SEVENTH ANNUAL REPORT OF THE FISHERY BOARD FOR SCOTLAND,

WITH APPENDIX CONTAINING REPORT TO THE BOARD BY THE INSPECTOR OF SALMON FISHERIES,

Being for the Year 1888.

IN THREE PARTS.

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

PART II.—SALMON FISHERIES.

Presented to both Houses of Parliament in pursuance of Act 45 and 46 Vict., cap. 78.

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1889.

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TABLE OF CONTENTS.

	PAGE
Mr Young's Report of 1888, ...	vii
Salmon Fishing Season of 1888 not a successful one, . . .	vii
Number of Boxes of Scotch salmon sent to Billingsgate, . . .	vii
Estimated Value of Scotch Salmon Fishings for 1888, . . .	vii
Fishings on the Tay, ...	vii
Alteration of close time on the Tay, ...	viii
Rivers whose close time has been altered during 1888, . . .	viii
Sparling Smacks on Tay, ...	viii
Obstructions made passable on West Coast of Sutherland, . .	viii
Salmon Fishery Law and Legislation, ...	viii
Defects of the Salmon Fishery Acts of 1862 and 1868, . . .	ix
Illicit traffic in Scotch salmon to English and French markets . .	ix
What is required in Scotland to prevent such traffic, . . .	ix
Prevention of illicit traffic in salmon in England, . . .	x

APPENDIX.

Seventh Annual Report to the Fishery Board for Scotland, containing an account of the Salmon Rivers and Lochs in the Black Mount and other parts of Argyleshire, and in Inverness-shire, Ross-shire, and Sutherlandshire,* 1–46

* A fuller Table of Contents will be found prefixed to this Report, page 3.

SEVENTH ANNUAL REPORT.

TO THE MOST HONOURABLE

THE MARQUIS OF LOTHIAN, K.T.,

Her Majesty's Secretary for Scotland.

FISHERY BOARD FOR SCOTLAND,
EDINBURGH, 1*st May* 1889.

MY LORD MARQUIS,

We, the Members of the Fishery Board for Scotland, have the honour to submit the Board's Seventh Annual Report, being for the year 1888.

The subject matter of the Report has been arranged, as was done last year, in three parts, under the following titles:—

Part I.—General Report.
Part II.—Report on Salmon Fisheries.
Part III.—Scientific Investigations.

We have the honour to be,

MY LORD MARQUIS,

Your Lordship's most obedient Servants,

THOMAS J. BOYD, *Chairman.*
JOHN GUTHRIE SMITH, *Deputy-Chairman.*
GEO. H. M. THOMS.
ALEXR. FORBES IRVINE.
J. R. G. MAITLAND.
J. COSSAR EWART.
JAMES JOHNSTON.
WILLIAM BOYD.
W. ANDERSON SMITH.

PART II.—REPORT ON SALMON FISHERIES.

During the summer and autumn of 1888, Mr Young, the Inspector of Salmon Fisheries, inspected the Rivers and Lochs in the Black Mount—which he had not previously visited—and in other parts of Argyleshire; also in Inverness-shire, Ross-shire, and on the north and west coasts of the county of Sutherland. His Report which has been presented to the Board forms the Appendix to this Report. After having given it careful consideration, it has been generally approved by the Board.

Mr Young's Inspection in 1888.

It cannot be said that the Salmon Fishery for 1888 has been, on the whole, a successful one, either for nets or rods; although in some places there has been, during part of the season, good netting and excellent angling.

Salmon Fishery of 1888 not, on the whole, successful.

In the course of the year, 22,859 boxes of Scotch salmon were sent to Billingsgate market, or the smallest quantity that has been sent since 1880, when only 17,457 boxes were despatched. The numbers since then are as follows:—

Number of boxes of Scotch salmon sent to Billingsgate.

1881,	23,905	boxes
1882,	22,968	„
1883,	35,506	„
1884,	27,219	„
1885,	30,362	„
1886,	23,407	„
1887,	26,907	„

The average of these 7 years is 28,610 boxes; so that the yield of last year is considerably below the average.

Estimated value of Scotch Salmon for 1888.

If £5, 5s. is taken as the value of the box of salmon, this represents a value £120,009, and if there is added as much more as the value of the salmon consumed in Scotland and sent from Scotland elsewhere than to London, £240,018 is got as the value of the Scotch Salmon Fisheries in 1888.

Fishings on the Tay.—The following is the rental of the salmon fishings on the Tay, the chief salmon river in Scotland, during the last 6 years:—

1883,	£17,773	2	0
1884,	19,655	14	5
1885,	20,417	0	2
1886,	22,542	2	8
1887,	22,143	16	7
1888,	19,655	0	0

It is stated on good authority that the falling off in the Tay rental for 1889 will be as great as that in 1888 when compared with 1887; or £5000 in 2 years. But it must be kept in mind that the Tay fishings have been made the subject of a good deal of speculative bidding during the last few years; and also it seems not improbable that the extensive illicit traffic in salmon, which has now been carried on at Newburgh and other places on the Tay for many years, against which the existing Salmon Fishery Acts, as interpreted by the decisions of the Courts, afford no protection whatever, may at length have severely injured the regular and legal fishing.

Alteration of close time on the Tay.

After this season, by Order under Secretary for Scotland's hand, the Tay will be included in the largest and earliest group of Scotch Salmon Rivers, and its fishing season will be from 27th August to 10th February, with extension of time for rod-fishing until 31st October. This year, the season commenced on 5th February, and will continue until 27th August.

During 1888, the following rivers have also had their close time altered by Order under the Secretary for Scotland's hand, published in the *Edinburgh Gazette*, viz., the Helmsdale, Halladale, Strathy, Naver, and Borgie (see Note I. to the Inspector's Report for 1888).

Sparling Smacks on Tay.—Many complaints have been made for a good many years past that the fishermen in the sparling smacks on the Tay, while nominally fishing for sparlings, really catch in their nets and appropriate and sell a great quantity of salmon; and the Board observe that an action, at the instance of the Tay District Board, against a number of these fishermen, is now in dependence before the Court of Session. The proprietors and tacksmen of salmon fishing on the Tay contend that if sparling fishing is to be permitted at all in salmon fishing waters, there should be a close time for sparlings extending from February until October. They also maintain that the sparling-nets should be so constructed and used as to prevent the capture of salmon.

