm., the average size being 48mm. to 49mm. ($1\frac{15}{16}$ inches). According to Masterman's tables showing the increments of growth per month, these are much too large to be the autumn herrings of the year before, which at the period would measure, on his scale, only about 30mm., or less; and they correspond rather to the spring herrings of the previous year, which at nine months would be about 50mm., and this would take them back to May; if referred to April, they ought to be about 54mm. They cannot be sprats, for, apart from diagnosis at that stage, the sprats in March, as stated above, measure only 34mm. to 45mm. The evidence obtained by myself supports the view that they are the herrings of the previous spring.

In *February* (19th) nine herrings from 35mm. to 41mm. ($1\frac{3}{8}$ to $1\frac{5}{8}$ inches), and with a mean size of 37·3mm. ($1\frac{1}{2}$ inches), were caught.

On 1st *March* eleven, from 33mm. to 39mm.; on 7th–21st, ten, from 26mm. to 44mm.; and on 31st, one of 40mm., were taken, making altogether for the month, 22, from 26mm. to 44mm., with a mean of about 35mm. ($1\frac{3}{8}$ inches).

In *April* (2nd–18th) twelve measured from 32mm. to 49mm. (all but the two smallest on 18th), the average being 42·3mm. ($1\frac{11}{16}$ inches).

All these were quite distinct from the young herrings that appear about this time, to be referred to below, and with these we have the following larger forms, viz.—(1) 14th to 31st March, seven herrings, from 79mm. to 103mm., with an average length of 95·6mm. ($3\frac{3}{4}$ inches), and on 29th April one at 110mm. ($4\frac{3}{8}$ inches).

In January-March we have thus three groups of these older clupeoids —(1) Those in January, with an average of 48mm. to 49mm., belonging to the previous spring; (2) in February, March, and April, a group

* 8th, p. 270; 9th, p. 334; 10th, p. 300, by Professor M'Intosh; and the others in the 11th, p. 250; 12th, pp. 298, 300; 13th, p. 258; 14th, p. 223; 15th, p. 246, by Masterman, Tosh, Williamson, Wallace, and Kyle.

† *Ibid.*, 7th, p. 267; 11th, p. 284.

from 26mm. to 49mm., derived from the previous autumn; and (3) in March a group from 79mm. to 103mm.

According to the rate of growth deduced by Masterman, the larger herrings, measuring about 96mm., would be approximately 19 to 20 months old, which would refer them back to the autumn fish, two years before.

In March, as mentioned above, the larval herrings begin to appear. The earliest in the tables is 3rd March. From 3rd to 7th, five measured 5mm. to 8mm.; on 14th, 135 measured from 6mm. to 9mm.; from 26th to 31st, 5804 measured from 6mm. to 11mm., the range during the month being from 5mm. to 11mm. Great hauls were taken on 30th March 1889, so much so that the bottom-net had to be disused. In April, from 2nd to 11th, 716 measured from 6mm. to 11mm.; from 11th to 21st, 108 were from 7mm. to 14mm.; from 21st to 28th, 39 were from 5mm. to 16mm., the progress in growth being shown by the larger sizes, the maximum for the month being 16mm. ($\frac{5}{8}$ inch), and the range from 5mm. to 16mm. In this month, however, a complication is introduced by the appearance of larval sprats.

Up to April, and well into that month, there seems to be little or no difficulty, owing to the limit of the spawning period of the sprat. Masterman, in describing the pelagic eggs collected by the "Garland" over a series of years,* states that the extreme limits of the spawning period of this fish, as inferred from the eggs obtained, were from 23rd March to 19th August, both in the same year (1891). The earliest dates in other years were 6th, 14th, 17th, 24th April, and at first very few were got. The chief spawning time is from the middle of May on towards the end of June.

It would be remarkable if all the early post-larval sprats were separated from the early post-larval herrings, and from the latter part of April the possibility of this disturbing factor has to be considered. From the Table given below, however, it appears that this disturbance cannot be serious, for in the months when sprats ought to be appearing in greater numbers (June–July) clupeoids are remarkably scarce.

On *May* 2nd five clupeoids measured from 10mm. to 17mm. ($\frac{3}{8}$ to $\frac{11}{16}$ inches), and are clearly herrings; in the period 14th to 31st, 28 measured from 5mm. to 25mm., but there appear to be again two groups, viz.—13 from 5mm. to 8mm., and 15 from 13mm. to 25mm., which show the continued growth of the young herring; at the end of May the herrings are 17mm. to 22mm. (up to $\frac{7}{8}$ inch), and as the one at 25mm. was taken on 16th, it is probable the limit is greater and slightly exceeds one inch.

The herring at this period and size may be approaching three months of age. At a nearly corresponding stage, Meyer's Baltic herrings (but at the end of July, with higher temperatures) were 30mm. to 35mm. ($1\frac{3}{16}$ to $1\frac{3}{8}$ inches); those in the sea, as he inferred, being 45mm. to 50mm.

In *June* (9th, 10th) only three were got; one at 13mm., the other two measured 20mm.

In *July* (9th) two alone of the smaller were caught, measuring 16mm. There are, however, a series of 25, extending from 28mm. to 37mm., the average size being 32·1mm ($1\frac{1}{4}$ inches). These can only be regarded as the spring herrings, now over three months, and it may be four months old—months, too, very favourable for growth.

There are four other herrings which were taken on the same date, viz., one 57mm., two 59mm., and one 75mm., the mean being 62·5mm. ($2\frac{1}{2}$ inches). They probably do not belong to the same group, and it is

* *Fifteenth Annual Report*, Part III., p. 233.

worth considering their origin. They could scarcely belong to the spring fish of the year, whose growth, as we have seen, is much slower; the two smaller might be referred to the previons autumn, and would thus be approximately ten months old; the one at 75mm. (almost 3 inches) is to be referred to the spring of the preceding year. According to the rate of growth given by Masterman, herrings of that average size, if spring herrings, would be almost exactly twelve months old, and if autumn herrings, all but twelve months old (61mm.).

It is, however, to be remarked that herrings of this size and larger are likely to escape from tow-nets, especially when used in daylight, and even from the slowly-towed and larger midwater net; and thus the average size of the herrings, except the smaller ones in collections obtained in this way, may be expected to be somewhat under rather than to exceed the true natural size for the group.

If the two smaller belong to the same group as those which had an average length of 42·3mm. on 18th April, the increment in the 82 summer days would amount to 15·7mm., or a mean of ·19mm. per day, or 5·9mm. ($\frac{1}{4}$ inch) per month.

In *August* we come again on the larval clupeoids. M'Intosh mentions them under date 2nd, from 5·5mm. to 8mm. In Masterman's tables, seven from 5mm. to 11mm. are entered between 3rd and 9th; also two at 15mm. and one at 20mm. From the 22nd to the 30th, 71 measured from 4mm. to 12mm., and one was 19mm., possibly to be referred to the spring series. Omitting the larger, the average for the 71 at the end of August was 6·7mm. This may be taken as the size at which the autumn herring starts the beginning of September.

In *September* M'Intosh notes the appearance of clupeoids from 7mm. to 13·5mm., the latter size only after the middle of the month. In the table of Masterman, 184 are entered between the 4th and 7th, of which 181 measure from 4mm. to 9mm., and are mostly 6mm.; one is 13mm., and two are 44mm. ($1\frac{3}{4}$ inches), and no doubt represent the herrings hatched in March or April.

From 13th to 30th there are 70 in two series, (1) 64 from 5mm. to 18mm. and mostly about 11mm., (2) 6 on 17th from 36mm. to 40mm., the average being 39·0mm.; if these are combined with the two taken earlier, the range is from 36mm. to 44mm., and the average size 40·2mm. ($1\frac{5}{8}$ inches).

These are no doubt the spring herrings, which show an increment of 8·1mm. (under $\frac{3}{8}$ inches) in the 68 days (approximately) from the series of 9th July, or only ·12mm. per day.

On the 7th September two other larger herrings were taken, measuring 75mm. and 80mm. (3, $3\frac{1}{8}$ inches), which no doubt represent the older series taken in July.

In *October*, from the 1st to 9th, 34 measuring 7mm. to 19mm., and mostly about 13mm. to 14mm, are entered; from 11th to 19th, there are 82, in three groupings, (1) 4 at 6mm.—indicating a late spawning—(2) 66 from 12mm. to 20mm., most about 17mm. ($\frac{11}{16}$ inches) representing the average size at this period, and (3) 12 from 32mm. to 41mm., taken on the 16th and 18th, the average length being 33·2mm. ($1\frac{5}{16}$ inches), or less than those taken a month earlier. These probably represent the spring herrings.

In *November*, the number is greatly diminished. From the 1st to the 8th, 14, from 14mm. to 24mm., and averaging 17·3mm. were taken; and from the 16th to the 24th, other four, from 19mm. to 26mm., the average length for the 18 specimens being 18·3mm. (barely $\frac{3}{4}$ inches), which approximately represents the size of the autumn herring in November, some specimens, however, attaining a little over 1 inch.

In *December*, only four of this series were taken, viz., on the 3rd, and they measured 15mm. and 17mm. There were also four at 37mm., or almost an inch and a half, probably spring fish, as well as one at 100mm., and another at 134mm.

It seems probable, therefore, from these observations that towards the end of the year the average size of the young autumn herring, when three to four months old, is under 20mm. ($\frac{3}{4}$ of an inch), and probably not much over $\frac{5}{8}$ of an inch ; some measure 26mm., or slightly over one inch.

The spring herring, which is, however, 1mm. to 2mm. longer when it issues from the egg, grows quicker, and may even reach, as we saw, a length of an inch at the end of May, when they are relatively younger. This is associated with a favourable and rising temperature, and probably better food supplies, since M'Intosh found traces of diatoms in them in March (25 *g*, 267), and also Dr. George Murray (26), who found *Coscinodiscus* abundant in small post-larval clupeoids.

From these tables of Masterman it would appear that the growth of the herring in its post-larval stages is much slower on the east coast of Scotland than Meyer found it to be at Kiel.

"GARLAND'S" COLLECTIONS OF CLUPEOIDS.

Mm.	Jan.	Feb.	Mar.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.
4–5			x	x x	x	x x	x	x x	x xx x			
6–7		A	x xxxx	x x xxx xx	C xx xx	x	x	x x x xx x xx	x xx x xx	x x		
8–9			xxxx xxxx	xxx xx xxx xx	xxx xxxx		x x	xx x xx xx x xx	x xx x xxx	x x		
10–11			xxx xxx	xxxx xxxx	xxxx xxxxx		x	x x xx x x xx	x xxx x xxxx	x x		
12–13				xxxx	x x xx	x	x	x x	xxxx			
14–15				xx xx	x x xx x x xx	x		x x	x xxxx xxxx	x x x x	x	
16–17				xx	x x xx x x xx	x x	x x x x		xxx xxx	xxx xxx xxxxxxxx	x x	
18–19					x x xx x x xx	x x			xx x	xxxxxxxx xxxxxxxx	x xx	
20 21					x xx x xx	x xx				xxxxxxxx xx xxx	xx xxx	
22–23					xxx xxx	x x				xx xxx xxx xx	xxx xxx	x x
24–25		B	x		x x x	x x				xxx xx x xx	xx xx	x x
26–27	x		x			x				x xx	x x x	
28–29		x x	x xx				x			x x		
30–31		x x	x xx				x x			x x		
32–33		x x	x x				x x			x		
34–35		x x	x x				x x			x x		
36–37		x x	x x				x x			x x		
38–39		x x	x x						x x	x x		x
40–41		x	x x						x x	x x		
42–43	x		x x							x		
44–45	x x		x						x x			
46–47	x x											
48–49	x x		x									
50–51	x x											
52–53	x x											
54–55	x x											
56–57	x x						x					
58–59	x						x x					

The Table embodying the references to the collections of the *Garland* and the above measurements shows generally the same features.

One sees the various groups, the spring series and the autumn series, as well as the older ones (B). At A, there is no doubt about the clupeoids representing the herring, but later, as at C, the sprat is doubtless present, and the smaller fishes represented in July may also be sprats.

In the Tables and curves appended to this paper (Tables I.-III., Plates XVII.-XIX.) it will be seen that the groups of herrings are well separated from one another, comparatively little admixture of the spring and autumn herrings taking place—though it does occur—and the elucidation of the rate of growth of the herring would be an extremely simple matter if it were not for the existence of these two series, one derived from spring and the other from autumn.

In dealing with the post-larval herrings, I have had the advantage of Dr. Williamson's experience in their diagnosis, and I have to thank him for his assistance in this respect and for measuring a number of these collections.

Place and Date.	Depth.	Series.	Number.	Range in Size.	Difference.	Average Size.				Origin.	Probable Age.
						Modal.	Mean.	Arithmetic.	Inches.		
	Fms.			Mm.	Mm.	Mm.	Mm.	Mm.			Mths.
Aberdeen Bay.											
11th Feb. 1905 .	8–12	III.	3	100–115	..	..	..	..	..	..	..
29th March 1905 .	18–25	V.	1	125	..	..	..	..	..	..	..
	..	..	3	165–195	..	..	..	..	..	..	..
24th April 1906 .	4–6	II.	157	41–46	5	43·5	43·5	43·5	$1\frac{3}{4}$	A	8
30th May 1901 .	12–16	IV.	598	142–186	44	159	164	162	$6\frac{3}{8}$	S	$38\frac{1}{2}$
	..	..	3	196–228	..	..	..	..	..	S	$50\frac{1}{2}$
June 1904 . .	..	II.	24	50–60	10	55	55	55·8	$2\frac{3}{16}$	..	..
19th June 1900 .	1	II.	15	55–65	10	60	60	..	$2\frac{3}{8}$	..	..
13th June 1903 .	8–10	IV.	523	118–163	45	138	140·5	141·8	$5\frac{5}{8}$	A	33
	..	V.	30	164–182	..	..	..	..	.	S	..
	..	..	4	208–234	..	..	..	..	..	..	..
28th June 1901 .	$12\frac{1}{2}$	IV.	650	148–192	44	167	170	168·9	$6\frac{11}{16}$	S	$39\frac{1}{2}$
5th July 1901 .	10	IV.	8	140–164	24	140	150	149·2	$5\frac{7}{8}$	..	..
18th, 20th Sept. '00	2–3	I.	194	21–44	23	33	32·5	34·3	$1\frac{5}{8}$	S	6
2nd October 1901	10	I.	297	9–20	11	..	..	15	$\frac{5}{8}$	A	$1–1\frac{1}{2}$
3rd October 1901	..	I.	334	8–27	19	17	17·5	16·2	$\frac{11}{16}$	A	$1–1\frac{1}{2}$
18th October 1901	7–10	II.	1	85	..	..	..	..	..	..	..
	..	III.	429	96–141	45	115	115	117·5	$4\frac{1}{2}$	A	25
	..	IV.	14	143–187	44	..	..	..	..	..	..

S=Spring. A=Autumn.

Place and Date.	Depth.	Series.	Number.	Range in Size.	Difference.	Average Size.				Origin.	Probable Age.
						Modal.	Mean.	Arith-metic.	Inches.		
	Fms.			Mm.	Mm.	Mm.	Mm.	Mm.			Mths.
Aberdeen Bay—*con.*											
31st October 1900	8–10	II.	650	52–95	43	80	73	77·8	$3\frac{1}{16}$	A	14
	..	III.	179	96–143	47	100	..	..	..	..	..
	..	..	1	157	..	..	..	..	..	..	..
6th November 1903	$5\frac{1}{2}$–12	I.	181	12–25	13	18	17·5	18·2	$\frac{11}{16}$	A	2
	..	..	6	132–143	11	..	..	137·5	..	..	..
	..	..	2	185–188	..	..	..	..	..	..	..
6th November 1901	6–13	II.	3	86–95	..	..	..	90·3	..	..	..
	..	III.	24	102–132	30	110	110	116·2	$4\frac{9}{16}$	..	..
9th November 1900	9	II.	4	75–100	..	..	..	85·7	$3\frac{3}{8}$	..	..
	..	III.	18	116–143	..	..	..	132·6	$5\frac{1}{4}$	..	..
23rd Dec. 1903 .	..	I.	6	23–36	13	..	29·5	..	$1\frac{3}{16}$	A	$3\frac{1}{2}$
12th Dec. 1903 .	5–10	I.	15	42–50	8	45	46	46·5	$1\frac{13}{16}$	S	9
	..	..	6	97–124	27	..	110·5	109·3	$4\frac{3}{8}$	..	..
17th Dec. 1901 .	$9\frac{1}{2}$–15	III.	47	103–147	44	122	125	122·1	$4\frac{13}{16}$	A	27
	..	..	3	146–157	..	..	..	..	..	..	..
18th Dec. 1900 .	8	..	4	109–112	..	..	..	..	..	..	..
	..	III.	405	114–161	47	141	137·5	135·9	$5\frac{3}{8}$	S	33
	..	..	1	165	..	..	..	..	..	..	..
19th Dec. 1900 .	6–$8\frac{1}{2}$	II.	6	78–95	17	..	..	90·5	$3\frac{9}{16}$	..	..
	..	..	5	110–131	21	..	..	120	$4\frac{3}{4}$	..	..
29th Dec. 1903 .	5–12	..	16	108–154	46	124	131	128·8	$5\frac{1}{16}$	..	..
Dornoch Firth.											
9th Feb. 1905 .	$6\frac{1}{2}$–12	III.	8	104–122	18	113	113	112·4	$4\frac{3}{8}$	S	24
31st March 1904 .	5–10	III.	16	106–136	30	112	121	117·6	$4\frac{5}{8}$	S	24
13th Nov. 1903 .	..	I.	156	13–26	13	20	19·4	19·5	$\frac{3}{4}$	A	$2\frac{1}{2}$
21st Oct. 1903 .	8–12	I.	28	14–20	6	17	17	16·8	$\frac{11}{16}$	A	2
5th Nov. 1900 .	7–10	II.	48	73–97	24	93	85	90	$3\frac{9}{16}$	..	..
	..	III.	544	98–141	43	115	119·5	114·4	$4\frac{1}{2}$	A	26
	..	..	9	144–162	..	..	.	..	..	..	..
11th Nov. 1903 .	6–12	I.	48	13–25	12	19	19	18·6	$\frac{3}{4}$	A	$2\frac{1}{2}$
	..	II.	99	79–109	30	95	94	94·3	$3\frac{3}{4}$	..	..
	..	..	11	112–124	..	..	..	..	..	..	..

S=Spring. A=Autumn.

Place and Date.	Depth.	Series.	Number.	Range in Size.	Difference.	Average Size.				Origin.	Probable Age.
						Modal.	Mean.	Arithmetic.	Inches.		
	Fms.			Mm.	Mm.	Mm.	Mm.	Mm.			Mths.
Dornoch Firth—*con.* 12th Nov. 1903 .	6–10	..	6	79–83	..	..	..	..	..	..	..
	..	III.	1228	84–133	49	105	108·5	105·4	$4\frac{1}{8}$	A	26
	..	..	15	134–152	..	..	..	..	..	..	..
	..	..	87	162–198	36	175	180	179·1	7	..	..
26th Dec. 1903 .	..	I.	51	14–34	20	19	24	22·3	$\frac{7}{8}$	A	$3\frac{1}{2}$
25th Dec. 1900 .	12	III.	1769	98–144	46	119	121	122·4	$4\frac{7}{8}$	A	27
	..	IV.	172	145–178	33	..	161·5	..	..	A	39
	..	..	41	182–217	35	196	..	190·8	$7\frac{1}{2}$	..	..
Burghead Bay.											
29th Dec. 1903 .	5–12	I.	56	15–33	18	20	24	23·3	$\frac{15}{16}$	..	..
	..	III.	3	130–140	..	..	..	..	$5\frac{1}{4}$	..	..
25th Dec. 1901 .	$7\frac{1}{2}$–18	IV.	19	139–183	44	..	161	162·4	$6\frac{3}{8}$	A	39
	..	..	68	186–223	37	198	204·5	201	$7\frac{15}{16}$	A	51
28th Dec. 1903 .	5–13	II.	2	81–88	..	..	..	..	..	..	..
	..	..	12	97–127	..	..	112	113·3	$4\frac{1}{2}$	..	..
Findhorn.											
	..	IV.	11	123–169	46	..	143	150·8	$5\frac{13}{16}$	..	..
1st April 1904 .	30–32	V.	478	177–228	51	200	202·5	203·2	8	S	$48\frac{1}{2}$
	..	..	8	230–245	..	..	..	..	..	..	..
Cromarty Firth. 10th Jan. 1901 .	..	III.	30	89–132	43	120	110·5	102 1	4	..	..
	..	..	3	140–149	..	..	..	..	..	..	..
1st June 1901 .	8	III.	1	104	..	..	..	..	..	..	..
	..	IV.	66	111–155	44	135	133	129·7	$5\frac{1}{8}$	A	33
	..	..	3	163, 174, 197	..	..	..	..	..	..	..
Firth of Forth.											
9th May 1901 .	7–11	II.	1	71	..	..	..	..	..		..
	..	III.	154	94–139	45	112	116·5	114	$4\frac{1}{2}$	S	26
	..	..	6	142–149, 187	..	..	..	..	..	S	..
10th May 1901 .	22	..	9	117–135	..	..	..	..	..	S	..
13th May 1901 .	7	III.	114	97–133	36	114	115	112·3	$4\frac{7}{16}$	S	26
Combined .	..	II.	*1*	*71*	..	..	..	..	..	*S*	..
	..	III.	*277*	*94–139*	*45*	*113*	*116·5*	*113·7*	$4\frac{1}{2}$	*S*	*26*
	..	..	*6*	*142–149, 187*	..	..	..	..	..	*S*	..

S=Spring. A=Autumn.

Place and Date.	Depth.	Series.	Number.	Range in Size.	Difference.	Average Size. Modal.	Mean.	Arithmetic.	Inches.	Origin.	Probable Age.
	Fms.			Mm.	Mm.	Mm.	Mm.	Mm.			Mths.
Firth of Forth—*con.*											
28th May 1901 .	$7\frac{1}{2}$	..	31	17–24	7	20	20·5	20·4	$\frac{13}{16}$	S	$2\frac{1}{4}$
23rd July, 1901 .	..	..	8	109–137	28	..	123	125·4	$4\frac{15}{16}$	..	..
4th Sept. 1901 .	..	..	48	6–13	7	10	9	9·7	$\frac{3}{8}$	A	..
(Isle of May.)											Years
16th Feb. 1904, ♀	..	VI.	215	225–250 (26·5)	25 (40)	244	237·5 (245)	239·9	$9\frac{1}{2}$	S	5
♂	..	VI.	256	218–250	32	237	234	236·7	$9\frac{5}{16}$	S	5
	..	VI.	471	218–250	32	238	237·5	237·7	$9\frac{3}{8}$	S	5
♀	..	VII.	248	251–281 (240)	30 (42)	257	266 (261)	262·1	$10\frac{5}{16}$	S	6
♂	..	VII.	282	251–281	30	257	266·0	261·0	$10\frac{5}{16}$	S	6
	..	VII.	530	251–282	31	257	266	261·5	$10\frac{5}{16}$	S	6
♀	..	..	10	283–305	22	..	..	..	..	..	..
♂	..	..	12	283–304	21	..	..	..	..	..	..
	..	..	22	283–305	22	..	..	..	..	..	..
15th March, . .	..	VI.	256	211–244 (254)	33 (43)	235	227·5 (232·5)	232·8	$9\frac{3}{16}$	S	5
	..	VI.	319	211–244	..	235	227·5	232·2	$9\frac{3}{16}$	S	5
	..	VI.	575	211–244	33	235	227·5	232·5	$9\frac{3}{16}$	S	5
♀	..	VII.	252	245–277 (235)	32 (42)	250	261 (256)	254·1	10	S	6
♂	..	VII.	317	245–277	32	250	261	252·7	10	S	6
	..	..	569	245–277	32	250	261	253·5	10	S	6
♀	..	VIII.	4	281–288	..	..	..	..	..	S	..
♂	..	..	5	278–304	..	..	..	..	..	S	..
♀	..	..	2	324, 325	..	..	..	..	..	S	..

S=Spring. A=Autumn.

The smaller groups in the collection are as follows, those from Aberdeen Bay being first considered :—

On 21st and 22nd August, 10 miles off Aberdeen, at the "Doghole," 22 small clupeoids were obtained in the tow-net, which may be referred to the autumn spawning. They measured from 8mm. to 11mm., the average being about $\frac{5}{16}$ of an inch.

About a month later, on 18th and 20th September, 194 were taken in shallow water (up to 3 fathoms) in Aberdeen Bay. They measured from 21mm. to 44mm. ($\frac{7}{8}$–$1\frac{3}{4}$ inches), the size of greatest frequency (modal size) being 33mm., or $1\frac{5}{16}$ of an inch, and the arithmetic average

34·3mm. They were thus about 24–25mm., or 1 inch, longer than the group in August, and clearly belonged to another and earlier spawning, that is, to the spring series.

Two of them, however, which measured 21mm., might possibly belong to the autumn herrings. The numbers in 2-millimetre grouping are these :—

20-1	22-3	24-5	26-7	28-9	30-1	32-3	34-5	36-7	38-9	40-1	42-3	44-5
2	1	8	6	15	19	30	33	25	24	20	10	1

These young herrings would thus be about 5–6 months old.

The autumn herrings are well represented in some collections procured later in the year. Thus, on 2nd October, 297 measured from 9mm. to 20mm., the average size being about 15mm. On 3rd October, 334, also taken in Aberdeen Bay, measured from 8mm. to 27mm. ($\frac{5}{16}$–$1\frac{1}{16}$ inches), the size of greatest frequency being 17mm., the average 16·2mm., and the mean size 17·5mm. ($\frac{11}{16}$ of an inch). Two of these herrings, again, probably belong to the spring series, measuring respectively 26mm. and 27mm. The sizes, arranged in 2-millimetre groups, are these :—

11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28
28	54	85	107	47	10	–	1	1

The age of these may be estimated at from one to two months.

The same group is again well represented about a month later, when 181 were taken on 6th November, but in a different year. They measured from 12mm. to 25mm. ($\frac{1}{2}$–1 inch)—the maximum size rather supporting the suggestion made above, that the two at 26mm. and 27mm. in the October collection belonged to the spring group—and the modal size or mean was about 18mm., the average size being 18·3mm. ($\frac{3}{4}$ inch). The arrangement, in 2-millimetre grouping, is as follows :—

12-13	14-15	16-17	18-19	20-21	22-23	24-25
6	17	42	57	40	15	4

On the 23rd December six herrings were taken, whose measurements were as follows :—23mm., 24mm., 25mm., and 32mm., 33mm., 36mm. (from $\frac{15}{16}$–$1\frac{7}{16}$ inches), and they possibly belonged to two series.

On the 12th of the same month, and in the same year, another collection in Aberdeen Bay numbered 15, their sizes ranging from 42mm. to 50mm. ($1\frac{11}{16}$–2 inches), the size of greatest frequency being 45mm., while the mean was 46mm., and the average 46·5mm., or nearly $1\frac{7}{8}$ inches.

These probably represent the spring herrings, whose average size in the September collection was 33mm., the growth over the twelve weeks amounting to about 14–15mm. ($\frac{5}{8}$ inch).

The sizes and increments of these post-larval autumn herrings may be thus summed up :—

Date.	Size.		Increase	Days.
	Range.	Average.		
	Mm.	Mm.	Mm.	
21st, 22nd August,	8-11	9·0	–	–
2nd October, – –	9-20	15·0	6	42
3rd October, – –	8-22	17	8	43
6th November, –	12-25	18	9	77

The next collection of small herrings from Aberdeen Bay was on 24th April, in another year. They numbered 157, and ranged in size from 41–46mm. ($1\frac{5}{8}$–$1\frac{13}{16}$ inches)—the modal size, the mean size (calculated on the base-line of the curve) and the arithmetical average, all agreeing at 43·5mm., or $1\frac{3}{4}$ inches.

These herrings are clearly not those from the previous spring series, but from the preceding autumn, and they are approximately seven or eight months old.

Small herrings were also obtained in June in Aberdeen Bay in two separate years. In 1900 a shoal appeared in the Bay of Nigg, apparently driven in by coal-fish (of which a large number were got in the salmon stake-nets); fifteen of these, taken on the 19th, were measured by Dr. Scott, who determined the contents of the stomach.* They ranged between 5·5cm. and 6·5cm. ($2\frac{1}{8}$–$2\frac{9}{16}$ inches), the mean length being about 60mm., or $2\frac{3}{8}$ inches; but it is, of course, quite uncertain if they were representative of the shoal.

Two of the herrings belonging to the shoal were placed by me in a large glass carboy, containing about 18 gallons of water, and a circulation maintained. These herrings were not attempted to be measured until 15th August, when one was found to be approximately 73mm. ($2\frac{7}{8}$ inches) and the other 83mm. ($3\frac{1}{4}$ inches); they were placed in a narrow tube full of sea-water while being measured. On the 28th September another attempt was made to measure them, and one was found to be 83mm. ($3\frac{1}{4}$ inches); but it showed such signs of collapse that I refrained from measuring the other herring, and both of them were lost some time afterwards.

If their size was about 60mm. on the 19th June, the indicated growth in the two months would be approximately 13–23mm. ($\frac{1}{2}$–$\frac{15}{16}$ inch), and the growth of one of them, assuming it to be the smaller measured in August, from the latter period to 28th September would amount to 10mm. for the 44 days. These data are obviously slender and uncertain. At all events, the remark was a common one at the time, that the herrings were growing very slowly.†

In June of another year a series was represented by 24 specimens, measuring from 50mm. to 60mm. (2–$2\frac{3}{8}$ inches), the modal size being 55mm., and the arithmetic average 55·8mm. ($2\frac{3}{16}$ inches).

On 18th October, in a large collection, there was one measuring 85mm. ($3\frac{3}{8}$ inches), the next, part of a large group, measuring 96mm. The former was certainly in its second year.

Turning now to the collections of small herrings from other parts of the coast, we find corresponding series.

In the Dornoch Firth, on 21st October, 28 post-larval herrings were taken in a tow-net. They measured from 14mm. to 20mm., the modal size and the mean being 17mm., and the arithmetical average 16·8mm. ($\frac{11}{16}$ inch). These were from the autumn spawning.

On 11th November, 48 were caught in a tow-net, which ranged in size from 13mm. to 25mm., the mode and the mean being 19mm., and the arithmetic average 18·6mm. ($\frac{3}{4}$ inch). On 13th November, in the same year, 156 were caught in tow-nets, measuring from 13mm. to 26mm. ($\frac{1}{2}$ to slightly over 1 inch); the modal size was 20mm., the mean 19·4mm., and the average 19·5mm. ($\frac{3}{4}$ inch). On 26th December, in the same year, the series is, perhaps, represented by 51 specimens, measuring

* See *Twentieth Annual Report*, Part III., p. 530.

† A small rockling kept in the same vessel, lurking among stones and weed at the bottom, offered a striking contrast to the herrings. On 15th August it measured 57mm., on 28th September 89mm., and on 14th November 97mm. It was fed with mussels. On the other hand, the growth of the common pipe-fish (*Syngnathus acus*) was very slow.

from 14mm. to 34mm. ($\frac{9}{16}$–$1\frac{3}{8}$ inches), the modal size, or size of greatest frequency, being 19mm., the mean 24mm., and the average 23·3mm., or $\frac{7}{8}$ of an inch.

The collection seems to include more than members of one series, however, the numbers under each millimetre being as follows:—

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1	2	5	3	5	3	3	2	3	5	4	1	1	3	2	2	2	2	2	–	1

The growth is thus very slow, the increments being as follow:—

Date.	Size.		Increase.	Days.
	Range.	Average.		
	Mm.	Mm.	Mm.	
21st October, ...	14–20	17		
11th November, ...	13–25	19	2	21
15th November, ...	13–26	19·5	2·5	25
26th December, ...	14–34 ? [14–26 ?	22·3 ? 20	5·3 ? 3·0	66 66]

The sizes, it will be seen, agree very well with the post-larval herrings from Aberdeen Bay at corresponding periods.

For the reason stated, it is probable that the average, and therefore the amount of growth in the December series, is too large.

Near Burghead Bay, on 29th December, 1903, 56 post-larval clupeoids, measuring from 15mm. to 33mm., were taken, the modal size being 20mm., the mean 24mm., and the arithmetical average 23·3mm ($\frac{15}{16}$ inch). The arrangement of the measurements under the various millimetres is as follows:—

15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1	2	2	6	5	5	1	6	2	3	4	3	2	3	1	5	1	3	1

There are some reasons to suspect that these clupeoids may be sprats; the diagnosis is therefore uncertain.

On May 28, a compact series, numbering 31 specimens, and measuring from 17mm. to 24mm. were taken in the Firth of Forth. The modal size was 20mm., the mean was 20·5mm., and the average 20·4mm., or $\frac{13}{16}$ of an inch. These represent the spring herrings, approximately two months old.

The autumn herrings are represented by a collection taken at the mouth of the Forth on 4th September, in the same year. There were 48, measuring from 6mm. to 13mm., the modal size being 10mm., the mean 9mm., and the average 9·7mm., or $\frac{3}{8}$ of an inch. The arrangement of the measurements of these two collections in millimetres is as follows:—

	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
(*1*)	–	–	–	–	–	–	–	–	–	–	–	1	4	2	10	7	3	2	2
(*2*)	3	–	1	16	17	7	3	1	–	–	–	–	–	–	–	–	–	–	–

In the Forth collections, the next older series is represented by one herring, 71mm, ($2\frac{13}{16}$ inches) long, taken on 9th May, and by one of 85mm., caught on 19th June.