Some Obstructions recommended to be removed have been removed.

Obstructions made passable on West Coast of Sutherland.—The Inspector's suggestions, made in former years, for opening up to sea-trout several lochs in the neighbourhood of Riconich Inn, by clearing out the channels of the burns that connect them with the sea have now been successfully carried out; and, between Scourie and Kylesku Ferry, the Falls on the Duartmore River have been made passable, and several lochs above are now frequented in the season by the migratory *Salmonidæ.* (For details respecting these improvements, see the Inspector's Report of 1888 to the Board, pages 31–2.)

Salmon Fishery Law and Legislation.

A Salmon Fisheries Consolidation and Amendment Bill was laid before Parliament by the Secretary for Scotland in the end of last

* There is also in dependence an action by the Tay Board against the use of Hang-nets in the river Tay. These nets are included under the definition of 'Fixed 'Engines' in the interpretation clause of the Tweed Fisheries Act of 1857. But as there is no definition of what constitutes a fixed engine in the Salmon Fisheries (Scotland) Acts of 1862 and 1868, there may require to be a proof whether a hang-net is, or is not, of the nature of a fixed engine. As to the destructive effects of hang-nets on river fisheries, the English Inspectors point out, in their Fourteenth Annual Report, that they, in a few years, reduced the annual yield of salmon in the Tyne from 129,100 to 21,746; after which a bye-law was passed restricting the area of their operations, since which time the Tyne Fisheries have very greatly improved.

year. That Bill met with strong opposition in various quarters, especially on Tweedside, and is not to be brought before Parliament this session. The Scotch Salmon Fisheries, therefore, with the exception of those in the Tweed, continue to be regulated by the Acts of 1862 and 1868, which, however efficient in some respects, haveproved utterly inadequate to prevent or to check the pollution of rivers; to put a stop to the illicit traffic in salmon; to provide for the removal or rendering passable of obstructions in rivers; to hinder the sale of salmon caught during the extension of time for rod-fishing; to provide for the administration of the law in those fishery districts where there are no District Boards; to prohibit the use of hang-nets in rivers; to compel the putting up of smolt-guards in the case of turbine wheels; to prevent stroke halling; to fix *minimum* as well as *maximum* penalties for offences; and to facilitate the removal of diseased fish from infected rivers.

Defects of the Salmon Fishery Acts of 1862 and 1868.

On the 14th of last December, the Inspector of Salmon Fisheries had a meeting in London, at the Board of Trade, with Mr Berrington, the English Inspector, and Mr Towse, Secretary to the Fishmongers Company of London, on the subject of the illicit traffic in Salmon from Scotland to English and French markets, which probably amounts to more than 100 tons annually, and against which the existing Scotch Salmon Fishery Acts afford a most inadequate protection. After discussing the matter fully, the plan that appeared to recommend itself most strongly was to endeavour to get a short Act of Parliament passed applicable to both England and Scotland specially directed against this traffic. In discussing the subject at this meeting it appeared that what is chiefly required in Scotland are powers of search and seizure, conferred on officers of District Boards, river watchers, police officers, &c., such as are given with regard to game by the second section of the Poaching Prevention Act of 1862; the prohibition of the sale, offering for sale, or having in possession for the purpose of sale, of salmon caught during the extension of time for rod-fishing; and the throwing on persons in whose possession salmon are found, in a district where the annual close time has commenced, the *onus* of proving that they got them in a district where it was still legal to take them. All these advantages have been possessed for some years past in England, and why they should be withheld from Scotland, where the salmon fishings are three times as valuable and the facilities for poaching so much greater, it is difficult to comprehend. Generally speaking, it may be said that the English Acts throw the burden of proof to a great extent on the persons in whose possession unseasonable salmon are found, whereas the Scotch Acts, as interpreted by the decisions, throw it on the prosecutor. It may also be stated that the Tweed Fisheries Act of 1859, section 10, throws the burden of proof on persons selling or offering for sale salmon caught during the annual close time, that such fish were not taken contrary to the provisions of the act. It will be seen from the 19th section of the English Salmon Fisheries Act of 1873, how distinctly the burden of proof is thrown on the person having the unseasonable salmon in his possession. That section is as follows:—

Illicit traffic in Scotch salmon to English and French markets.

What is required in Scotland to prevent illicit traffic in salmon.

b

'No person shall buy, sell, or expose for sale any salmon or part of a salmon between the 3rd day of September and the 1st day of February following, both inclusive; and any person acting in contravention of this section shall forfeit any salmon or part of any salmon so bought, sold, or exposed for sale, or in his possession for sale, and shall incur a penalty not exceeding £2 for every such salmon or part of any salmon. But nothing herein contained shall apply to any person buying, selling, or exposing for sale, or having in his possession for sale, any salmon which has been cured, salted, pickled, or dried beyond the limits of the United Kingdom, or if within the limits of the United Kingdom between 1st day of February and the 3rd day of November in any year or any clean fresh salmon caught within the limits of this act, provided its capture by any net, instrument, or device other than a rod and line, if within the United Kingdom, was lawful at the time and in the place where it was caught; but the burden of proving that any clean salmon so bought, sold, exposed for sale, or in the possession of any person for sale, was captured abroad, or lawfully captured within the United Kingdom, shall lie on the person selling, or exposing for sale, or having in his possession for sale any such salmon; and the burden of proving that any cured, salted, pickled, or dried salmon was cured, salted, pickled or dried elsewhere than in the United Kingdom, or if within the United Kingdom, then between the 1st day of February and the 3rd day of November in any year, shall lie upon the person in whose possession for sale such salmon is found.'

Prevention of illicit traffic in salmon in England.