In some collections from the Firth of Clyde, the series is well indicated. Thus, on 17th October, the shrimp-trawl, working in from

37 to 53 fathoms, took 91, measuring from $2\frac{1}{4}$ to $3\frac{1}{2}$ inches (57mm. to 82mm.), most measuring from $2\frac{1}{4}$ to $2\frac{3}{4}$ inches (63mm. to 70mm). The measurements were carefully made to fractions of an inch, as follows:—

$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3	$3\frac{1}{4}$	$3\frac{1}{2}$
6	35	35	12	3	–

One at $2\frac{3}{4}$ inches (70mm.) was caught in the same neighbourhood on the same day, and another of 70mm. at the mouth of the Clyde on 23rd November, while in December, on the 17th and 18th, 20 were taken in Lochfyne, measuring from 5·5cm. to 9cm., as follows:—

5·5	6	6·5	7	7·5	8	8·5	9
2	4	4	5	3	1	–	1

Some of the herrings taken in the Firth of Forth in previous years by the *Garland*, which are included in the Table at the end of the paper (III.), and shown on Plate XIX. by dotted lines, belong to the same series. They were measured by Dr. T. Scott in fractions of an inch, and grouped together, and thus in some cases it is not easy to separate them into groups. In some instances, however, the distinction is easy. They were all taken in a fine-meshed shrimp trawl net.

The number of hauls made was 135, apportioned to the various months as follows—the depths are in fathoms:—

	1889.		1890.		1891.		1892.	
	No.	Depths.	No.	Depths.	No.	Depths.	No.	Depths.
February, –	–	–	6	6–27	–	–	2	3–5
March, –	–	–	10	3–28	–	–	–	–
April, – –	–	–	10	4 24	–	–	5	6–14
May, – –	26	$3\frac{3}{4}$–31	9	5–24	–	–	–	–
June, – –	14	4–24	–	–	–	–	–	–
August, –	–	–	–	–	3	5–12	–	–
September,	33	4–29	–	–	–	–	–	–
October, –	11	5–28	–	–	–	–	–	–
December,	–	–	–	–	–	–	6	8–27

The particulars in regard to the herrings taken are given in the following Table, the ordinary figures referring to the length in inches, and those in brackets to the corresponding length in millimetres:—

Date.	Depth.	Herrings.
	Fms.	
21st February 1890 .	24–27	1 at 4 (100).
17th ,, ,, .	6½–9	12, 3½–5 (90–127).
20th ,, ,, .	11–14	3, 4½–5 (115–127); 2, 3 (76).
6th ,, 1892 .	5	240, 1¾–3¼ (45–69).
19th March 1890 .	20–27	21, 4–5½ (102–140).
19th ,, ,, .	18–28	2, 4½–5½ (115–140).
21st ,, ,, .	9½–14	29, 4–5 (102–127); 2, 3½ (89).
21st ,, ,, .	4½	1, 4 (102).
22nd ,, ,, .	5–6	5, 4½–5½ (115–140); 158, 2½–3½ (63–89).
22nd ,, ,, .	4–6	11, 4½–5¼ (115–133); 169, 2½–3½ (63–89).
22nd ,, ,, .	3–4	16, 4–4½ (102–115); 14, 3–3½ (76–89).
20th April 1892 . .	7–8	316, 1¾–3¼ (45–82).
26th ,, 1890 . .	4	767, 2–3½ (50–90); 1, 5½ (140).
28th ,, ,, . .	18–20	6, 4–5 (102–127).
29th ,, ,, . .	17	1, 5½ (140); 8, 5 (127); 15, 2¾–4 (70–102).
29th ,, ,, . .	6–15	37, 6 (150); 219, 3½–4 (90–102); 786, 1¾–3 (45–76).
29th ,, ,, . .	8–10	6, 3–3½ (76–89).
9th May 1889 . .	4	1, 7 (177); 124, 4–5 (102–127); 7, 3 (76); 24, 2½ (63); 30, 2 (50).
10th ,, ,, . .	6	1, 3 (76),
11th ,, ,, . .	11–12	1, 7 (177); 1, 6½ (165); 3, 4¼ (108).
14th ,, ,, . .	15	1, 4½ (115).
15th ,, ,, . .	5	3, 2½ (63).
7th ,, 1890 . .	9	6, 4½ (115).
8th ,, ,, . .	5–9	2, 4 (102).
9th ,, ,, . .	20	1, 5 (127).
5th August 1891 .	6	3, 3¾ (95).
3rd September 1889 .	5	118, 2½–3½ (63–89).
4th ,, ,, .	15	1, 3 (76).
4th ,, ,, .	29	2, 3 (76).
5th ,, ,, .	5	14, 2–2½ (50–63).
5th ,, ,, .	6	2294, 2½–3½ (63–89).
12th ,, ,, .	26	1, 3 (76).
13th ,, ,, .	22	1, 3 (76); 1, 2 (50).
5th October 1889 .	5	8, 3 (76).
10th ,, ,, .	5	2, 4½ (115); 4, 3½ (89); 9, 3 (76).
10th ,, ,, .	12	22, 4–4½ (102–115).
16th ,, ,, .	12	2, 3½ (89).
9th December 1892 .	13–15	6, 3½–4 (89–102).
10th ,, ,, .	11–14	3, 4½–5 (115–127).

At least three annual series of herrings are represented in these Forth collections. From what has been said above as to the slow growth of the post-larval herring, it is clear that none of them belong to the year in which they were caught, but that the smallest of them are in their second year.

The measurements in fractions of an inch, and the slumping of lots together, are less accurate than the separate measurements in millimetres, and two separate series may be mixed up together, but it appears, on the whole, probable that the smaller herrings in spring represent the spring herrings and not the autumn fish. In February, March, and April their sizes range from about 45mm. to about 89mm. or 90mm.; the smaller sizes would suit well enough the supposition that they were autumn herrings, but the larger are much too large for that class at that time of year, and if they are all regarded as belonging to one group, the group must be looked upon as spring fish nearing one year of age, though the larger sizes are too large for this interpretation. This must be said, on the balance of evidence, even regarding the large

collection on 29th April and the collection on 9th May, measuring in the former from 45mm. to 76mm. approximately, and in the latter from 50mm. to 76mm.; but what has been said as to the method of measurement and recording must be borne in mind.

On the other hand, it appears probable that the bulk of those obtained in September, measuring from 50mm. and 63mm., are autumn herrings of the year before, and thus about one year of age. The important point established, however, is that all these small herrings are in their second year and are not derived from the spawning of the same year.

The next group, extending from about 90mm. to 127mm. or 130mm., are one year older, that is to say, they are in their third year. It is possible that in spring they may go as high as 140mm. ($5\frac{1}{2}$ inches), a limit included in the above Table, but it is not probable, judging from the other collections, although in autumn the size would be in accordance with the collections referred to.

It will be noticed that none of these small herrings were taken in the shrimp-trawl in the latter part of May, or in June. It is not unlikely that they leave the bottom for the most part in the early part of May. I may add that no herrings were obtained in fifteen hauls of the same net in the Moray Firth in June and July.

A few small herrings were also obtained from the shrimp-nets used in the Solway Firth. On 30th July, nine were got, seven measuring from 60mm. to 75mm., one 83mm., and one 90mm. The average for the nine fish, if taken together, is 72·9mm., or $2\frac{7}{8}$ inches. On 28th September three were taken, which measured 60mm., 72mm., and 78mm., the average being 70mm. ($2\frac{3}{4}$ inches); on 31st October, three taken measured 50mm., 64mm., and 81mm., the average being 65mm., or a little over $2\frac{1}{2}$ inches.

A summary of the range of sizes of the herrings, both of the spring and of the autumn series, is given in the following Table, arranged according to the data furnished by Masterman (M.) and also by the collections of the Fishery Board (F. B.).

	Spring.		Autumn.	
	M.	F. B.	M.	F. B.
	Mm.	Mm.	Mm.	Mm.
February, . .	..	..	..	..
March, . .	5-11	7-11	..	..
April, . . .	5-16	6-17	..	..
May, . . .	5-25	7·5-24	..	..
June, . . .	13-20	15-26	..	..
July, . . .	16-37	16-	..	..
August, . .	[11-20]	..	5-12	6-14
September, . .	36-44	21-44	4-18	6-18
October, . .	32-41	32	6-23	8-25
November, . .	..	..	14-26	12-29
December, . .	[37]	39-50	15-[37]	14-34, 36
January, . .	42-56	..	..	27
February, . .	41	45-69	35-37	31, 32
March, . .	44	(63)-(89)	26-40	..
April, . . .	..	(45)-(82)	32-49	41–46
May, . . .	..	71	..	50–63

In the *Fourth Annual Report of the Fishery Board for Scotland* Mr. Duncan Matthews described the young herrings found in various samples of whitebait from the Thames. His results may be thus summarised, the words in brackets indicating my interpretation of the derivation of the herrings, which thus differs from that of Cunningham, who dealt with the same observations of Matthews (18, p. 162).

Month.	Number Herrings Examined.	Remarks.
February, .	98	Some under 2 inches (50mm.) and only partially scaled (probably spring-herrings of previous year).
March, . .	60	Some reached nearly 4 inches (102mm.) (autumn herrings in third year).
April, . .	112	14 under 1½ inches (38mm.) (autumn herrings of previous year).
May, . .	180	72 were 2 inches (50mm.) fully scaled (autumn herring) and 108 from 1½–1¾ inches (38mm.–44mm.) and only partly scaled (autumn herrings).
June, . .	696	417 fully scaled, 2–2¼ inches (50mm.–57mm.) (autumn), 279, from 1 to 1½ inches (25mm.–38mm.) partially scaled, or entirely scaleless (spring herrings of year, but possibly two series).
July, . .	450	1½-2½ inches (38mm.–63mm.), of these, 360 under 2 inches (50mm.) (probably two series—spring and autumn).
August, . .	260	2–3 inches (50mm.–76mm.) (autumn).

The usual difficulties involved in measurements in fractions of an inch, and slumping, is encountered here, though in most cases the derivation of the series seems clear. To suppose that herrings of 63 or 55mm. in July, were derived from the spawning in the previous spring would be contrary to the facts referring to the Scottish collections. The spawning-seasons may differ to some extent off the mouth of the Thames.

The observations of Hoek on the small herring in the Zuiderzee (14), previously referred to, would be valuable for comparison, but it is clear that different series have been included together in some of the groups. A summary of his measurements, in millimetres, is as follows:—February, 73–100, most between 88 and 95: March, 49–75, 70–78, 83–114, 77–100, most between 85–95, 67–106: April, 67–102, "most part about 80"; a few days later, "most of them 75," a few about 90: May, many about 90, four 55: June (29th), a few 37: July, 37–42, 57–60, 75, 80, 98: August, 56–81, 60–68, and on 31st, 40–50, 60–70: September, 58–75, 76–83, 65–95: October, 81–90, 65–80: November, one 75, many 85–90, 100-112·5: December, many 80–100.

(*b*) *The Annual Groups.*

In dealing with the numerous collections of larger herrings, it will not be necessary to refer to them all in detail. The method I adopted in elucidating the rate of growth and the age of the herrings in the various collections was as follows. After determining the rate of growth and the sizes for the first and second year, I set down on a very large and long sheet, divided into centimetre and millimetre squares, all the other collections, showing the range of sizes and the average or modal size, that is, the size at and around which the great bulk of the herrings in a collection were aggregated. Very little consideration was required to allot almost all the collections in a particular month to the proper year, and in the accompanying Table I have represented the modal sizes of the collections in this manner, and also in some cases (by a cross) the sizes of individual herrings or small collections.

There are a few general considerations that may be referred to. The collections were in nearly every case made by means of a small-meshed net fixed outside the cod-end of an ordinary large otter-trawl, which was dragged along the bottom for an hour and more. Several miles of bottom were thus trawled over, and this is probably the explanation that a mixture of herrings of different series occurs in a few of the collections. In most instances this has not happened, the groups being very distinct; but in some there are a few, or many, herrings either larger or smaller than the limits of the series, and in one or two collections the spring and autumn series seem to be more or less blended. They are referred to below.

The larger fully adult herrings are not well represented in the collections, probably from their more pelagic habitat. The small herrings in their second year are also not very fully represented until the winter, doubtless due to the fact that they were able to escape through the meshes of the net. They are well shown, however, in the collections made in the Firth of Forth by the *Garland*, with a fine-meshed shrimp-trawl, and also in Lochfyne, as above described.

In May certain collections of small herrings were obtained in the Firth of Forth with the small-meshed net around the otter-trawl. On the 9th, in from 7 to 11 fathoms, 161 were taken. The smallest was a single herring measuring 71mm. ($2\frac{13}{16}$ inches), representing the herrings in their second summer, and about one year old, more or less. The next measured 94mm. ($3\frac{11}{16}$ inches, and was the smallest of a group of 154 herrings, apparently the largest of which measured 139mm. ($5\frac{1}{2}$ inches). The modal size was 112mm. ($4\frac{7}{16}$ inches), the mean 116·5mm., and the arithmetic average 114mm. ($4\frac{1}{2}$ inches). There were other four herrings, from 142mm. to 149mm., and a single one at 187mm. The four referred to might belong to the group; but the indications of other series are against this view; the series might, on the other hand, so far as the millimetre table indicates, have stopped at 130mm. or 133mm. In either case, the modal size is unaffected, and the average but slightly.

On the 10th May, twelve herrings were taken, nine of which were from. 117mm. to 135mm. in length, and three from 140mm. to 153mm.

On the 13th, the collection contained 114 herrings, forming a compact series from 97mm. to 126mm., there being another at 133mm., which is taken as the end of the group. The modal size was 114mm. ($4\frac{1}{2}$ inches), the mean 115mm., and the arithmetic average 112·3mm.

If the herrings in this group in the three collections are combined, the number is 277, the apparent range of sizes from 94mm. to 139mm. ($3\frac{11}{16}$ to $5\frac{5}{16}$ inches), the modal size 113mm., the mean 116·5mm., and the average 113·7mm. ($4\frac{1}{2}$ inches).

Cm.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
January, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
February,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
March, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
April, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
May, .	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
June, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
July, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
August, .	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
September,	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..
October, .	1 11	1	..	..	..	..	..	..	..	..	..	..	..	..	..
November,	1	111	..	..	..	..	..	..	..	..	..	..	..	..	..
December,	1	1 1	..	1	..	..	..	..	..	..	..	..	..	..	..
January, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
February,	..	..	..	..	1	..	x	..	..	..	..	..	..	..	..
March, .	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..
April, .	..	..	..	1	..	1 1	1	..	..	..	..	..	..	..	..
May, .	..	..	..	..	..	1	x x	..	..	..	..	..	..	..	..
June, .	..	..	..	..	11	..	..	..	..	..	..	..	..	..	..
July, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
August, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
September,	..	..	..	..	..	..	1	1	..	..	..	..	..	..	..
October, .	..	..	..	..	..	1	..	1	..	1	..	..	..	..	..
November,	..	..	..	..	..	..	..	..	11	1	..	..	..	..	..
December,	..	..	..	..	..	1	..	..	1	1	..	..	..	..	..
January, .	..	..	..	..	..	..	..	..	..	1	..	1	..	..	..
February,	..	..	..	..	..	..	..	..	x x	1	1	..	..	..	..
March, .	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..
April, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
May, .	..	..	..	..	..	..	..	..	..	x	111	..	..	..	..
June, .	..	..	..	..	..	..	..	..	..	..	..	..	1 1	..	..
July, .	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..
August, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
September,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
October, .	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..
November,	..	..	..	..	..	..	..	..	..	..	1	..	1	..	..
December,	..	..	..	..	..	..	..	..	..	..	1 1	1 1	1 1	1	..
January, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
February,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
March, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
April, .	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1 x
May, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
June, .	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..
July, .	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..
August, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
September,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
October, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
November,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
December,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
January, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
February,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
March, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
April, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
May, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
June, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
July, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
August, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
September,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
October, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
November,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
December,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
January, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
February,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
March, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
April, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
May, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
June, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
July, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
August, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
September,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
October, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
November,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
December,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
January, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
February,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
March, .	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cm		2	3	4	5	6	7	8	9	10	11	12	13	14	15

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Cm.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	January.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	February.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	March.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	April.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	May.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	June.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	July.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	August.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	September.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	October.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	November.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	December.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	January.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	February.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	March.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	April.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	May,
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	June.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	July.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	August.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	September.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	October.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	November.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	December.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	January.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	February.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	March.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	April.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	May.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	June.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	July.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	August.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	September.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	October.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	November.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	December.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	January.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	February.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	March.
x 1	x	..	..	..	..	..	..	..	..	..	..	..	..	..	April.
1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	May.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	June.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	July.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	August.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	September.
..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	November.
1	..	..	11	..	..	..	..	..	..	..	..	..	..	..	December.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	January.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	February.
x	..	x	x	..	..	..	..	..	..	..	..	..	..	..	March,
..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	April.
..	..	..	x	..	..	..	..	..	..	..	..	..	..	..	May.
xx	xx	xx	..	x	x	..	..	..	..	..	..	..	..	..	June.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	July.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	August.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	September.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	October.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	November,
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	December.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	January.
..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	February.
..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	March.
..	..	..	..	..	..	..	xxx	xxx	..	..	..	..	..	..	April.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	May.
..	..	..	..	..	..	xx	xx	..	..	..	..	..	..	..	June.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	July.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	August.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	September.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	October.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	November.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	December.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	January.
..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	February,
..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	March.
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Cm.

These herrings, as the other collections and measurements show, are in their third summer, and are spring herrings a little over two years of age.

To this series also belong nine herrings taken by the *Garland* on 16th May, measuring from about 9cm. to 12cm.

In July in the same year a small collection of herrings was secured. There were only eight of them, ranging in size from 109mm. to 137mm., the mean being 123mm. and the average 125·4mm. ($4\frac{15}{16}$ inches).

In Aberdeen Bay some large collections of herrings at a corresponding stage were obtained. On October 18th they numbered 444. There was one at 85mm. ($3\frac{3}{8}$ inches), the next being 96mm., and the group to which the latter belonged extended to about 141mm. It contained 429 herrings, the modal size of which was 115mm., the mean was also 115mm. ($4\frac{1}{2}$ inches), and the average was 117·5mm., or $4\frac{7}{8}$ inches. These herrings were thus of almost the exact size of the group caught in the Forth in May, and may be referred to the autumn series, somewhat over two years old. The group might terminate at a slightly smaller size than that indicated, *e.g.*, 137mm.; on the other hand, there were five herrings measuring 143mm. to 145mm., three from 151mm. to 154mm., and one at 164mm. It is possible that the first five belong to the group, but the balance of evidence is against the supposition; in any case, the mode and average would not be appreciably affected. All the herrings referred to probably belong to a group, extending in this case from 143mm. to 187mm.

Another large collection obtained on 31st October, but in the previous year, was made up of younger herrings. The curve of the measurements (see Plate XVII.) is slightly irregular, there being a small depression at about 7·5cm., and two slight cusps at 7cm. and 8cm. Consideration of other cases shows that the group extends to about 9·5cm., and is really one. The 650 herrings contained in it extend from 52mm. to about 95mm. ($2\frac{1}{16}$ to $3\frac{3}{4}$ inches); the chief mode is at 8cm. ($3\frac{1}{8}$ inches), the mean at 73mm. ($2\frac{7}{8}$ inches), and the average at 77·8mm., or $3\frac{1}{16}$ inches. These herrings are obviously those of the year before, and autumn herrings, so that they would be about 13 to 15 months old. The difference between this group and the group of the 18th (in the following year), both of which are supposed to be autumn herrings, is, on the modes 35mm., on the means 42mm., and on the averages as computed 39·7mm., the mean of the three being 38·9mm. ($1\frac{9}{16}$ inches). The mode, as we have seen, is not regular in the collection of 31st, and is better at 7·5cm., which would make the difference 40mm. and the mean of the three comparisons 40·6mm., or $1\frac{5}{8}$ inches, representing a year's growth.

The next group consisted of 179 herrings from about 96mm. to 143mm., but the larger individuals are not well represented. They appear to belong to the corresponding group so well shown in the collection of 18th October. There was a single herring at 157mm.

On November 6th and 9th, in three different years (1900, 1901, 1903) small collections were obtained, which may be combined and summarised. Seven measured from 75mm. to 100mm., the computed average being 87·7mm. ($3\frac{7}{16}$ inches); 48 ranged from 102mm. to 143mm. (4 to $5\frac{5}{8}$ inches), the computed average being 125mm. ($4\frac{11}{16}$ inches). There were also two herrings 185mm. and 188mm.

On 12th December, six herrings measured from 97mm. to 124mm. ($3\frac{13}{16}$ to $4\frac{7}{8}$ inches), the mean size being 110·5mm. and the average 109·3mm.

On 19th December, six, measuring from 78mm. to 95mm. were caught, the average size being 90·5mm., or $3\frac{9}{16}$ inches; there were also five ranging from 110mm. to 131mm., the average being 120mm., or $4\frac{3}{4}$ inches.

On the 18th December, a collection of 410 herrings varied in size from 110mm. to 165mm. ($4\frac{1}{4}$ to $6\frac{1}{2}$ inches), the range being thus 56mm. The mean was 137mm., the average 137·5mm., and the mode 141mm. (a little over $5\frac{1}{2}$ inches). An examination of the millimetre table, or of the curve (Pl. XVII.) shows that there is in this case a slight fusion of two groups, and that the beginning of the large group is probably about 11·5cm. The 2-millimetre arrangement of the measurements is as follows—

109-110	111-2	113-4	115-6	117-8	119-20	121-2	123-4
1	3	1	3	5	8	9	17

At the end of the series the 2-millimetre arrangement is this :—

150-1	152-3	154-5	156-7	158-9	160-1	162-3	164-5
11	12	3	4	3	4	–	1

the mode being 141mm., the mean 137·5mm., and the computed average 135·9mm. The mode ($5\frac{9}{16}$ inches) probably best represents the group. These herrings are spring herrings about 2 years and 8 or 9 months old; those taken on the 17th appear to be the autumn series, about 2 years and 3 or 4 months old. On the 29th December, 16 herrings were taken, from 108mm. to 154mm.

A series of older herrings than these were caught in Aberdeen Bay in May and June, 1901 and 1903.

On the 30th May, 1901, the collection numbered 601, ranging from 142mm. to 228mm., and forming two series at least. The first contained 598 herrings, from 142mm. to 186mm. ($5\frac{7}{8}$ to $7\frac{3}{8}$ inches), or it might be 182mm. The modal size was 159mm. or 160mm., the mean 164mm., and the computed average 162mm., or $6\frac{3}{8}$ inches. These herrings are in their fourth year, and, judging from their position in relation to other series on the synthetic table, they are spring herrings, and thus a little over three years old.

There were other three herrings, measuring respectively 196mm., 207mm., and 228mm. (9 inches).

Two collections were obtained in June. The first, on the 13th (1903), contained 557 herrings, and three series were present. The curve (Pl. XVII.) and the millimetre table show that the first great group is not pure, but is slightly mixed with the next group of larger herrings, represented on 30th May and on 28th June, and the measurements extend from 118mm. to 182mm., a range of 64mm., which is too large. The first series begins at 118mm., and apparently extends to 163mm. ($4\frac{5}{8}$ to 6 inches), but it might go to 167mm. The 2mm. arrangement of the measurements at this part is as follows:—

156-7	158-9	160-1	162-3	164-5	166-7	168-9	170-1
19	17	13	6	9	4	6	5

The modal size of the group is 138mm. or 139mm. ($5\frac{1}{2}$ inches), the mean is 140·5mm., and the computed average 141·8mm., or $5\frac{5}{8}$ inches. This group is thus about 2cm. ($\frac{3}{4}$ inch) less than the group on 30th May, and I take it to represent autumn herrings in the fourth year, that is, which want about three months of being three years old. The group of 405 spring herrings, taken in Aberdeen Bay on 18th December, above referred to, were of about the same age (2 years and 9 months) and of the same size as these.

The spring herrings mixed with them number about 30, and range from about 164mm. to 182mm. There were also four herrings measuring 208mm., 223mm., 225mm., 234mm.

On the 28th June, fifteen days later, but in 1901, 650 herrings were taken at Lunan Bay, a little further down the coast, in $12\frac{1}{2}$ fathoms.

They formed a compact group (Pl. XVII.) ranging from 148mm. to 192mm. $5\frac{13}{16}$ to $7\frac{9}{16}$ inches), the modal size was 167mm. ($6\frac{9}{16}$ inches), the mean was 170mm., and the computed average 168·8mm., or $6\frac{11}{16}$ inches. These herrings were obviously the same series as those taken on 30th May, that is, herrings in the fourth year, and thus, in all probability, spring herrings somewhat over three years of age.

The increment of length in the 29 days is, on comparison of the modes, 7mm. to 8mm., on the means 6mm., and on the averages 6·9mm., or a little over $\frac{1}{4}$ inch. The rate per day, taking the increase at 7mm., was 0·241mm., and per month about 7·5mm., and this in the best period for growth. If a similar rate is assumed for July and August, the increase in the three best months of the year would amount to a little over 22mm. ($\frac{7}{8}$ inch), which contrasts with the growth of the whiting, as indicated on a former page.

If the group taken on 13th June is contrasted with the small herrings got in the Bay of Nigg, Aberdeen, on the 19th June, referred to previously, whose average was about 60mm., and which were also judged to be autumn herrings, the growth in the two years is seen to amount to about 80mm. ($3\frac{3}{16}$ inches). If, moreover, the herrings taken in Aberdeen Bay on 30th May are contrasted with those taken at the beginning of the same month (and year) in the Firth of Forth (both being judged to be spring herrings, and the latter about thirteen months younger), the differences are as follows:—On the modes 46mm., on the means 47·5mm., and on the computed averages 48·5mm., showing a mean difference of about 47mm. ($1\frac{7}{8}$ inches), or at the rate for the whole period of 385 days of about ·122mm. per day, or 3·7mm. per month. On 5th July, 1901, eight herrings were taken in Aberdeen Bay, measuring from 140mm. to 164mm. The modal size was 140mm., the mean 150mm., and the computed average was 149·2mm., or $5\frac{7}{8}$ inches. They belonged, no doubt, to the same series as that of 13th June.

Some good collections of herrings were obtained in the Dornoch Firth. On 9th February 8 ranged from 104mm. to 122mm., the mode and the mean were 113mm., and the average was 112·4mm., or $4\frac{3}{8}$ inches. The position of these is in February of the third year, *i.e.*, nearly two years old, if spring herrings, as they probably are.

Sixteen obtained on 31st March ranged from 106mm. to 136mm. ($4\frac{3}{16}$ to $5\frac{3}{8}$ inches), the mode being 112mm., the mean 121mm., and the computed average 117·6mm., or $4\frac{5}{8}$ inches. No doubt they represent the same series as in February, and are about two years of age.

Several collections were obtained in November. On 5th November, 1900, in from 7 to 10 fathoms, 4784 herrings were taken in a haul of $1\frac{1}{2}$ hours' duration, of which 601 were measured. The smallest noted was 73mm., and the largest 206mm., and the great maiority ranged about 11cm. to 11·5cm. The first series is not fully represented, probably because of the escape from the net of the smaller fishes. It extended from 73mm. to about 97mm.; it might be 99mm.; the mean was 85mm., and the computed average 90mm., but the herrings represent only part of a series (in their second year). The 2mm. arrangement of the measurements at this place is as follows:—

86–7	88–9	90–1	92–3	94–5	96–7	98–9	100–1	102–3	104–5	106–7	108–9
5	7	7	9	8	3	5	7	6	17	19	36

The next series is taken as extending from 98mm. to 141mm. ($3\frac{7}{8}$ to $5\frac{9}{16}$ inches), but it may end about 13cm. or 13·5cm. The arrangement of the 2mm. measurements is as follows:—

124–5	126–7	128–9	130–1	132–3	134–5	136–7	138–9	140–1	142–3	144–5
21	16	8	2	4	3	1	2	1	-	2

This series comprised 544 herrings, the mode was 115mm., the mean 119·5mm., and the computed or arithmetical average 114·4mm. ($4\frac{1}{2}$ inches). These were probably autumn harrings over two years of age. There were also 9 herrings from 144mm. to 162mm.

On the 11th November, 1903, in from 6 to 12 fathoms, 110 herrings were caught. Of these 99 ranged from 79mm. to 109mm., the mode was 95mm., the mean 94mm., and the average 94·3mm., or $3\frac{3}{4}$ inches.

On the following day (12th) 1336 herrings were taken in from 6 to 10 fathoms, and all measured. The first series, comprising 1234 herrings, apparently ranged in length from 79mm. to 133mm. ($3\frac{1}{8}$ to $5\frac{1}{4}$ inches); the series might, however, terminate about 133mm. or 136mm. or 138mm. The above range (54mm.) is greater than usual. On the other hand, the series might not begin till about 83mm. or 85mm. There is not uncommonly a difficulty in assigning the position of the odd fish at the beginning or end of a series, which may belong to different groups, but the influence on the average size is quite unappreciable, while the mode is unaffected. The 2mm. arrangement at the beginning of the series on 11th and 12th November is as follows:—

	79–80	81–2	83–4	85–6	87–8	89–90
11th . .	1	–	5	9	9	9
12th . .	2	2	3	9	15	22

The most appropriate interpretation is that the series begins at 84mm. and extends to 133mm. ($3\frac{3}{8}$ to $5\frac{1}{4}$ inches). The modal size is 105mm., the mean 108·5mm., and the average 105·4mm., or $4\frac{1}{8}$ inches. These herrings are doubtless autumn herrings, two years and a few months old.

Most of the remaining herrings in the collection, viz., 87., measured from 161mm. to 198mm. ($6\frac{3}{8}$ to $7\frac{13}{16}$ inches), the mode being 175mm., the mean 180mm., and the computed average 179·1mm., or a trifle over 7 inches. The group is only partially represented, but as the difference from the other and younger group amounts to over 70mm., it is evident that they do not represent that series when one year older. They are apparently spring herrings, about three years and seven months old, members of the group present in the collection from the Dornoch Firth on 15th December, and in that taken at Burghead Bay in December, referred to below.

The herrings between 133mm. and 162mm. numbered 15, from 134mm. to 152mm., and they belong to another group, viz., that shown in the December collection from Aberdeen Bay.

A large number of herrings were taken on 25th December in the Dornoch Firth in another year. The youngest series comprised 1769 fishes, measuring from 98mm. to about 144mm. ($3\frac{7}{8}$ to $5\frac{11}{16}$ inches); the modal size was 119mm. ($4\frac{11}{16}$ inches), the mean was 121mm., and the computed average 122·4mm. ($4\frac{13}{16}$ inches).

These are autumn herrings, two years and some months old. The size of the corresponding group taken on 12th November, and described above, was 105mm., while here, 43 days later, it is above 14mm. higher. The amount is too much to be accounted for by increment of growth in the interval; and the explanation is probably to be found in the fact that the collections belong to different years (1900 and 1903) there being, doubtless, as with other fishes, a variation in the growth in different years.

Only a few belong to the second series (represented in Aberdeen Bay in the same month), viz., 172, ranging from 145mm. to 178mm.

A third group is better indicated by 41 herrings from 182mm. to 217mm., the modal size being about 196mm., and the average 190·8mm., or a little over 7 inches.

On 25th December, 1901, a collection of 87 herrings was obtained at Burghead Bay, in from $7\frac{1}{2}$ to 18 fathoms. Two series were present, the first consisting of 19 fish, ranging from 139mm. to 183mm. ($5\frac{1}{2}$ to $7\frac{3}{16}$ inches) the mean being 161mm., and the average 162·4mm., or $6\frac{3}{8}$ inches. These are apparently autumn herrings over three years of age.

The second series consisted of 68 fish, ranging from 186mm. to 223mm. ($7\frac{5}{16}$ to $8\frac{3}{4}$ inches); the modal size was about 198mm., the mean 204·5mm., and the average 201mm., or $7\frac{15}{16}$ inches. These also were autumn herrings over four years of age.

The numbers are not large, but comparison of the sizes of the two groups shows an increment in the year of 39·6mm., or a little over $1\frac{1}{2}$ inches.

On 1st April, 1904, off Findhorn, in the same neighbourhood, 497 herrings were obtained, the depth of the water in this case being from 30 to 32 fathoms. They were the largest herrings got in any of the collections by means of the otter-trawl. (Plate XVIII.)

Eleven of them belonged to one series, and ranged from 123mm. to 169mm., the mean size being 143mm., and the average computed 150·8mm., or about $5\frac{15}{16}$ inches.

The next group consisted of 478 herrings, ranging from 177mm. to 228mm. (7 to 9 inches), but the series might stop about 223mm. The modal size was about 200mm., the mean was 202·5mm , and the computed average was 203·2mm. These herringe were therefore about 8 inches long, and they were spring herrings, as their position in the synthetic table shows, a little over four years of age.

Another collection from the Moray Firth was obtained in the Cromarty Firth on 1st June 1901, and of the 70 taken, 66 measured from 111mm. to 155mm. ($4\frac{3}{8}$ to $6\frac{1}{8}$ inches); the mode was 135mm. ($5\frac{5}{16}$ inches), the mean was 133mm., and the computed average 129·7mm. or $5\frac{1}{8}$ inches.

These were autumn herrings approaching their third year of age.

The next largest herrings measured by me consisted of a "cran" of spring herrings, caught by drift-net, in the ordinary way, on 16th February 1904, in the neighbourhood of the Isle of May, at the mouth of the Firth of Forth, and landed at Anstruther. They were actually spawning, and it was thus a simple matter to separate the sexes and measure them apart, a task in which Mr. William Keir, the Fishery Officer of the district, was good enough to assist me. The measurements will be found in Table III., and the curves on Plate XIX.

A glance at the peculiar curve is enough to show that the herrings do not form a homogeneous group. The range is too great for one series, viz., over 70mm. ($2\frac{3}{4}$ inches); the oblique line on the synthetic chart connecting the extreme limits of the spring herrings of various ages, when prolonged, goes through the middle of the collective measurements; and consideration of the millimetre table and the curves shows that two groups are present. The males and females were measured separately in two lots each, or four in all, and when curves are made of these separate measurements, they all agree in having two cusps, or modes, with a depression at about 25cm. The following Table shows the grouping in each of the four measurements, in ·5cm., and also the arrangement of the 2mm. grouping at the critical place:—

[TABLE.

CENTIMETRES.

	21·5	22	22·5	23	23·5	24	24·5	25	25·5	26	26·5	27	27·5	28	28·5	29	29·5	30	30·5
Males, I.	1	2	9	25	35	24	23	32	35	40	35	14	7	5	5	1	–	1	–
,, II.	–	1	12	20	35	28	32	23	36	27	19	14	7	1	1	–	–	–	–
Total, –	1	3	21	45	70	52	55	55	71	67	54	28	14	6	6	1	–	1	–
Females, I.	–	–	11	19	27	32	34	29	42	34	31	15	9	2	2	3	–	1	–
,, II.	–	–	4	12	25	23	21	19	23	21	14	8	7	2	2	–	–	–	1
Total, –	–	–	15	31	52	55	55	48	65	55	45	23	16	4	4	3	–	1	1

MILLIMETRES.