It was stated that what is wanted in England, in addition to the powers they already possess for preventing illicit traffic in salmon, is an extension of the powers, which the Fishmongers Company at present have to search for and seize unseasonable salmon in any part of London, to the whole of England; to enable the market authorities to enforce within their jurisdiction the Acts relating to the sale of fish; to strengthen the hands of the Fisheries Department of the Board of Trade, especially with regard to places not included in any fishery district; and to apply the Acts restraining the exportation and sale of salmon to trout wherever a close time for that fish exists.

On returning from London, Mr Young gave an account of what had taken place—as above stated—at the conference between Mr Berrington and Mr Towse and himself; and the Board, after carefully considering the matter, drew up 'Notes for draft Bill to put down illicit traffic in salmon,' and forwarded them to the Secretary for Scotland on the 27th of February last.

Since Mr Young's conference with Mr Berrington and Mr Towse, Mr Young has had a letter from Mr Berrington, dated 1st April 1889, stating that the Irish Inspectors have been written to on the subject, so that the Bill to prevent the illicit traffic in salmon will probably apply to the United Kingdom.

APPENDIX.

SEVENTH ANNUAL REPORT TO THE FISHERY BOARD FOR SCOTLAND,

CONTAINING AN ACCOUNT OF

THE SALMON RIVERS AND LOCHS IN THE BLACK MOUNT AND OTHER PARTS OF ARGYLESHIRE, AND IN INVERNESS-SHIRE, ROSS-SHIRE, AND SUTHERLANDSHIRE.

By ARCHIBALD YOUNG, Advocate,
Inspector of Salmon Fisheries for Scotland.

TABLE OF CONTENTS.

	PAGE
Salmon Rivers and Lochs in the Black Mount, - - -	5
Salmon prevented by the Falls of Tummel from reaching Rivers and Lochs in the Black Mount, - - - - - - -	5
Legislation with regard to opening up Natural Obstructions, - -	6
Unfairness of making District Boards pay all the expense of opening up Natural Obstructions, - - - - - - -	7
Legal difficulties that may arise in connection with opening up such Obstructions, - - - - - - -	7–8
Lochs-na-Ba, Lydoch, Tulla, and Dochard, - - - -	8–11
The Land-locked Salmon, - - - - - -	11
Fishing for Salmon by baskets fixed at Waterfalls, - - -	12
The Kinglass, - - - - - - - -	12–13
Loch Bea and the Lochy, - - - - - -	14
Answers to printed queries by Marquis of Breadalbane, - -	14
Illegal Fishing by Yachtsmen, - - - - -	14–15
'Scringing,' - - - - - - - -	16–17
Salmon Fishery Legislation, - - - - - -	17–18
Illicit traffic in Salmon from Scotland to foreign markets, - -	18–19
Awe District Board, - - - - - - -	19
Failure of the system of District Boards among the small Fishery Districts on the West Coast, and the remedy for such failure, -	20–21
Estuary Line of Ness and Beauly, - - - - -	21–22
Salmon Rivers on the North and West Coasts of Sutherland, - -	23–34
Lairg, Overscaig, and Loch Shin, - - - - -	23–24
Returns of fish caught in Tongue district, - - - -	24–25
Answers to printed queries from Mr Box, Factor at Tongue House, -	25–27
Importance of constructing a Fishing-Boat Harbour at Island Talmine in Kyle of Tongue; letter from Mr Box on the subject, - -	27–28
Kyle of Durness and the River Grudie, - - - -	28–30
Early and late Salmon Rivers, - - - - -	29–30
Riconich, the River Inchard, and adjacent Lochs, - - -	30–31
Return by Messrs Speedie, Perth, of Bag-Net Fishings between Riconich, and Lochinver, - - - - - - -	31
Scourie and Duartmore River, - - - - -	32
Sea-Fishing in Loch Kylesku, - - - - -	32–33
Estuary of the Kirkaig - - - - - -	33
Falls of the Polly; importance of opening them up, - - -	33–34
Overfishing in Scotch Lochs, - - - - - -	34–35
Salmon Angling in 1888, - - - - - -	35–36
Trout Fishing in Loch Leven, - - - - - -	36
The Esk (Midlothian) Angling Improvement Association, - -	36–39
Unchartered Salmon Waters in Scotland, - - - -	39–40
NOTE I. Annual Close Time applicable to the Scotch Salmon Rivers,	41–44
NOTE II. Sketch Map of the present and of the proposed Estuary for the Rivers Ness and Beauly, - - - -	44
NOTE III. Notice by the Fishery Board for Scotland, with regard to the sale of salmon smolts, - - - - -	45
NOTE IV. Recent Hatcheries in Scotland, - - - -	45–46

REPORT.

SALMON RIVERS AND LOCHS IN THE BLACK MOUNT.

I HAVE the honour to report that, during the summer and autumn of last year, I inspected, by the direction of the Fishery Board, a number of salmon rivers and lochs in the Highlands of Scotland, commencing with the rivers and lochs of the Black Mount, which I had not previously visited.

Between the eastern side of the upper part of Loch Etive and the head of Loch Lydoch, lies the Black Mount Deer Forest, a vast tract of mountain and moorland,—a wild but picturesque solitude, watered by many a river and burn and by numerous lochs and tarns. Among the rivers are the Orchy, the Etive, the Kinglass, the water of Tulla, the Linne-nan-Beathach, the Gannich, the Ba, and several smaller streams. One of the largest of the lochs is Loch Lydoch or Laidon, a dismal and remote lake, bounded on one side by the moor of Rannoch. The rivers Ba and Gannich, after passing through Loch-na-Ba and Loch-na-Gannich, fall into the head of Loch Lydoch. A few miles southwards is Loch Tulla, $2\frac{1}{4}$ miles long by 5 furlongs wide, and covering 697 acres, into which flow the water of Tulla and the Linne-nan-Beathach, and out of which flows the Orchy, the principal river of the district, which, after a course of about 14 miles, falls into the head of Loch Awe, near Kilchurn Castle. Then there are Loch Mathair Etive, the fountain head of the Etive; the Black Lochs, near Kingshouse; Loch Dochard, between Loch Tulla and Glenkinglass; and many lesser lochs.