	235–6	237–8	239–40	241–2	243–4	245–6	247–8	249–50	251–2	253–4	255–6	257–8
Males, I.	14	16	10	11	8	11	9	8	9	18	13	16
,, II.	14	15	13	12	9	15	14	7	8	11	14	16
	28	31	23	23	17	26	23	15	17	29	27	32
Females, I.	10	13	10	10	16	17	14	7	11	14	16	20
,, II.	8	11	10	10	9	9	9	6	5	11	10	9
	18	24	20	20	25	26	23	13	16	25	26	29
Total, –	46	55	43	43	42	52	46	28	33	54	53	61

The younger herrings show the following:—The females, 215 in number, extend from 225mm. to 250mm. ($8\frac{7}{8}$ to $9\frac{7}{8}$ inches), viz., to the point where fusion takes place with the older group; but if the curve is continued into the second group, as it ought to be to give the true limit, then herrings of this series will extend to about 26·5cm., or $10\frac{3}{8}$ inches—perhaps more. The modal size is 24·25cm., according to the ·5cm. arrangement of the measurements; according to the millimetre table it is at 244mm. ($9\frac{5}{8}$ inches); the mean size is 237·5mm., or on the extension of the series to 26·5cm., it is 245mm., and the computed average is 239·9mm., or nearly $9\frac{1}{2}$ inches.

The males number 256, ranging from 218mm. to 250mm ($8\frac{5}{8}$ to $9\frac{7}{8}$ inches, or further, as described for the females); the mode is 23·5cm., according to the ·5cm. arrangement, and according to the millimetre table 237mm. ($9\frac{3}{8}$ inches); the mean is 234mm., or, if the group is extended, 241·5mm. ($9\frac{1}{2}$ inches), and the computed average is 236·7mm., or $9\frac{5}{16}$ inches.

The figures for the two sexes grouped together are 471 herrings, ranging from 218mm. to probably 26·5cm. ($8\frac{5}{8}$ to $10\frac{3}{8}$ inches), a range of 47mm. The modal size is 238mm. ($9\frac{3}{8}$ inches), and the average 237·7mm., or the same.

These spring herrings are five years of age, and they appear to be the first annual series which attains maturity.

The second group of herrings comprised 248 females and 282 males. The beginning of the series is where the fusion with the younger series occurs, at 251mm., but it probably extends back to about 23·5cm. ($9\frac{1}{4}$ inches), judging from the form of the curve. The place where it ends is not so immediately clear. The following shows the arrangement in 2mm. groups:—

	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300	302	304	306	308
Female,	11	7	11	5	5	2	1	2	2	–	2	1	–	–	–	1	–	1	–	–
Male, -	14	11	7	8	3	2	2	4	4	–	1	–	–	–	–	–	–	1	–	–
	25	18	18	13	8	4	3	6	6	–	3	1	–	–	–	1	–	2	–	

And the measurements under the millimetres are these:—

	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291
Female,	3	2	4	1	2	1	–	1	–	2	1	1	–	–	2	–
Male, -	3	5	2	2	1	1	–	2	2	2	2	2	–	–	1	–
	6	7	6	3	3	2	–	3	2	4	3	3	–	–	3	–

It appears from this that the group terminates at 281mm. ($11\frac{1}{16}$ inches), the rest of the herrings belonging to, at least, one older group. The modal size is 257mm. ($10\frac{1}{8}$ inches), the mean is 266mm. (or 261mm. on the extension of the group back to 240mm.), and the average as computed is 262·1mm. ($10\frac{5}{16}$ inches).

The males begin and end like the females, have exactly the same modal size, while the computed size is 261mm.

The group comprising both sexes contains 530 herrings, with the same range, modes, and means, the computed average size being 261·5mm. These herrings are six years of age.

The rest of the herrings numbered 10 females and 12 males; the former ranged in size from 283mm. to 305mm. ($11\frac{1}{8}$ to 12 inches), and the latter practically the same, 283mm. to 304mm. These herrings are seven years old, and although the range of size shown is only 22mm. and 21mm., it is probable, judging from the 2mm. table given above, that the three herrings at about twelve inches (300mm., 304mm., 305mm.) are at least a year older still. Growth in length, as is well known, is much retarded when the fish attain to maturity and afterwards, as is shown, indeed, by comparing the modal sizes of the two series under discussion, the growth indicated in a year being only about 19mm. ($\frac{3}{4}$ inch).

It will be noticed that in both series the males are more numerous than the females, and that, while in the second or older series the size of the males and females is the same, the males in the first group are appreciably smaller than the females. In both lots of males of this series measured, the mode in the ·5cm. curves is at 23·5cm.; in the older group one of the modes is at 25·5cm.; and the other at 26cm. When all the males are considered together, the mode in the ·5cm. curve is at 23·5cm. in the younger group and at 25·5cm. in the older group. In the two lots of females, the cusp in one case in the younger group was at 23·5cm., and in the other at 24·5cm.; in the older group both the cusps or modes were at 25·5cm.

There was thus a greater number of small males than of small females in the younger series, but this does not necessarily denote that the male reaches maturity at a smaller size than the female.

In March, another lot of these spring herrings from the Forth were measured. They were forwarded to the laboratory, and placed in weak formaline solution for a time; they were measured by the laboratory attendant, who also determined the sexes in most of them by opening the fish; doubtful cases were determined by myself.

The herrings numbered 1155, of which 514 were females and 641 were males. Most of them were spawning, but 40 females and 43 males were spent. The herrings as a whole were smaller than those got in February. Whether this was due to any extent to their having been soaking in weak formaline solution is doubtful; my experience with other fishes is that they do not appreciably diminish in length under such circumstances. The fact that they were measured by another person has to be kept in view, but, making all due allowances, I think it may be assumed that these herrings were on the whole smaller than those in the previous month.

The table of measurements and the curve (Plate XIX.) show that the bulk of the herrings was composed of two annual series, but it is not very clear where the division occurs in this case. Theoretically, it should be about 24·5cm., and a consideration of the curves and tables suggests that it should be placed at 244mm.; but the division is somewhat arbitrary. The separate curves for the sexes does not help much, except in the case of the males, where there are cusps or modes at 23cm. and 25cm., the depression being at 24cm.

To this series belong 256 females and 319 males. Both have a similar range, from 211mm. to 244mm. (but the latter is no doubt greater, and possibly goes to over 25cm.); the modal size for each may be put at 23·5cm. ($9\frac{1}{4}$ inches); the means are 227·5mm. (or, if the series is extended to 254mm.—a centimetre more—it is 232·5mm.); the computed average sizes are, for females 232·8mm., and for the males 232·2mm.

Combining both sexes, the group of 575 herrings have the same range as above, the same modes and means, and the avarage size is 232·5mm., or $9\frac{3}{16}$ inches.

The second series of herrings begins about 245mm., or, if extended for 1cm. backwards, at 235mm. ($9\frac{1}{4}$ inches). Where it ends is not so clear. The 2mm. grouping is as follows:—

267	269	271	273	275	277	279	281	283	285	287	289	291
18	14	13	12	5	4	2	2	1	–	2	1	–

and the millimetre measurements are:—

271	272	273	274	275	276	277	278	279	280	281	282	283	284	285
8	8	4	2	3	2	2	1	1	1	1	–	1	–	–

It might end at 281mm., or 274mm., or at 277mm., and I take the latter ($10\frac{15}{16}$ inches).

To this group belong 252 females and 317 males. Both have the same range, 245mm. (or 235mm.) to 277mm.; the modal size is about 25cm. ($9\frac{7}{8}$ inches); the means are 261mm. (or 256mm.); and the computed averages are, for the males 252·7mm. (almost 10 inches), and for the females 254·1mm. (10 inches). The group of 569 herrings has the same range, mode, and mean as described, and the computed average is 253·5mm.

The difference between the first and the second series in the March herrings (on the averages) is, for females 21·3mm., for males 19·9mm., and for the series combined 21·0mm.

There were other eleven herrings of larger size in the collection, viz., six females, measuring 281mm., 283mm., 287mm., 288mm., 324mm., and 325mm.; and five males, measuring 278mm., 279mm., 280mm., 287mm., and 304mm.

These obviously belong to different annual series. It is very probable that the herring at 304mm. represents an older group than those smaller, while the two large females ($12\frac{3}{4}$ inches) must be some years older.

With regard to the spent herrings, it may be noted that 13 females and 8 males belonged to the first series, and 24 females and 35 males to the second series. The two large females were spent and another at 288mm. The grouping of the spent fish in ·5cm. is as follows:—

	21·5	22	·5	23	·5	24	·5	25	·5	26	·5	27	·5	28	·5	29	·5	30	·5	31	·5	32	·5
Males,	1	–	1	2	5	4	5	4	8	4	1	2	–	–	1	–	–	–	–	–	–	1	1
Females,	–	–	–	5	2	1	7	13	7	1	3	3	1	–	–	–	–	–	–	–	–	–	–
	1	–	1	7	7	5	12	17	15	5	4	5	1	–	1	–	–	–	–	–	–	1	1

8. Conclusions.

It is evident from the above account that the herring grows slowly, and that those authors who supposed that it might reach the mature condition in a year or eighteen months were very wide of the mark.

At the end of the year in which it was born, that is to say, in December, the spring herring rarely exceeds 50mm. (2 inches), and the great majority are much smaller; at the same period, the autumn herring may be as small as 14mm. (a little over ½ an inch), and is rarely over 1⅜ inches, or 35mm. This difference between the spring and autumn herring, it may be said, persists throughout. There is nothing to indicate that the rate of growth is greater in one than in the other, an interval of about 1·5cm.-2cm., or a little more, separating the mean sizes of the two classes at the same date. This is what might be expected, since an interval of five or six months intervenes between the spawning periods, and the difference in size between the spring and autumn herrings thus represents about half the amount of the growth in a year.

While both autumn and spring herrings are included in the collections with which I have dealt in this paper, those of the latter are the most complete; and I have set forth on the accompanying table the particulars regarding a number of the collections in order to show, in collective fashion, the rate of growth and the age at different sizes. Though these collections belong to different years and to various localities (but all on the east coast of Scotland), it will be seen that there is a very considerable uniformity of results.

The monthly rate and the annual rate of growth, it may be said, are calculated from a larger number of decimals than the rate per day, and the age is computed from the middle of March. It will be observed that the growth in the summer months is much more rapid than in the colder part of the year; and the mean annual rate of growth in the four best cases, where the period is long and the numbers of herrings considerable, is 43·4mm., or about 1¾ inches. If the rate between January and May is included (49·6) the mean rate is 44·6mm.

[Table.

Date.	Place.	No. of Herrings.	Range in Size.	Mode, or Size of Greatest Frequency.		Probable Approximate Age.		Increase in Interval.	No of Days from Previous Entry.	Rate of Increase.		
										Per Day.	Per Month.	Per Year.
			Mm.	Mm.	Inches.	Yrs.	Mos.	Mm.		Mm.	Mm.	Mm.
April,	Various,	–	6–17	–	–	–	1	–	–	–	–	–
June,	Various,	–	13–26	(19·5)	$\frac{3}{4}$	–	3	–	–	–	–	–
18th, 20th September 1900,	Aberdeen Bay,	194	21–44	32·5	$1\frac{1}{4}$	–	6	13	(90)	·144	4·39	–
12th December 1903,	Aberdeen Bay,	15	(42)–50	45	$1\frac{3}{4}$	–	9	13·5	85	·159	4·83	–
19th, 20th January,	St. Andrews Bay,	11	42–56	48	$1\frac{7}{8}$	–	10	3·0	38	·079	2·40	–
*6th February 1892,	Firth of Forth,	240	45–(69)	(57)	$2\frac{1}{4}$	–	$10\frac{1}{2}$	(9·0)	18	(·500)	(6·0)	–
*29th April 1890,	Firth of Forth,	786	45–(76)	(60·5)	$2\frac{3}{8}$	1	–	(3·5)	82	(·043)	1·29)	–
9th-13th May 1901,	Firth of Forth,	277	94–139	113	$4\frac{7}{16}$	2	$1\frac{1}{2}$	†65	477	·136	4·14	49·6
18th December 1900,	Aberdeen Bay,	405	114–161	141	$5\frac{9}{16}$	2	9	28	218	·128	3·90	46·8
30th May 1901,	Aberdeen Bay,	598	142–186	159	$6\frac{1}{4}$	3	$2\frac{1}{2}$	18	164	·109	3·33	40·0
28th June 1901,	Lunan Bay,	650	148–192	167	$6\frac{5}{8}$	3	$3\frac{1}{2}$	8	29	·276	8·38	100·6
1st April 1904,	Off Findhorn (Moray Firth)	478	177–228	200	$7\frac{7}{8}$	4	$0\frac{1}{2}$	33	276	·120	3·63	43·6
16th February 1904,	Firth of Forth,	471	218–250 (265)	238	$9\frac{3}{8}$	4 (5)	11	38	321	·118	3·60	43·2
16th February 1904,	Firth of Forth,	530	251–281 (240)	257	$10\frac{1}{8}$	5 (6)	11	19	365	·052	1·58	19·0

* *Garland's* collections transferred from inches to millimetres. † The calculation is from January.

Growth in length, however, as with most fishes, is somewhat more rapid in the early stages, and diminishes with age, at first very slowly, and then on the occurrence of sexual maturity with great and marked rapidity.

The following gives the main features of the growth of the herring, according to this investigation :—

Approximate Age.	Length.		Increase in Length from Previous Year.	
	Mm.	Inches.	Mm.	Inches.
1 Year, ...	60·5	$2\frac{3}{8}$	–	–
2 Years, ...	113	$4\frac{7}{16}$	52	$2\frac{1}{16}$
3 ,, ...	159	$6\frac{1}{4}$	47	$1\frac{7}{8}$
4 ,, ...	200	$7\frac{7}{8}$	41	$1\frac{5}{8}$
5 ,, ...	238	$9\frac{3}{8}$	38	$1\frac{1}{2}$
6 ,, ...	257	$10\frac{1}{8}$	19	$\frac{3}{4}$

The herring, both male and female, appears to attain the mature condition, and to reproduce for the first time, when it is five years of age.

If the same rate of growth as is indicated above between the fifth and sixth years be assumed to continue during the next few years, the approximate average sizes of older herrings would be as follows:—7 years, 276mm. ($10\frac{7}{8}$ inches); 8 years, 295mm. ($11\frac{5}{8}$ inches); 9 years, 314mm. ($12\frac{3}{8}$ inches); 10 years, 333mm. ($13\frac{1}{8}$ inches). It is certain, however, that the growth in the later series of larger herrings is not nearly so rapid as this, and herrings over 12 inches are probably more than ten years old. The larger herrings of 13 to 15 inches, such as are referred to on a former page, must be very old; the latter probably from fifteen to twenty years.

It may be of interest now to compare briefly the results as stated above and those obtained by Jenkins and Masterman. The research of the former, as previously mentioned, was made on the otoliths of spring herrings of the Baltic, and the precise age could not, therefore, be determined with certainty, not within several months. The research of Masterman was on both spring and autumn herrings at St. Andrews, but was confined to specimens taken in tow-nets—to larval and post-larval forms, and to small numbers of young herrings obtained in the same way—and so far as his research was carried it agrees well with my own. He did not attempt to deal with the growth of the older series of herrings, except in a few cases, but made certain calculations as to the rate of growth per month. In the following Table I give a summary of the results of Jenkins (as amended by the intercalation of a year, so as to make his annual series a year older than he represents them), and also of the results of Masterman on the spring herring, as far as they go, and the approximate sizes of the older series as calculated on the basis he gives, viz., a growth of from 4mm. to 5mm. per month. The latter is quite accurate for the early stages, but it is rather wide of the mark for the older herrings, owing to the diminution of the rate of growth with age that actually takes place.

Year of Age.	I.			II.		III.			
	Year.	Range.	Mean.	Mean.	Range.	Observed.	Computed.		
							Min.	Max.	Mean.
1	...	...	...	60·5	45–76	62	...	...	...
2	(1)	113–121	117	113	94–139	112	110	122	116
3	(2)	156–164	160	159	142–186	...	158	170	164
4	(3)	190–198	194	200	177–228	...	206	218	212
5	(4)	217–225	229	238	218–265	...	254	266	260
6	(5)	237–245	241	257	240–257	...	302	314	308

Column I. shows Jenkins' results, Column II. shows my own results, and Column III. shows the results obtained by Masterman, and the size at the later stages, computed at the mean rate of increase of 4mm. to 5mm. It will be observed that my results and those of Jenkins agree remarkably well, when a year is added to the age he assigns to his various series.

In the later work of Masterman and M'Intosh (17*a*) it is suggested that 3 inches (76mm.) and 5 inches (127mm.) represent a rough average of the size of the herring when one year and two years of age respectively; and that sexual maturity is attained when it is between 8 and 9 inches (203–228mm.) in length and probably three years of age. This, however, involves a more rapid growth than the facts warrant, and is not consistent with the results of Masterman's own earlier paper.

The earlier authors referred to at the beginning of this paper as a rule under-estimated the rate of growth of the herring. The most correct are those of Malm, Sars and Nilsson. It is interesting to observe that the estimate of the fishermen of Bohuslän, Sweden, as given by Nilsson, is accurate; and that the estimates of the Scottish fishermen (three or seven years) was much nearer the truth than those of the naturalists.

The elucidation of this question of the growth of the herring has an important bearing on several fishery problems. Compared with most fishes caught by lines or trawls, it is clear that the herring, caught by drift-nets, has a great advantage, inasmuch as no immature herrings are caught in this way, no less than four generations of undersized or immature herrings escaping through the meshes.

It may also help to explain such problems as the presence every summer for a period of years of large herrings in the deep water of Upper Lochfyne, and their absence for a period of years. It is quite possible that these herrings belong to one and the same shoal, which has accustomed itself to the route of migration and the locality, and which is ultimately fished out or destroyed. It may also serve to explain the presence in the loch of small herrings in autumn and winter without supposing that they were spawned there. Such little herrings are one year old and more, and could therefore easily make their way into the loch from the spawning grounds in the outer part of the Clyde.

LITERATURE.

1. Huxley, T. H.—"Report of the Royal Commission on the Operation of the Acts relating to Trawling for Herring on the Coasts of Scotland." 1863, p. 27.

1a. ——.—"Nature." XXXI. 1881, p. 607.

2. Mitchell, J. M. "The Herring: Its Natural History and National Importance." 1864.

3. Yarrell, W.—"A History of British Fishes." 1859.

4. De Caux.—"The Herring and the Herring Fishery." 1881, p. 50.

5. Sim, G.—"The Natural History of the Herring." 1883, p. 46.

6. Ljungmann, A. V.—"Om sillens och skarpsillens fortplantning och tillväxt." 1879. Nordisk Tidsskrift for Fiskeri. V. 193.

6a. ——. —"Bidrag till kännedomen om sillens lefnadsförhallanden." 1880.

7. Widegren, H.—"Nagra ord om sillfiske samt om sillens eller Strömmingens rätta beredning till handelsvara." Tidsskrift for Fiskeri, 6 Aarg., X., 1871.

8. Boeck, A.—"Om Silden og Sildefiskerierne," p. 13.

9. Sundevall, C. J.—"Stockholms läns K. Hush. Sällsk. Handl." VI., p. 105.

10. Ekstrom, C. U.—"Praktisk Afhandling," p. 10.

10a. ——.—"Danmarks Fiske," III., pp. 170, 171.

11. Nilsson, S.—"Handlingar rörande Sillfisket," p. 45.

12. Sars, G. O.—"Indberetning til Departementet for det Indre," 1870–73, pp. 38, 39.

13. Malm, A. W.—"Göteborgs och Bohusläns Fauna." 1877, p. 581.

14. Hoek, P. P. C.—"The Fishes of the Zuiderzee" (Tijdschrift der Nederlandsche Dierkundige Vereeniging (2), III. Afl. I. 1890).

14a. ——.—"Bericht über die Fischerei mit Steerthamen." (*Ibid.* Suppl. Deel II. 1888).

15. Meyer, H. A.—"Biologische Beobachtungen bei künstlicher Aufzucht des Herings der westlichen Ostsee." 1878.

15a. ——.—"Beobachtungen uber das Wachstum des Herings im westlichen Teile der Ostsee" (Jahresbericht der Komm. z. wiss. Untersuch. der deutschen Meere in Kiel, 1878, 227).

16. Jenkins, J. T.—"Altersbestimmung durch Otolithen bei den Clupeiden." (*Ibid.* Neue Folge, 6th Bd. Abtheil., Kiel., p. 83). 1902.

17. Masterman, A. T.—*Fourteenth Annual Report, Fishery Board for Scotland,* Part III., p. 294. 1896.

17a. M'Intosh and Masterman.—"British Marine Food Fishes," pp. 420, 422 (1897).

18. Cunningham, J. T.—"Marketable Marine Fishes of the British Islands," p. 162.

19. Matthews, J. D.—*Fourth Annual Report, Fishery Board for Scotland,* 1886.

19a. ——.—*Fifth, ibid.*, 1887.

20. Brook, G.—*Fourth, ibid.*, p. 48.

21. Murie, J.—"Kent and Essex Sea Fisheries Committee—Report on the Sea Fisheries, &c., of the Thames Estuary." 1903.

22. Lundberg, R.—"Bidrag till kännedomen om Strömmingen i Stockholmskärgard." 1875.

23. Trybom, —.—"Iakttagelser vid Sillfisket i Bohuslän." 1883.

23a. ——.—"Sillundersökningar vid Sveriges Vestkust." 1889.

24. "Verslag van den Staat der Nederlandsche Zeevisscherijen over 1863," p. 15.

25. M'Intosh, W. C.—"*Seventh–Twelfth Reports of the Fishery Board for Scotland,* Part III.

26. Murray, G.—*Fifteenth Annual Report of the Fishery Board for Scotland,* Part III.

EXPLANATION OF PLATES XVII.-XIX.

The diagrams shown on the plates represent the measurements of the various collections of herrings dealt with, the measurements being shown in ·5cm. groups.

TABLE I.—ABERDEEN BAY.

Cm.	Feb.	Mar.	Apr.	May	June.				July	Aug.*	Sept.	October.			November.			December.						
	11, 1905	29, 1905	24, 1906	30, 1901	19, 1902	– 1904	13, 1903	28, 1901	5, 1901	21-22, 1901	18-20, 1900	3, 1901	18, 1901	31, 1900	6, 1903	6, 1901	9, 1900	23, 1903	– 1900	12, 1903	18, 1900	17, 1901	19, 1900	29, 1903
1	–	–	–	–	–	3	–	–	–	19	–	1	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	3	–	82	–	–	10	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–	6	216	–	–	112	–	–	2	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	26	33	–	–	58	–	–	1	–	–	–	–	–	–
3	–	–	–	–	–	–	–	–	–	–	66	2	–	–	1	–	–	2	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	65	–	–	–	–	–	–	1	–	–	–	–	–	–
	–	–	130	–	–	–	–	–	–	–	31	–	–	–	–	–	–	–	–	4	–	–	–	–
·5	–	–	27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10	–	–	–	–
	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–
·5	–	–	–	–	×	18	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	×	5	–	–	–	–	–	–	–	48	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	×	–	–	–	–	–	–	–	–	104	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	–	–	–	–	–	–	–	–	–	113	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	92	–	–	1	–	–	–	–	–	1	–
8	–	–	–	–	–	–	–	–	–	–	–	–	–	122	–	–	1	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	1	94	–	1	1	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–	–	–	–	–	–	70	–	1	–	–	–	–	–	–	3	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	5	43	–	1	–	–	–	1	–	–	2	–
10	1	–	–	–	–	–	–	–	–	–	–	–	17	54	–	4	1	–	–	1	–	1	–	–
·5	1	–	–	–	–	–	–	–	–	–	–	–	54	43	–	6	–	–	–	1	1	4	–	1
11	–	–	–	–	–	–	–	–	–	–	–	–	103	22	–	9	–	–	–	2	4	5	1	1
·5	1	–	–	–	–	–	1	–	–	–	–	–	105	12	–	3	2	–	–	–	10	10	2	2
12	–	–	–	–	–	–	12	–	–	–	–	–	57	2	–	2	2	–	–	1	32	12	1	3
·5	–	1	–	–	–	–	42	–	–	–	–	–	42	1	–	–	2	–	1	–	39	5	–	3
13	–	–	–	–	–	–	72	–	–	–	–	–	29	3	2	1	3	–	1	–	56	4	1	1
·5	–	–	–	–	–	–	103	–	–	–	–	–	15	2	2	–	4	–	–	–	72	4	–	1
14	–	–	–	2	–	–	96	–	3	–	–	–	6	2	2	–	5	–	1	–	89	–	–	2
·5	–	–	–	12	–	–	75	2	2	–	–	–	1	–	–	–	–	–	–	–	69	2	–	1
15	–	–	–	46	–	–	54	10	1	–	–	–	2	–	–	–	–	–	1	–	25	–	–	1
·5	–	–	–	165	–	–	49	41	1	–	–	–	1	1	–	–	–	–	–	–	8	1	–	–
16	–	–	–	176	–	–	25	96	1	–	–	–	1	–	–	–	–	–	1	–	4	–	–	–
·5	–	1	–	122	–	–	13	200	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
17	–	1	–	53	–	–	9	173	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	18	–	–	1	93	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–
18	–	–	–	3	–	–	1	28	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	1	–	–	–	6	–	–	–	–	2	–	2	–	–	–	–	–	–	–	–	–
19	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	3	4	157	601	–	24	557	650	8	22	194	334	444	830	189	28	22	6	5	21	410	47	10	16

* 10 miles off.

TABLE II.—MORAY FIRTH.

Cm.	Dornoch Firth.													Burghead Bay.				Findhorn.	Cromarty Firth.	
	Feb.	Mar.	Oct.	November.						December.				December.				April.	Jan.	June.
	9, 1905	31, 1904	21, 1903	– 1903	5, 1900	6, 1900	11, 1903	12, 1903	11-12, cmb	26, 1903	7, 1904	25, 1900	28, 1903	6-7, 1904	25, 1901	29, 1903	28, 1903	1, 1904	10, 1901	1, 1901
																	*	†		
1	–	–	2	3	–	–	4	–	–	1	–	–	–	–	–	–	–	–	–	–
·5	–	–	25	74	–	–	25	–	–	18	–	–	–	–	–	16	–	–	–	–
2	–	–	1	77	–	–	18	–	–	17	–	–	–	–	–	17	–	–	–	–
·5	–	–	–	2	–	–	1	–	–	9	–	–	–	–	–	13	–	–	–	–
3	–	–	–	–	–	–	–	–	–	6	–	–	–	–	–	10	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–	–	–	x	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	x	–	1	1	2	–	–	–	–	–	–	–	–	–	–	–
8	–	–	–	–	6	2	6	7	13	–	–	–	–	–	–	–	1	–	–	–
·5	–	–	–	–	15	1	22	31	53	–	–	–	–	–	–	–	1	–	1	–
9	–	–	–	–	19	4	22	98	120	–	–	–	–	–	–	–	–	–	4	–
·5	–	–	–	–	13	1	23	216	239	–	–	3	–	–	–	–	1	–	5	–
10	–	–	–	–	20	–	12	257	269	–	–	9	–	–	–	–	2	–	2	1
·5	3	2	–	–	66	–	13	244	257	–	3	91	1	–	–	–	1	–	2	–
11	–	5	–	–	179	–	3	158	161	–	4	296	–	–	–	–	2	–	4	2
·5	3	3	–	–	157	1	6	116	122	–	1	411	–	–	–	–	1	–	1	6
12	2	2	–	–	70	–	2	63	65	–		343	1	1	–	–	1	1	6	8
·5	–	2	–	–	34	–	–	33	33	–		257	1	–	–	–	4	–	4	10
13	–	1	–	–	8	–	–	12	12	–	–	150	–	–	–	1	–	1	1	8
·5	–	1	–	–	4	–	–	6	6	–	–	112	–	1	1	1	–	–	–	12
14	–	–	–	–	2	1	–	4	4	–	–	97	1	–	1	1	–	1	2	9
·5	–	–	–	–	4	–	–	2	2	–	–	84	–	–	5	–	–	1	1	6
15	–	–	–	–	2	–	–	1	1	–	1	48	–	–	–	–	–	1	–	3
·5	–	–	–	–	–	1	–	–	–	–	–	25	–	–	1	–	–	2	–	2
16	–	–	–	–	2	–	–	2	2	–	–	9	–	1	1	–	–	3	–	1
·5	–	–	–	–	–	–	–	10	10	–	–	2	–	3	3	–	–	1	–	–
17	–	–	–	–	–	–	–	18	18	–	–	1	–	2	1	–	–	–	–	1
·5	–	–	–	–	–	–	–	16	16	–	–	3	–	2	3	–	–	2	–	–
18	–	–	–	–	–	–	–	15	15	–	–	6	–	–	3	–	–	9	–	–
·5	–	–	–	–	–	–	–	15	15	–	–	7	–	–	9	–	–	22	–	–
19	–	–	–	–	–	–	–	7	7	–	–	6	–	–	11	–	–	40	–	–
·5	–	–	–	–	–	–	–	4	4	–	–	9	–	–	17	–	–	63	–	1
20	–	–	–	–	x	1	–	–	–	–	–	5	–	–	13	–	–	108	–	–
·5	–	–	–	–	x	2	–	–	–	–	–	4	–	–	7	–	–	99	–	–
21	–	–	–	–	x	1	–	–	–	–	–	3	–	–	6	–	–	69	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	1	–	–	3	–	–	36	–	–
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	19	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11	–	–
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
	8	16	28	156	601	15	158	1336	1446	51	10	1982	4	10	87	59	14	497	33	70

* 30 Fathoms. † 30–32 Fathoms.

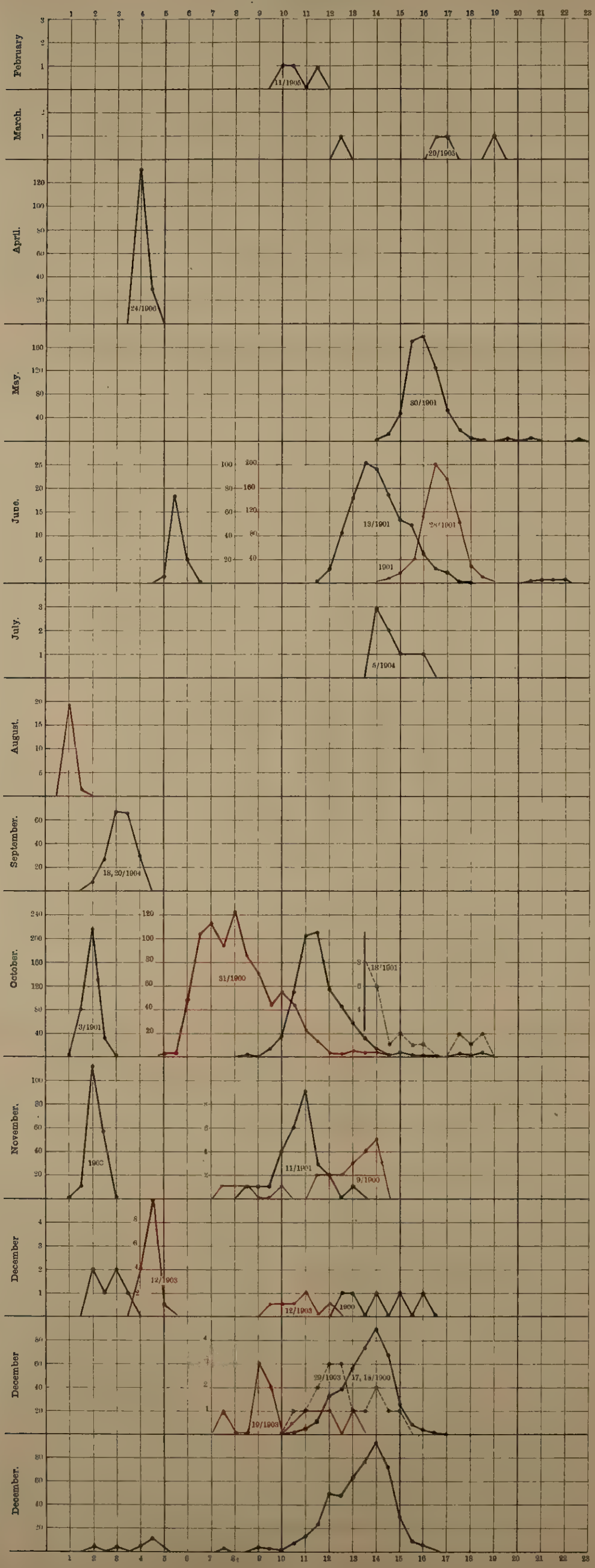
TABLE III.—FIRTH OF FORTH.