Of these waters, the Orchy, Etive, and Kinglass contain salmon and trout, and so does Loch Tulla. Neither salmon nor sea-trout can, at present, ascend to Loch Lydoch, or to Loch-na-Ba, or Loch-na-Gannich, which, discharge their waters into it. But, as I had the honour of pointing out to the Board, in a Report dated 8th May 1884, the opening up of the Falls of Tummel would enable salmon and sea-trout to ascend to these lochs and the streams connected with them. The distance—measuring by water, through a continuous chain of rivers and lochs from the Falls of Tummel to the head of Loch-na-Ba in the Black Mount, and to Loch-na-Gannich, which is within an hour's walk of Kingshouse, at the head of Glencoe—is between fifty and sixty miles, of which about one-half are lochs and the remainder rivers, with beds of gravelly spawning grornd, where hundreds of salmon might breed if they were enabled to reach them.

In 1861, a Salmon Fisheries Bill was prepared and brought in by Lord Moncrieff, then Lord Advocate, and by the late Sir George Lewis, the 73rd clause of which contained stringent provisions with regard to the removal of natural obstructions. That clause runs as follows :—

If any natural obstruction shall exist in any river which prevents the free passage of salmon, salmon-ladders shall be constructed, so as to permit and allow such passage at all times over, across, or through the same ; and if the owner of the soil, land, or fishery, in or upon which such obstruction exists, shall refuse or neglect to allow such salmon-ladder to be constructed, within fourteen days of being thereunto required in writing by the Central Board or their Secretary, or by the District Board or their Clerk, or by any surveyor or inspector, it shall be lawful for the Central Board, or for the Sheriff within whose jurisdiction the obstruction or cause of interruption is wholly or partially situated, upon the application or information of the Clerk of the District Board respectively, to order and direct that such salmon-ladder shall be constructed by or under the inspection or direction of a proper person to be appointed by the Central Board or District Board, or such Sheriff, and at the expense of the District Board, in such manner as may sufficiently effect the object intended with the least possible injury to the property of such owner.

In 1871, in our Report 'On the Effects of Recent Legislation on the Salmon Fisheries in Scotland,' the late Mr Frank Buckland and I wrote as follows on page 19 :—

The falls of Tummel keep the fish out from Loch Tummel, Loch Rannoch, Loch Ericht, and Loch Lydoch, and from tributaries that extend as far as the deer forest of the Black Mount, in all from about 100 miles of water.

That the Fishery Board are in favour of further powers being conferred on District Boards to open up such obstructions, or on such Boards and the Fishery Board conjointly, is shown by the following resolution extracted from their Second Report to Parliament, p. 62 :—

The Board having considered the Report by Mr Young on the opening of rivers and lochs now closed against salmon, by the existence of such obstructions as the Falls of Tummel, the Falls of Mounessie, and the Falls on the Conon, approve of said Report ; and having regard to the extensive area of spawning and angling water which could be opened in different districts of Scotland by the removal of said obstructions and the introduction of an efficient fishway, resolve to transmit a copy of said Report to the Secretary of State, with a request that a short Act should be brought in by the Government, giving District Boards the requisite compulsory powers, subject to such control on the part of this Board or otherwise as may be considered just.

In the Salmon Fisheries Bill laid before Parliament by the Secretary for Scotland, during the autumn session of 1888, several sections are devoted to the subject of the removal of obstructions. It is therein provided that a District Board may apply for authority to make fish passes ; that the Fishery Board shall thereupon direct a local inquiry to be held by the Inspector of Salmon Fisheries, or by one or more of their number ; that the Fishery Board may grant authority by an order to the District Board to execute the works applied for ; that any such order shall be submitted to the Secretary for Scotland for his confirmation ; and that the proprietor or proprietors of such obstruction shall be entitled to claim compensation. There is also a provision with regard to the expense to be incurred in removing the obstruction, to the effect that, if it does not exceed £50, it shall be defrayed out of the general fishery assessment ; but if it exceeds £50, it shall be defrayed by a special assessment, additional to the general assessment, to be spread over a number of years not exceeding fifteen, and the District Board are empowered to borrow the amount necessary to defray such costs on the security of the general assessment ; provided always that in no case shall the annual interest on the sum so borrowed exceed one-fourth of the amount annually collected under the said general assessment.

It humbly seems to me that it is somewhat unfair that the whole expense of making obstructions in rivers passable for salmon should be thrown upon District Boards. The persons who are chiefly to profit by such obstructions being removed are the proprietors above the obstruction, who may obtain a right to salmon fishings *ex adverso* of their respective lands. In the case of the Falls of Tummel being effectually opened up, there is one proprietor, for example, who would have about 30 miles of lochs and rivers stocked with salmon. It, therefore, appears to me to be but fair and reasonable that those, whoever they may be, who receive grants of the new salmon fishings created by making hitherto inaccessible waterfalls passable for salmon, should pay a considerable portion of the expense incurred by the District Board in opening them up, whether they may be the Woods and Forests as representing the Crown; a proprietor having a charter to follow salmon above the obstruction and beyond his own lands, if such a right shall be held good in law; or the riparian owners above who may obtain a grant of salmon fishings.*

In carrying out any general scheme for opening up the many natural obstructions to the ascent of salmon which might profitably be made passable for salmon, it may be found somewhat difficult to reconcile the interests of the riparian owners above these obstructions with the rights of a chartered proprietor below, who claims, under his charter, a right to follow salmon beyond the obstruction; or, where there is no such chartered proprietor, with the claims of the Crown to the new salmon fishings created by making an obstruction passable.

It is well known that in Scotland, salmon fishings do not pass as part and pertinent of lands, but form a separate property requiring a special conveyance, mere riparian ownership giving no title, even to rod-fishing for salmon without a charter of fishings; and it sometimes happens that one person holds the land on both sides of a river, while another has a right to the salmon fishings, which entitles him to enter upon these lands for the purpose of carrying out that right. Suppose, then, that A has a chartered right to all the salmon fishings in the district of B, through which a salmon river flows; and suppose, further, that half-way up the course of that river there is a natural obstruction in the shape of a fall which totally prevents the ascent of salmon, and that this fall and the land on both banks of the river for several miles above belong to D, who has no right of salmon fishing. It is perfectly clear that it would be very much against the interest of D to allow that obstruction to be made

* It should be stated that great diversity of opinion exists with reference to this subject. One proprietor of salmon fishings of great experience writes me as follows:—'I do not agree that it is unfair that the cost of removing obstructions should fall on the District Board. Proprietors below the obstruction will benefit by an increased number of fish, and proprietors above will benefit by having salmon where before they had none; and as all will be ineluded in the district assessment, each will bear a burden in proportion to the benefit received. It may be assumed that the Crown will be proprietor of all the fishings above the obstruction, and it will sell its rights to the owners of the estates or other persons who may be willing to buy at a priee regulated by two factors: (1) the number of fish expected to be taken, and (2) the amount of assessment to be imposed. If it is to be a heavy assessment, the price will be less than if the assessment be small. The riparian owner has no interest in the matter except in so far as the right of salmon fishing involves the right of passing over his ground; and he probably would be entitled to some compensation for this quasi right of trespass being constituted on his grounds. I don't know that there is in Scotland any grant of salmon fishing in a *district*, there may be in a *river* generally without any upper or lower boundary being specified; but I eannot think for a moment that such a grant would confer a right to the salmon fishing newly created in miles of river and loehs which did not contain salmon at the date of the grant,—undoubtedly the Crown would elaim and get this right and it should bear its share of the expense of creating so valuable a property for it.'

passable for salmon; because the only effect of this would be to entitle A, who has a right to all the salmon fishings in the district, to come upon D's lands and prosecute his right of salmon fishing. D, therefore, could scarcely be blamed for opposing the removal of the obstruction, unless A would consent to give him a share of the new salmon fishings to be opened up by its removal. It is possible, indeed, that D might plead that the Crown—in whom all the salmon fishings in Scotland were originally vested—could only give the salmon fishings which it possessed at the date of the charter, namely, those below the impassable falls, and could not convey a thing not then in existence, namely, the salmon fishings above; and that, consequently, the new salmon fishings, to be created by the removal of that obsruction, would vest not in A, but in the Crown, and might be granted by the Crown to D, the riparian owner; to A, who possesses the charter to the salmon fishings in the district; or to any other person. In several parts of Scotland, difficulties of the kind described might arise in connection with the removal of natural obstructions, and much care would be required in dealing with the subject in any future legislation.

Another difficulty springs from the fact that only about thirty District Boards exist in the hundred fishery districts of Scotland. Who then is to take up the matter in those districts where there are no District Boards, and where it is, at the same time, desirable that certain natural obstructions should be removed or made passable? Proprietors of salmon fishings in such districts might, indeed, apply to the Secretary for Scotland, and the consequence of such an application would probably be a remit to the Fishery Board for Scotland to inspect and report; and a satisfactory result might in this way be ultimately arrived at, though a considerable time would, in all likelihood, elapse before the requisite operations could be carried out.

LOCHS-NA-BA, LYDOCH, TULLA, AND DOCHARD.

Almost all the lochs in the Black Mount abound in trout. The best are Loch-na-Ba (612 acres) and Loch Lydoch. The trout in the former are beautiful in shape and colour, cut quite pink, and are of delicious flavour. They are occasionally got of 3 and 4 lbs. weight. But this is rare and exceptional, and the average is from a third of a pound to half-a-pound each. On one occasion I fished it with fly for five hours on a very bad day, with pouring rain and an east wind, and captured 75 trout weighing 18 lbs. The upper part of the loch is diversified by islands and indented by creeks and winding bays, many of them shallow and weedy. The river Ba, which runs into its head, is a brawling, rocky, mountain stream running through a wild corrie to the westward of the public road between Inveroran and Kingshouse. Its source is upwards of 2300 feet above the level of the sea. Below the public road and between it and the head of the loch the character of the river changes, owing to the more level surface of the ground through which it flows, its course is still and quiet, and it preserves the same character in the lower part of its course—a mile and a quarter long—between the outlet of Loch-na-Ba and the head of Loch Lydoch. When the river is in good order, the trouting here is excellent, and one of Lord Breadalbane's keepers told me that he had once killed in a day in the lower part of the Ba, with fly and worm, 10 dozen trout some of them weighing 3 lbs. In the part of the river between the public road and the head of Loch-na-Ba there are a number of pearl mussels, and occasionally very good pearls have been found. The fishing in Loch Ba and in the river is strictly preserved; but visitors staying at the inn at Kingshouse, at the head of Glencoe, are allowed by Lord Breadalbane the privilege of fishing in the following lochs in the neighbourhood, namely, the Black Lochs, Loch Mathair Etive, and Loch-na-Gaunich, in all of which there is fair trouting.

Between forty and fifty years ago, Loch Tulla was nearly equal to Loch Leven as a trouting loch, and it had the great advantage of being likewise well stocked with salmon which ascended into it through the River Orchy. The trouting was then wonderfully good, and I was told by an old keeper of Lord Breadalbane's that, in those days, when weather and water were favourable, he has not unfrequently taken in a few hours with fly, wading into the loch, 3 or 4 dozen beautiful trout from 1 to 3 lbs. weight. Such sport, unfortunately, is a thing of the past. The quality of the trout is as good as ever, but their numbers have been greatly diminished. What could once be done in a day, could not now be done in a fortnight. In an evil hour, the late Marquis of Breadalbane, about forty years ago, introduced pike into Loch Tulla which have almost exterminated the trout and the salmon fry both in Loch Tulla and its feeders—the Water of Tulla and the Linne-nan-beathach. Through the Orchy, these fresh-water sharks have also passed down to Loch Awe, to the great detriment of the trout fishing; and the chief expense now incurred by the Loch Awe Angling Improvement Association is in killing down the pike. As to Loch Tulla and its tributaries, they seem to have established themselves there so firmly that it will be difficult, if not impossible, to extirpate them. When the extreme voracity of the pike is taken into account, the immense amount of food it consumes in proportion to its weight, and also how prolific it is in comparison with the trout or the salmon, the danger of giving it a chance in inland waters where salmon and trout exist can scarcely be exaggerated. In a pike of 28 lbs. weight 292,000 eggs were found, whereas in a salmon of the same weight there would be only 22,400 eggs, while in trout the number of eggs varies from 200 to 500 in a two year old trout and in a trout from four to five years old it does not exceed 2000. The pike spawns in spring, ascending for that purpose narrow creeks and ditches, at which time it may be easily destroyed.