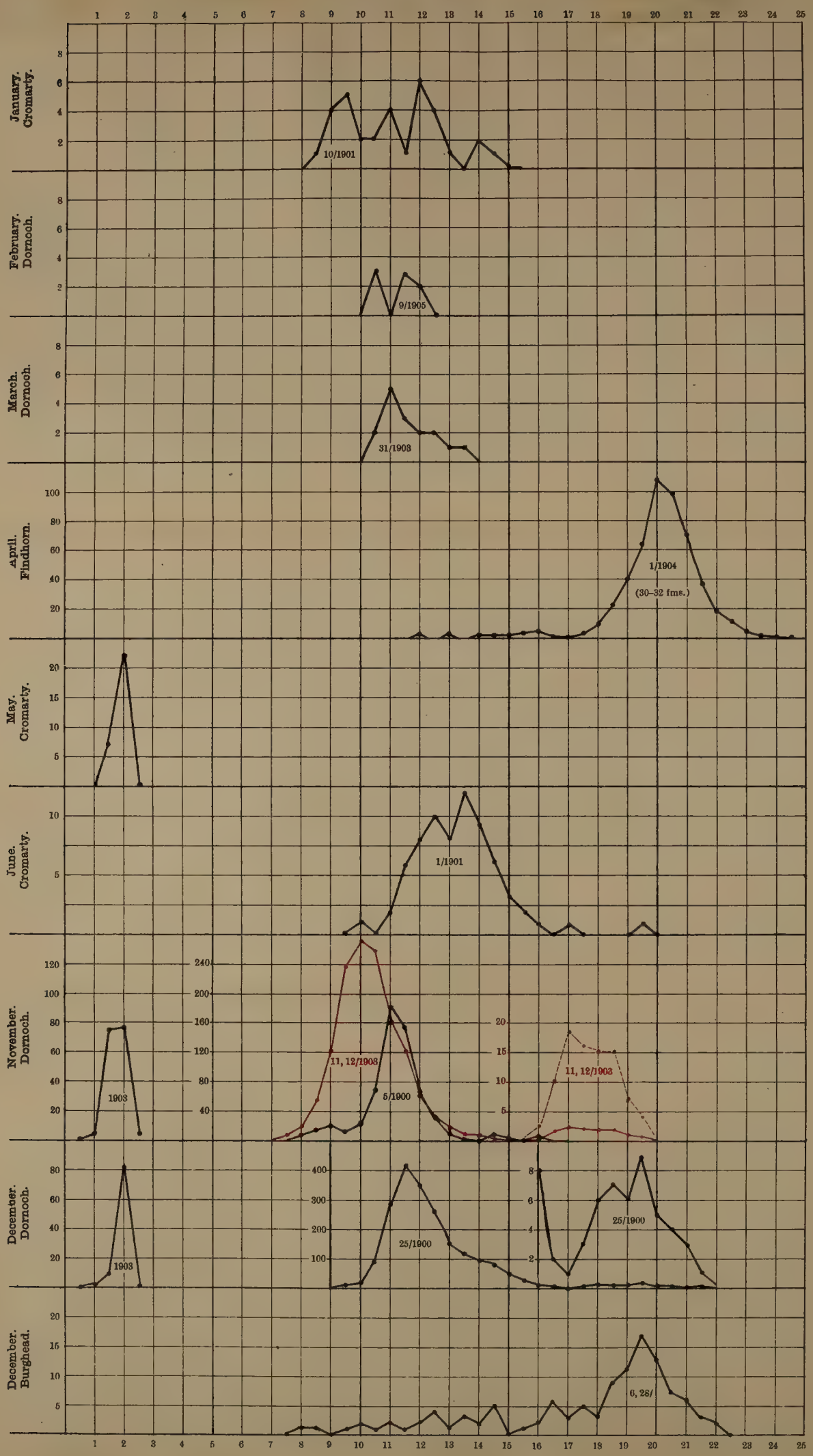
Cm.	February		Mar.	April.		May.		Aug.	Sept.	Oct.	Dec.	May.					July.	Sept.	February. 16, 1904.			March. 15, 1904.		
	17-21, 1890	6, 1892	17-22, 1890	26-29, 1890	20, 1892	9-15, 1889	7-9, 1890	5, 1891	3-5, 1889	10-19, 1889	9-10, 1892	9, 1901	10. 1901	13, 1901	9, 10, 13, com	28, 1901	23, 1901	4, 1901	Spawning.			Spawning and Spent.		
																			F.	M.	Tl.	F.	M.	Tl.
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	48	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	–	–	–			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–		–			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5	–		–				–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	240	–	788			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–		–		312		–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–					64	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	–	–					–	–		–	–	1	–	–	1	–	–	–	–	–	–	–	–	–
·5	2	–	345				–	–	2428	17	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8	–	–				–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	2	–		238	–	–	–	–		6	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	–	–	–		–	–	–	3		–	3	1	–	–	1	–	–	–	–	–	–	–	–	–
·5	–	–	–		–	–	–	–	–	–	–	5	–	3	8	–	–	–	–	–	–	–	–	–
10	6	–	43	–	–	44	2	–	–	6	–	20	–	11	31	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	3	–	–	–	2	5	26	–	26	52	–	1	–	–	–	–	–	–	–
11	–	–	37	–	–	–	6	–	–	16	–	43	–	32	75	–	–	–	–	–	–	–	–	–
·5	4	–	–	–	–	–	–	–	–	–	–	15	2	27	44	–	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	5	–	–	–	–	17	2	11	30	–	1	–	–	–	–	–	–	–
·5	5	–	14	10	–	80	–	–	–	–	1	14	2	3	19	–	2	–	–	–	–	–	–	–
13	–	–	2	–	–	–	–	–	–	–	–	7	2	1	10	–	2	–	–	–	–	–	–	–
·5	–	–	–	2	–	–	–	–	–	–	–	6	1	–	7	–	2	–	–	–	–	–	–	–
14	–	–	8	–	–	–	–	–	–	–	–	3	1	–	4	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	2	1	–	3	–	–	–	–	–	–	–	–	–
15	–	–	–	37	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–
19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

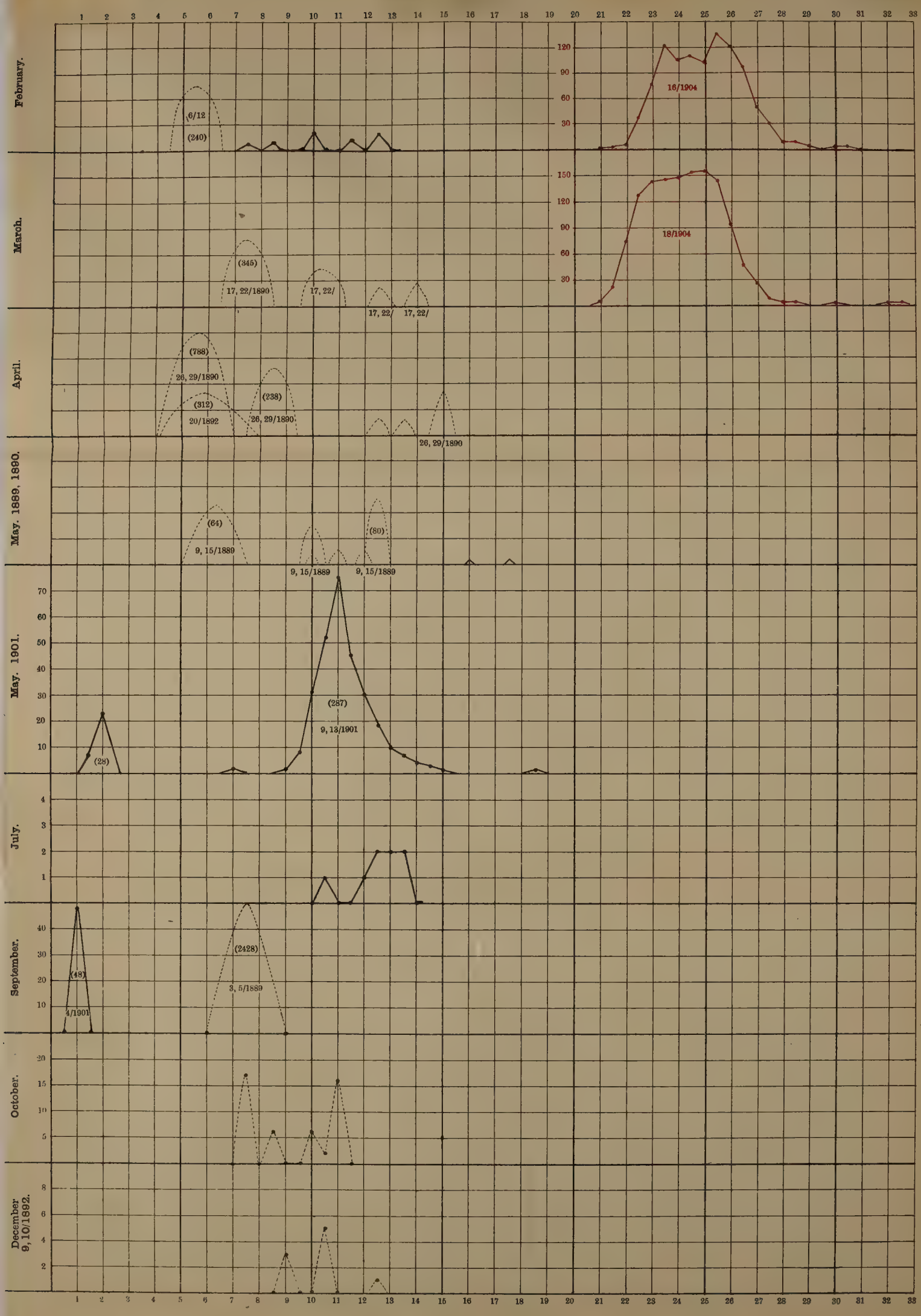
TABLE III.—FIRTH OF FORTH—*continued.*

Cm.	February		Mar.	April.		May.		Aug.	Sept.	Oct.	Dec.	May.					July.	Sept.	February, 16, 1904.			March, 15, 1904.		
	17-21, 1890	6, 1892	17-22, 1890	26-29, 1890	20, 1892	9-15, 1889	7-9, 1890	5, 1891	3-5, 1889	10-19, 1889	9-10, 1892	9, 1901	10, 1901	13, 1901	9, 10, 13, com	28, 1901	23, 1901	4, 1904	Spawning.			Spawning and Spent.		
																			F.	M.	Tl.	F.	M.	Tl.
21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	4
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	7	13	20
22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	3	32	40	72
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15	21	36	49	57	106
23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31	45	76	48	73	121
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	52	70	122	57	67	124
24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	55	52	107	62	66	128
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	55	55	110	61	72	133
25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	48	55	103	55	80	135
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	65	71	136	56	68	124
26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	55	67	122	39	54	93
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	45	54	99	24	25	49
27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23	28	51	13	15	28
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16	14	30	4	5	9
28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	6	10	2	1	3
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	6	10	2	1	3
29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	1	4	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	2	–	1	1
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–
31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
32	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
·5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
	19	240	449	1075	312	194	13	3	2428	47	9	161	12	114	287	31	8	48	473	550	1023	514	641	1155

Herring. I. Aberdeen Bay.




January. Cromarty.
10/1901
February. Dornoch.
9/1905
March. Dornoch.
31/1903
April. Findhorn.
1/1904
(30–32 fms.)
May. Cromarty.
June. Cromarty.
1/1901
November. Dornoch.
1903
11, 12/1903
5/1900
11, 12/1903
December. Dornoch.
1903
25/1900
25/1900
December. Burghead.
6, 28/


February.
6/12
(240)
16/1904
March.
(345)
17, 22/1890
17, 22/
17, 22/
17, 22/
18/1904
April.
(788)
26, 29/1890
(312)
20/1892
(238)
26, 29/1890
26, 29/1890
May. 1889, 1890.
(64)
9, 15/1889
(80)
9, 15/1889
9, 15/1889
May. 1901.
(28)
(287)
9, 13/1901
July.
September.
(48)
4/1901
(2428)
3, 5/1889
October.
December 9, 10/1892.

INDEX.

ABERDEEN Bay: Trawling investigations in, 25.
Acartia bifilosa, 277.
Age of Herring, 293.
—— Brill at maturity, 209.
—— Herring at maturity, 332, 336.
—— Lemon Dab at maturity, 196.
—— Turbot at maturity, 203.
Ameira longicaudata, 277.
Amphiascus Catherinæ, 275.
—— *minutus*, 275.
Angler (*Lophius piscatorius*): Otoliths of, 57.
Argentine (*Argentina sphyraena*): Otoliths of, 76.

BALLAN Wrasse (*Labrus bergylta*): Otoliths of, 61.
Beatricella mimica, 277.
Bib: see Brassy.
Black Sole (*Solea vulgaris*): Otoliths of, 75.
Blue-mouth (*Scorpæna dactyloptera*): Otoliths of, 55.
Brassy (*Gadus luscus*): Otoliths of, 63.
—— Reproduction of, 130.
—— Ripe eggs of, 131.
—— Specific characters of, 116, 133.
Brill (*Rhombus lævis*): Age of, at maturity, 209.
—— Growth of, 203.
Butter-fish (*Pholis gunnellus*): Otoliths of, 59.

Canthocamptus parvus, 277.
Canuella perplexa, 277.
Cat-fish (*Anarrhichas lupus*): Otoliths of, 59.
Cletodes similis, 277.
Coal-fish (*Gadus virens*): Otoliths of, 65.
Cod (*Gadus callarias*): Otoliths of, 61.
—— Growth of, 209.
—— Growth of, at Iceland, 211.
—— Hermaphroditism in, 290.
Commercial trawlers: Employment of, 17.
Composition of Herring, 83.
—— of muscles and ovaries in Herrings, 99.
—— of muscles and testes in Herring, 100.
Conger (*Conger niger*): Otoliths of, 79.
Copepoda: Rare, from Scottish seas, 275.
Couch's Whiting (*Gadus poutassou*): Otoliths of, 64.
Cunningham, Mr. J. T., on growth of Herring, 298.

DAB, Common (*Pleuronectes limanda*): Otoliths of, 74.
—— Growth of, 189.
Dactylopusia brevicornis, 276, 277.
—— *finmarchicus*, 277.
—— *vulgaris*, 277.
Description of new fish-hatchery, 108.
Differences between male and female Lumpsuckers, 170.
Diosaccus propinquus, 278.
—— *tenuicornis*, 279.
Dragonet (*Callionymus lyra*): Otoliths of, 58.
—— Spotted (*Callionymus maculatus*): Otoliths of, 58.
Duration of embryonic development in the Herring, 303.

EARSTONES: see Otoliths.
Ectinosoma curticorne, 277.
Eel, Common (*Anguilla vulgaris*): Otoliths of, 79.
Eggs of Lumpsucker: Paternal guardianship of, 169.
Enhydrosoma incurvatum, 277.
Euryte longicauda, 277.

FAT: Utility of storage of, in fishes, 181.
Fish-hatchery: Description of, 108.
Fishes: Rate of growth of, 179.
—— Utility of storage of fat in, 181.
Fecundity of Plaice, 281.
Flounder (*Pleuronectes flesus*): Otoliths of, 73.
—— Growth of, 191.
Food value of Herring, 83.
Four-bearded Rockling (*Onos cimbrius*): Otoliths of, 67.

GADID species: Key to diagnosis of, 138.
Gadus esmarkii: see Norway Pout.
—— *luscus*: see Brassy.
—— *minutus*: see Poor-cod.
Goby, Black (*Gobius niger*): Otoliths of, 58.
—— Speckled (*Gobius minutus*): Otoliths of, 58.
Greater Fork-beard (*Phycis blennoides*): Otoliths of, 66.
—— Weaver (*Trachinus draco*): Otoliths of, 57.
Grey Gurnard (*Trigla gurnardus*): Otoliths of, 55.
—— Growth of, 232.
—— Relation of temperature to migrations of, 236.
Growth of fishes, 179.

Growth of fishes: A law of growth in relation to maturity, 182.
—— Influence of external conditions on, 181.
—— Influence of temperature upon, 182.
—— Modification of, in deeper parts of North Sea, 182.
—— of Brill, 203.
—— of Cod, 209.
—— of Cod at Iceland, 211.
—— of Common Dab, 189.
—— of Flounder, 191.
—— of Grey Gurnard, 232.
—— of Haddock, 226.
—— of Herring, 293.
—— of Herring: Various opinions on, 293, 294, 295.
—— of Herring, male and female, 332.
—— of Herring in larval and post-larval stages, 308.
—— of Herring: Conclusions as to, 334.
—— of Herring, spring and autumn, 334.
—— of Lemon Dab, 192.
—— of Long Rough Dab, 196.
—— of Plaice, 184.
—— of Turbot, 199.
—— of Whiting, 229.

Haddock (*Gadus æglefinus*): Otoliths of, 62.
—— Great catches of small, 29, 31.
—— Growth of, 226.
Hake (*Merlucius vulgaris*): Otoliths of, 66.
Halibut (*Hippoglossus vulgaris*): Otoliths of, 69.
Halicyclops æquoreus: 277.
Harpacticus obscurus: 277.
Hatchery, Bay of Nigg, Aberdeen: Report on operations at, 108.
Hatching of Plaice, 110.
—— of eggs of Lumpsucker, 177.
Helmsdale Herring: Chemical composition of, 93.
Hermaphroditism in Cod, 290.
Herring (*Clupea harengus*): Age of, at maturity, 332, 336.
—— A criticism of Dr. Meyer's observations on growth of, 303.
—— Chemical analyses of, 83.
—— Chemical composition of Helmsdale, 93.
—— Chemical composition of Lochboisdale, 95.
—— Chemical composition of Lochfyne, 86, 104.
—— Composition of muscles and ovaries in, 99.
—— Composition of muscles and testes, 100.
—— Conclusions as to growth of, 334.
—— Duration of embryonic development in, 303.
—— External differences from Sprat, 167.
—— Food value of, 83.
—— Growth and age of, 293.
—— Growth of, in larval and post-larval stages, 308.
—— Growth and age of, 293.
Herring, Growth of males and females, 332.
—— Growth of spring and autumn fish, 334.
—— Maximum size attained by, 301.
—— Notes on natural history of, 165.
—— Numbers taken in Sprat fishery, 161.
—— Nutritive value of, at different periods, 83.
—— Nutritive value of spent, 103.
—— Otoliths of, 77.
—— Proportions of sexes of, 332.
—— Relation of temperature to growth of, 306.
—— Relation of temperature to spawning periods of, 303.
—— Size of, at maturity, 299, 232.
—— Spawning periods of, 302.
—— Variation of fat in, 101.
—— Variation of fat in ovaries of, 102.
—— Variation of proteids in, 101.