It is clear that there were no pike in Loch Tulla and Loch Awe and their tributary streams, when the first statistical account of Scotland was written during the last decade of the 18th century. The minister who contributes the account of the parishes of Glenorchy and Inishail—in which these waters are situated—mentions only salmon, char, trout, and eels as abounding in the lakes and rivers, and of the eels he says :—'The last is 'the abhorrence of almost all the common people in the Highlands who 'consider them as water serpents and unfit for the use of man.' When, however, we look at the new statistical account of Scotland we find the Rev. Duncan Maclean writing as follows in his description of the aforesaid parishes, which is dated 1843 :—'Various kinds of trout abound in all 'our lakes, especially in Loch Awe, viz., salmon, eels, char, now rather 'scarce fish, perch, and pike; *the pike is only of recent importation, and it 'is greatly feared that the character of the lakes will suffer from the 'ravages of this active and voracious fish.*'

The fears, expressed in the above-quoted sentence, have been more than realised. The fishing in Loch Tulla and its tributaries, has greatly deteriorated since the first statistical account of Scotland was drawn up. Looking to what Loch Tulla was before pike were introduced into it, and also considering what a passion for angling there now is—what sums are cheerfully paid for good fishing—and how much may be done by artificial breeding to increase the stock of trout in a loch under favourable conditions, it is not too much to say that Loch Tulla might now have been worth, as a trouting loch, £300 or £400 a year, but for the unfortunate introduction of pike. The present Marquis of Breadalbane, it is satisfactory to be able to report, has commenced an active crusade against the pike in Loch Tulla and its tributaries, both by net and lines, which in course of time may either extirpate or greatly thin them in these waters.

The chief feeder of Loch Tulla is termed the Water of Tulla. It rises in the extreme east of the parish of Glenorchy, at a height of 2700 feet above the level of the sea; has a winding course of $10\frac{3}{4}$ miles between lofty mountains to Loch Tulla, through which it flows for upwards of a mile and a half, and then issues from it as the Orchy. There is a small loch at the very head of the Water of Tulla to which salmon are said to find their way in large numbers in the end of autumn. The water of Tulla enters the eastern extremity of the loch through a broad bay of yellow sand, above which it winds for a short distance in the direction of the Moor of Rannoch and then takes a bend to the southwards between two lofty mountains. At the time I inspected it, it was very low, owing to a long course of dry weather, and only a narrow shallow rill of water was trickling through the sand into the loch, up which not even a sea-trout could have found its way. There are, however, some deep pools above, but the water was so clear at the time of my visit that I could see to the bottom of all of them.

The Linne-nan-Beathach, which flows into the other extremity of Loch Tulla, is a much smaller stream than the Water of Tulla. But it used to be frequented by trout and salmon in large numbers before the introduction of pike into the loch. On the lower part of this river there is a long stretch of deep still water. Farther up, there are several successive rocky barriers across the river which effectually prevent the pike from having access to Loch Dochard from which the river flows. This loch is about two miles in circumference, and at least one considerable burn (the Alt Dochard), with a large extent of good spawning ground, falls into it. It has a fine bottom and is said to be of considerable depth. At present it contains great numbers of small trout. It seemed to me, from its position and capabilities in various ways, to be a very good place for trying an experiment with the American land-locked salmon. Not far below the falls, which, fortunately, prevent the ascent of pike into Loch Dochard, there is a round, broad, deep pool in the river which is said to be a favourite haunt of pike; and, as it probably contains but little else, a charge of dynamite would be far more effectual in getting rid of these pests than either nets or lines. Certainly, if in any case such a strong measure could be justified, it would be here, as Lord Breadalbane is the sole proprietor of Loch Tulla and all its tributary streams and the greatest sufferer from the plague of pike.

Pike-killing Apparatus.—On the long stretch of still deep water in the lower part of the Linne-nan-Beathach, already described, where the pike reign in undisputed supremacy, I saw several specimens of an ingenious apparatus employed by Lord Breadalbane for their capture. This apparatus consists of a wooden pole fixed into the river's bank, a stout cord being attached to the extremity of the pole, the said cord being fixed about a foot below the pole to the apex of a wooden triangle, like an inverted Λ. The cord is wound round and round this inverted Λ, each limb of which is about five inches in length, and it is then jammed into a cleft in the extremity of one of the arms of the Λ. From the cleft the cord hangs down into the water, and within a short distance of the bait, which is generally a small trout, the cord has a piece of wire attached to it to guard against the teeth of the pike. When the pike seizes the bait, he pulls the cord out of the cleft in the one extremity of the inverted Λ, gradually unwinds it in his struggles to get away, and is kept sailing about in the water until one of the keepers comes to inspect the apparatus. I was told that a great many pike had been captured in this comparatively rude and primitive manner, and that, consequently, the number of these snares was to be largely increased.

THE LAND-LOCKED SALMON.

With reference to the suggestion made above that Loch Dochard would be a good place for an experiment with the land-locked salmon, it may be thought that it is somewhat too small a loch for such an experiment. But then it should be remembered that these fish, in the United States, appear to thrive as well, other things being considered, and to attain as large a size in lakes of a few hundred acres in area as in those covering thousands of acres. For example, the largest fish in Grand Lake region are found in West Musquash Lake, the area of which is less than 1000 acres; and among new localities may be mentioned Shrewsbury Lake, in Vermont, only one mile long and half a mile wide, where signal success has attended the introduction of this fish. Depth of water appears to be of more importance than extent of area; and, as a rule, the largest salmon are found in deep lakes. Thus, among the native haunts of the land-locked salmon, Lake Sebago, where 410 feet of water have been found, contains the largest fish in the State of Maine; while West Musquash Lake, which produces the heaviest salmon of that region, is known to be, in some places, over 130 feet deep. Grand Lake is 115 feet in depth, and Shrewsbury Lake, in Vermont, 160 feet. A competent American observer states that he does not think that the land-locked salmon would thrive where they were compelled to endure through the summer a surface temperature of 70 degs. Fahrenheit, or upwards. Assuredly, there need be no fear of that in any of our Scottish lakes. But, apart from the temperature, these fish are not fastidious. Muddy water is certainly objectionable; but among their native haunts there are many lakes the waters of which are strongly coloured with peaty and earthy solutions. The land-locked salmon spawn on gravelly rapids in rivers and brooks. Colonel Macdonald, the inventor and patentee of the 'Macdonald Fishway,' told me when he was in Scotland a few years ago, that he felt certain that the land-locked salmon would thrive in many of our Scotch lakes, and that impregnated eggs could be had from the United States Fish Commission. A recent Report of that Commission states that there have been distributed, during the year to which it refers, no fewer than a million and a half of the eggs of the land-locked salmon for the purpose of stocking the rivers, lakes, and ponds of America.*

During my inspection of the rivers and lochs of the Black Mount, I saw some hauls of the net made for pike in Loch Tulla, not far from where the river Orchy issues from it, and in some of the upper pools of the Orchy. No pike or salmon were captured, the extreme lowness of the river having prevented the latter from ascending. But one or two beautiful specimens of Loch Tulla trout, up to $2\frac{1}{2}$ lbs., were taken. These were,

* As I found that the Marquis of Breadalbane was both willing and anxious to ascertain whether the land-locked salmon could be acclimatised in our Scotch lochs, and as, from the extent of his property and the number and variety of lochs on it, he possesses exceptional facilities for making the experiment, I applied to Colonel Marshall Macdonald, of the United States Fishery Commission, to ascertain whether he would send over from America a supply of impregnated ova. He complied with my request in the handsomest and most liberal manner, and sent a consignment of no fewer than 25,000 ova, which arrived in this country with very trifling loss, and were deposited in hatching-trays at Taymouth Castle in February last.

in all respects, equal to Loch Leven trout, and the pity is that they are so few and far between. The Orchy above the falls is always a very late river; and, last season, probably owing to the exceptional dryness of the weather, no salmon had been taken in the Black Mount water up to the end of June.

FISHING FOR SALMON BY BASKETS FIXED AT WATERFALLS.

A curious mode of fishing used to be practiced at a place called Catnish, near the falls of the Orchy. It is thus described by a writer about a hundred years ago :—

Four miles below the church, at a place called Catnish, shoals of salmon are taken in the Orchy by a simple but fatal device. A bold projecting rock crosses the river nearly from side to side. Its height is such that few fish can overleap the torrent; which, after rains, rushes forcibly into the pool below. Many salmon, in attempting to leap, fall into a creel or basket, fixed transversely within the stream. But the great slaughter is affected in a more fraudulent manner. On the one side of the river there is an opening, of the wideness of a mill-race, betwixt the rock and the bank. Here a wicket-gate is fixed that can be opened and shut at pleasure. Many yards above this entry the stream is secured by a like barrier. When the water is high and turbid, the fish are let in below, and when the fisherman is satisfied with the numbers that have passed into his toils, he shuts the doors of his prison, and, like a merciless executioner he drags his prey with his spear, one after another, on shore. Scores, at times, are thus destroyed in the course of a few hours.

In several other places in Scotland, a creel or basket was fixed near a waterfall, in order to catch salmon who fell back after vainly attempting to clear the obstruction. For a long time there was a basket of this kind at the Falls of Tummel; and, previously to the construction of the Caledonian Canal, which changed the levels of the waters, there was a creel near Lochiel's residence at Auchnacarry, and I have been told that when a salmon fell into this creel it was not only captured but announced its capture to the cook, as there was an arrangement by which the falling of the salmon into the creel rang a bell in the kitchen. Of course all creels or baskets or similar contrivances for catching salmon are now illegal, as the 5th subsection of the 15th section of 'The Salmon Fisheries (Scot-'land) Act, 1868,' enacts that every person 'who sets or uses, or aids in 'setting or using, a net or any other engine for the capture of salmon, 'when leaping at or trying to ascend any fall or other impediment, or 'when falling back after leaping, shall for every offence be liable to a 'penalty not exeeding £5; and to a farther penalty not exceeding £2 for 'every salmon taken or killed in an illegal manner, and shall forfeit the 'salmon so taken.'

THE KINGLASS.

The Kinglass, one of the best little rivers in the west of Scotland for salmon and sea-trout, runs through the Black Mount, past Forest Lodge, and falls into the side of Loch Etive. It rises in a wild mountain glen, 2200 feet above the level of the sea, on the northern skirt of Ben-nan-Aighean. Thence it has a winding course through Glen Kinglass until it joins Loch Etive. In its upper part it is a rapid brawling mountain torrent; but between Forest Lodge and its mouth, a distance of about six miles, its descent is less precipitous, and there are upwards of twenty-five pools for salmon and sea-trout,—among the best of which are Rock Pool, Maiden's Pool, Ford Pool, Dog's Pool, Bridge Pool, &c. The Kinglass is a late river, July, Angust, and September being the best months. As many as from 13 to 20 sea-trout, averaging 3 lbs., have been taken from the lower pools by a good fisherman in a single day. The salmon do not run large; no fish above 20 lbs. having ever been captured in it. At Inverkinglass, where the river joins Loch Etive, there was once an iron smelting furnace, and a fine pine forest formerly occupied a great part of the area of the glen; but the trees were cut down about the middle of last century to supply fuel for the iron furnace. Many other parts of the Black Mount once produced valuable timber, which has now nearly disappeared.

The water of the Kinglass is remarkably clear, and when I inspected this part of the river it was so low that I could see to the bottom of even the deepest pools. There had been no rain for three weeks, and consequently, though it was the 29th of June, not a single salmon or sea-trout had yet ascended. Below the bridge, near the farm of Acharn, there is a large deep pool, which, when the river is in good order, must be a favourite haunt for salmon and sea-trout; and a good way farther down there is a long stretch of splendid spawning ground, even in the low state of the river, all covered with water. I was told, however, that six or seven years ago, there had been a violent flood in the Kinglass which very much altered and injured the spawning beds generally. But between the Lodge and Loch Etive there is still sufficient spawning ground to afford redds to stock a much larger stream than the Kinglass.