Idya furcata, 277.
—— *gracilis*, 277.
—— *minor*, 278.
Immature fish caught by trawl, 29, 31.
Influence of external conditions on growth of fishes, 181.

Jago's Goldsinny (*Labrus rupestris*): Otoliths of, 61.
Jenkins, Dr. Travis, on growth of Herring, 298, 307.

Laophonte curticauda, 278.
—— *gracilis*, 278.
—— *hispida*, 278.
—— *inopinata*, 278.
—— *intermedia*, 278.
—— *littorale*, 278.
—— *longiremis*, 278.
—— *thoracica*, 278.
Lemon Dab (*Pleuronectes microcephalus*): Age at maturity, 196.
—— Growth of, 192.
—— Otoliths of, 73.
Lesser Fork-beard (*Raniceps raninus*): Otoliths of, 68.
—— Sand-eel (*Ammodytes tobianus*): Otoliths of, 69.
—— Weaver (*Trachinus vipera*): Otoliths of, 57.
Ling (*Molua molva*): Otoliths of, 67.
Lochboisdale Herring: Chemical composition of, 95.
Lochfyne Herring: Chemical composition of, 86, 104.
Longipedia scotti, 278.
Long Rough Dab (*Drepanopsetta platessoides*): Otoliths of, 69.
—— Growth of, 196.
Lumpsucker (*Cyclopterus lumpus*): Hatching of eggs of, 177
—— Habits of, 171.
—— Differences between males and females, 170.
—— Otoliths of, 59.

Lumpsucker, Paternal guardianship of the eggs of, 169.
—— Rivalry of males, 172.
—— Spawning of, 169.

MACKEREL (*Scomber scombrus*): Otoliths of, 57.
Marine fish-hatching: Report on, 108.
Masterman, Dr. A. T., on growth of Herring, 298, 308.
Maturity of fishes: Remarks on, 24.
Maturity: Size of Herring at, 299.
Maximum size attained by Herring, 301.
Megrim (*Lepidorhombus whiff*): Otoliths of, 71.
Meyer, Dr. H. A., on growth of Herring, 295.
Migrations of Grey Gurnard: Relation of, to temperature, 236.
Milroy, Professor T. H., on the food value of the Herring, 83.
Moray Firth: Trawling investigations in, 18, 27, 31, 34.
Muller's Top-knot (*Zeugopterus punctatus*): Otoliths of, 71.

Nannopus palustris, 278.
Norway Haddock (*Sebastes norvegicus*): Otoliths of, 54.
Norway Pout (*Gadus esmarkii*): Otoliths of, 64.
—— Maturity of, 131.
—— Specific characters of, 116, 134.
Notes on natural history of Herring, 165.
Notes on natural history of Sprat, 165.
Notes on new and rare copepoda, 275.
Nutritive value of spent Herring, 103.

OTOLITHS of Angler, 77.
—— of Argentine, 76.
—— of Ballan Wrasse, 61.
—— of Black Goby, 58.
—— of Black Sole, 75.
—— of Blue-mouth, 55.
—— of Brassy, 63.
—— of Brown Trout, 76.
—— of Cat-fish, 59.
—— of Cod, 61.
—— of Coal-fish, 65.
—— of Common Dab, 74.
—— of Common Sea-bream, 54.
—— of Conger, 79.
—— of Couch's Whiting, 64.
—— of Dragonet, 58.
—— of fishes: Observations on, 48.
—— of Flounder, 73.
—— of Greater Fork-beard, 66.
—— of Greater Weaver, 57.
—— of Grey Gurnard, 55.
—— of Halibut, 69.
—— of Haddock, 62.
—— of Herring, 77.
—— of Jago's Goldsinny, 61.
—— of Lemon Dab, 73.
—— of Lesser Fork-beard, 68.
—— of Lesser Weaver, 57.
—— of Ling, 67.
—— of Lumpsucker, 59.
—— of Mackerel, 57.
—— of Megrim, 71.
Otoliths of Muller's Top-knot, 71.
—— of Norway Haddock, 54.
—— of Pike, 77.
—— of Pilchard, 78.
—— of Plaice, 72.
—— of Pollack, 66.
—— of Poor-cod, 64.
—— of Red Gurnard, 56.
—— of Red Mullet, 54.
—— of Roach, 77.
—— of Salmon, 76.
—— of Sand Smelt, 60.
—— of Sapphirine Gurnard, 56.
—— of Scald-fish, 72.
—— of Sharp-tailed Lumpenus, 60.
—— of Solenette, 75.
—— of Speckled Goby, 58.
—— of Spotted Dragonet, 58.
—— of Sprat, 78.
—— of Streaked Gurnard, 56.
—— of Striped Wrasse, 61.
—— of Thick-lipped Grey Mullet, 60.
—— of Three-bearded Rockling, 67.
—— of Turbot, 70.
—— of Variegated Sole, 75.
—— of Viviparous Blenny, 60.
—— of Whiting, 65.
—— of Witch, 74.
—— of Worm Pipe-fish, 79.

Parathelestris hibernica, 278.
Paternal guardianship of the eggs of the Lumpsucker, 169.
Perch (*Perca fluviatilis*): Otoliths of, 53.
Pike (*Esox lucius*): Otoliths of, 77.
Pilchard (*Clupea pilchardus*): Otoliths of, 78.
Plaice (*Pleuronectes platessa*): Artificial propagation of, 110.
—— Duration of spawning of female, 281.
—— Eggs of, 288.
—— Fecundity of, 281.
—— Growth of, 184.
—— Otoliths of, 72.
—— Spawning of, 281.
—— Spawning period of, 111, 281.
—— Variation of growth with locality, 184.
Platychelipus littoralis, 278.
Pogge (*Agonus cataphractus*): Otoliths of, 56.
Pollack (*Gadus pollachius*): Otoliths of, 66.
Pontopolites typicus, 278.
Poor-cod (*Gadus minutus*): Otoliths of, 64.
—— Reproduction of, 130.
—— Ripe eggs of, 131.
—— Specific characters of, 116, 133.
Powan (*Coregonus lavaretus*): Otoliths of, 76.
Proportion of marketable and unmarketable fishes, 17.
Proportion of sexes in Herring, 332.
Pseudodiosaccus propinquus, 278.
Pseudothalestris major, 278.

RATE of growth of fishes, 179.
Red Gurnard (*Trigla pini*): Otoliths of, 56.

Red Mullet (*Mullus barbatus*); Otoliths of, 54.
Reproduction of Brassy, 130.
Reproduction of Poor-cod, 130.
Rivalry of male Lumpsuckers, 172.
Roach (*Leuciscus rutilus*): Otoliths of, 77.

SALMON (*Salmo salar*): Otoliths of, 76.
Sand Smelt (*Atherina presbyter*): Otoliths of, 60.
Sapphirine Gurnard (*Trigla lucerna*): Otoliths of, 56.
Scald-fish (*Platophrys laterna*): Otoliths of, 72.
Sea-bream, Common (*Sparus centrodontus*): Otoliths of, 54.
Sea Scorpion (*Cottus scorpius*): Otoliths of, 55.
Sharp-tailed Lumpenus (*Lumpenus lampretiformis*): Otoliths of, 60.
Size of Herring at maturity, 299, 332, 336.
Solenette (*Solea lutea*): Otoliths of, 75.
Spawning of Plaice, 281.
—— of Plaice: Duration of, in females, 281.
—— of Lumpsucker, 169, 176.
—— Period of Plaice, 111, 281.
—— Periods of Herring, 302.
Specific characters of Brassy, 116.
—— characters of Poor-cod, 116.
—— characters of Norway Pout, 116.
Spent Herring: Nutritive value of, 103.
Sprat (*Clupea sprattus*): External differences from Herring, 167.
—— Notes on natural history of, 165.
—— Otoliths of, 78.
—— Fishery in Tay, 1905–6, 159.
—— Fishery in Tay: Fish caught in, 160.
Stephos scotti, 278.
Streaked Gurnard (*Trigla lineata*): Otoliths of, 56.
Striped Wrasse (*Labrus mixtus*): Otoliths of, 61.
Tachidius dicipes, 278.
—— *littoralis*, 278.
Tay: Sprat fishery of, 159.
Teleostean fishes: Otoliths of, 48.
Temperature: Influence of, on growth of fishes, 182.
—— Relation of, to embryonic development of Herring, 303.
—— Relation of, to growth of Haddock, 306.
—— Relation of, to growth of Whiting, 306.
—— Relation of, to migration of Grey Gurnard, 236.
—— Relation of, to spawning periods of Herring, 303.
Thick-lipped Grey Mullet (*Mugil chelo*): Otoliths of, 60.
Three-bearded Rockling (*Onos tricirratus*): Otoliths of, 67.
Trawling investigations, 17.
—— investigations in Aberdeen Bay, 25.
—— investigations in Moray Firth, 18, 27, 31, 34.
Trout, Brown (*Salmo fario*): Otoliths of, 76.
Turbot (*Bothus maximus*): Age at maturity, 203.
—— Growth of, 199.
—— Otoliths of, 70.

VARIEGATED Sole (*Solea variegata*): Otoliths of, 75.
Viviparous Blenny (*Enchelyopus viviparus*): Otoliths of, 60.

Westwoodia minuta, 278.
Whiting (*Gadus merlangus*): Otoliths of, 65.
—— Growth of, 229.
Witch (*Pleuronectes cynoglossus*): Otoliths of, 74.
Worm Pipe-fish (*Nerophis lumbriciformis*): Otoliths of, 79.

Zaus spinatus, 278.

Trade (Imports and Exports) of the United Kingdom with the Colonies and Foreign Countries; Rates of Wages and Hours of Labour at Home and Abroad; Customs Tariff; Food Supply, &c., viz. :—

[Cd. 3092.] STATISTICAL ABSTRACT OF THE UNITED KINGDOM. 1891-1905. Price 1*s.* 6*d.*
[Cd. 2679.] Do. do. COLONIES. 1890-1904. Price 1*s.* 9*d.*
[Cd. 2566.] Do. do. FOREIGN COUNTRIES. Years 1893-1902-03. Price 1*s.* 6*d.*
[Cd. 3166.] Do. do. BRITISH INDIA. 1895-1896 to 1904-1905. Price 1*s.* 3*d.*
[Cd. 2928.] TRADE OF THE UNITED KINGDOM, 1905. Vol. I. Price 7*s.* 8*d.*
[Cd. 3022.] Do. do. do. Vol. II. Price 4*s.* 2*d.*
[Cd. 2797.] FOREIGN IMPORT DUTIES, 1905. Price 2*s.*
[Cd. 3093.] NAVIGATION AND SHIPPING STATEMENT. 1905. Price 3*s.* 1*d.*
[Cd. 1761, 2337, 2669.] BRITISH AND FOREIGN TRADE AND INDUSTRIAL CONDITIONS. Memoranda, Tables, and Charts. Prepared by the Board of Trade. First and Second Series, and Index. Price 7*s.*
[Cd. 2473.] EAST INDIA. Trade of. Years 1899-1900 to 1903-1904. Price 1*s.* 3*d.*
[Cd. 2629.] STATISTICAL TABLES RELATING TO BRITISH COLONIES, POSSESSIONS, AND PROTECTORATES. Part XXVIII. 1903. Price 7*s.*
[Cd. 2856.] STATISTICAL ABSTRACT OF THE BRITISH EMPIRE, YEARS 1900-1904. Price 10*d.*
[Cd. 2594.] AGRICULTURAL RETURNS—GREAT BRITAIN. 1904. Price 1*s.* 5*d.*
[Cd. 2627.] COLONIAL IMPORT DUTIES. 1905. Price 2*s.* 3*d.*
[Cd. 3172.] WAGES AND HOURS OF LABOUR—Report on the Changes in; 1905. Price 7*d.*
[Cd. 2828.] ROUMANIA. New Customs Tariff. Price 7*d.*
[Cd. 2857.] RUSSIA. New Customs Tariff. Price 9*d.*
[Cd. 2862.] BULGARIA. New Customs Tariff. Price 6*d.*
[Cd. 2977.] SOUTH AFRICA. Customs Union Convention, 1906. Price 2½*d.*
[Cd. 3066.] SPAIN. New Customs Tariff, 1st July, 1906. Price 5½*d.*
[Cd. 3120.] FOREIGN LABOUR STATISTICS. Third Report. Price 1*s.* 6*d.*
[Cd. 3065.] STRIKES AND LOCK-OUTS. Report, 1905. Price 8*d.*

Military :—

ARMY SERVICE CORPS. Regimental Standing Orders, 1906. Price 6*d.*
EQUIPMENT REGULATIONS. Part 2. Sec. III. Army Service Corps. Price 3*d.*
INFANTRY. MOUNTED. TRAINING. 1906. Price 6*d.*
MAP READING AND FIELD SKETCHING. Manual. 1906. Price 1*s* 3*d.*

Hydrographical :—

EASTERN ARCHIPELAGO. Part II. Supplement, 1906. Price 4*d.*
NORTH SEA PILOT. Part IV. Supplement, 1906. Price 8*d.*
NOVA SCOTIA AND BAY OF FUNDY. Sailing Directions, 1903. Supplement, 1906. Price 6*d.*
SOUTH AMERICA PILOT. Part I. Supplement, 1906. Price 7*d.*

Local Government Board.

GENERAL SANITARY CIRCUMSTANCES AND ADMINISTRATION OF THE TAVISTOCK RURAL DISTRICT, AND OUTBREAK OF DIPHTHERIA AT PRINCETOWN. No. 240. Price 4*d.*
SANITARY CIRCUMSTANCES AND ADMINISTRATION OF THE WINDSOR RURAL DISTRICT AND NEED FOR A DRAINAGE SYSTEM IN THE PARISHES OF SUNNINGHILL AND SUNNINGDALE. No. 241. Price 4*d.*
SANITARY CIRCUMSTANCES AND ADMINISTRATION OF THE BOROUGH OF BATLEY. No, 242. Price 9*d.*
SANITARY CIRCUMSTANCES AND ADMINISTRATION OF THE URBAN DISTRICT OF DARLASTON IN THE COUNTY OF STAFFORD. No. 243. Price 4*d.*

Emigrants' Information Office, 31 Broadway, Westminster, viz. :—

COLONIES, HANDBOOKS FOR. 8vo. Wrapper.
No. 1. Canada. 2. New South Wales. 3. Victoria. 4. South Australia. 5. Queensland. 6. Western Australia. 7. Tasmania. 8. New Zealand. 9. Cape Colony. 10. Natal. 11. Transvaal. 12. Orange River Colony. Price 1*d.* each.
No. 13. Professional. 14. Emigration Statutes and General. Price 3*d.* each.
No. 15 (viz., Nos. 1 to 14, in cloth). Price 2*s.*
INTENDING EMIGRANTS, INFORMATION FOR :—Argentine Republic, price 2*d.* British East Africa Protectorate, 1904, price 6*d.* Ceylon, June 1904, price 1*d.* Federated Malay States, &c., 1905, price 6*d.* Newfoundland, March 1905, price 1*d.* British Central Africa Protectorate, July 1905, price 6*d.* Uganda Protectorate, 1906, price 6*d.* West African Colonies, Dec. 1904, price 6*d.* West Indies, 1904, price 6*d.*
SUMMARY OF CONSULAR REPORTS, NORTH AND SOUTH AMERICA, 1904-5. Price 2*d.*

Foreign Office :—

COMMERCIAL TREATIES. (Hertslet's.) A complete collection of Treaties, &c., between Great Britain and Foreign Powers so far as they relate to Commerce and Navigation, &c. By Sir E. Hertslet, K.C.B., &c. Vols. I. to XXIII. Price 15*s.* each.
STATE PAPERS. British and Foreign. Vol. 93 (Index vol.); Vol. 94, 1900-1901; and Vol. 95, 1901-1902. Price 10*s.* each.

Board of Trade Journal, of Tariff and Trade Notices and Miscellaneous Commercial Information. Published weekly. Price 1*d.*

Board of Trade Labour Gazette. Monthly. Price 1*d.*

TWENTY-FOURTH
ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND,

Being for the Year 1905.

IN THREE PARTS.

PART I.—GENERAL REPORT.
PART II.—REPORT ON SALMON FISHERIES.
PART III.—SCIENTIFIC INVESTIGATIONS.

PART III.—SCIENTIFIC INVESTIGATIONS.

Presented to both Houses of Parliament by Command of His Majesty.

GLASGOW:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE
BY JAMES HEDDERWICK & SONS LIMITED,
AT "THE CITIZEN" PRESS, ST. VINCENT PLACE.

And to be purchased, either directly or through any bookseller, from
OLIVER & BOYD, EDINBURGH; or
WYMAN & SONS, LTD., FETTER LANE, E.C., and
32 ABINGDON STREET, WESTMINSTER, S.W.; or
E. PONSONBY, 116 GRAFTON STREET, DUBLIN.

1906.

[Cd. 3199.] *Price* 4*s.* 7½*d.*

Date Due