There is a small loch, called Lochan-na-Turaiche, connected with Loch Dochard, which sends out a burn in the direction of the Kinglass, and it has been proposed to close the communication in the direction of Loch Dochard, and to make a cut diverting the waters of Lochan-na-Turaiche into the Kinglass. In this way the volume of the Kinglass would be increased, and its too clear water be darkened by the mossy water from this small mountain loch. This may be so; but the operation would be somewhat costly, and I doubt much whether the game would be worth the candle.

About a mile above the Lodge in Glen Kinglass, there is a waterfall on the river at least 12 feet perpendicular, which entirely stops the ascent of the migratory salmonidæ; and, two miles above this fall, there is another impassable obstruction. By making a subsidiary dam of stones or concrete a little below the first fall, salmon and sea-trout might be enabled to ascend easily, or by blasting a ledge of rock, which juts out from the centre of the fall; then, above the main fall, there is a long slope of granite, over which the stream runs when the river is high, in a rapid current of white water; and it would be necessary to form a resting-pool in the centre of the slope in order to enable salmon and sea-trout to get up. It would probably cost at least £100 to make this fall passable, and the two or three pools between it and the second impassable fall, two miles farther up, that would thus be opened up to salmon and sea-trout, would never repay the cost of the operation.

In Glenkinglass, between the Falls a mile above the Lodge, and two green mounds of earth, a little below it, through which the river has cut its way, there is a large level space sharply marked out, perhaps 1½ miles in circumference, which has once evidently been the bed of a lake, and which would become so again if the space between the said green mounds —not a very wide one—were filled up by an artificial dam. This would be the best thing that could happen for the river as it would afford a magnificent shelter for salmon and sea-trout; but as the Lodge stands nearly in the centre of what would be the bed of the lake, such a scheme could never be carried out.

LOCH BEA AND THE LOCHY.

In the beginning of July I left the Black Mount for Oban, in order to meet the members of the Awe District Board. On my way to Tyndrum, I passed Loch Bea—a nice little trouting loch attached to the hotel at Tyndrum—and the Lochy, the stream which flows out of it into the Orchy. This stream runs through a prettily wooded and picturesque gorge in which there are several waterfalls, and it has been proposed to blast them in order to let salmon or, at all events, sea-trout into Loch Bea. This, I think, would be a mistake, because it would cost too much, and, because, even if carried out, salmon and sea-trout would have to pass into Loch Bea through a small shallow stream, which would offer great temptations and facilities to the poacher.

ANSWERS TO PRINTED QUERIES BY MARQUIS OF BREADALBANE.

In his answers to the printed queries, the Marquis of Breadalbane expresses his opinion that the angling season on the Awe and Orchy should close on the 10th October, instead of, as at present, on the 31st. He approves of a close time for trout and char, from 1st October to 1st March, and he is satisfied with the present period of the weekly close time; but states that it is not strictly observed, either by net and coble, or by bag and stake nets, in those parts of the west of Scotland with which he is acquainted. He approves of having a fixed *minimum* as well as a *maximum* penalty for offences under the Salmon Fishery Acts—the *minimum* penalty to be one-fourth of the *maximum*; and he is also in favour of prohibiting the sale, or offering for sale, of salmon caught during the extension of time for rod-fishing. With regard to the prevention of pollutions, he would give to District Boards, within their own districts, the same powers, for the abatement of pollutions in rivers and waters, as are at present competent to riparian proprietors at common law. But he states that in his district of Argyleshire there are no pollutions, and that the salmon disease has never yet shown itself. He farther states that there is a great deal of illegal fishing by yachtsmen on the West Coast for salmon and sea-trout, and that 'scringing' for salmon and sea-trout by fishermen who have no title or right to fish for or to take such fish is 'increasing enormously.' He suggests as a remedy that the police should have the right of search, and should be obliged to prosecute unqualified persons found in possession of fish of the salmon kind.

ILLEGAL FISHING BY YACHTSMEN.

With regard to the illegal fishing by yachtsmen complained of by Lord Breadalbane, in his answers to the printed queries, I may state that complaints have again and again, and year after year, been made to me by proprietors and lessees of salmon fishings on the West Coast of Scotland, of the injury done to their fishings by poaching by yachtsmen in the mouths of rivers, in bays and sea-lochs, and along the coast in the narrow seas, where all the salmon fishings are the private property either of the Crown or of the grantees of the Crown; and the illegality of the conduct of yachtsmen in fishing for and capturing salmon or sea-trout in such localities, was brought before the Fishery Board in my Third Annual Report. The complaint is a very old one, though no effectual steps have as yet been taken to prevent or abate the unlawful fishing complained of. So far back as February 1874, I drew up a circular, which was signed by the Commissioners of Scotch Salmon Fisheries, and sent to the

Secretaries of all the Yacht Clubs in the United Kingdom. That circular narrated the law applicable to the subject, and concluded by stating that the Commissioners had the authority of the Home Office for drawing it up and sending it to the secretaries of the various yacht clubs, with a request that they would take an early opportunity of bringing it prominently under the notice of their members.

This circular, however, did not produce the desired effect, as complaints of illegal fishing by yachtsmen were made to the Fishery Board for Scotland, who have succeeded to the powers and duties of Commissioners of Scotch Salmon Fisheries, and have the general superintendence of the Salmon Fisheries in Scotland, and the following circular, signed by the Secretary to the Board, was sent to the secretary of every yacht club in the country, and also to a number of newspapers :—

Scottish Salmon Fisheries.—Fishery Board for Scotland, Edinburgh, 31*st May* 1884.—Sir,—I am directed by the Fishery Board for Scotland to inform you that the Inspector of Salmon Fisheries has laid before the Board complaints from lessees of salmon fishings, that yachtsmen, while cruising along the coasts of Scotland, and especially along the coasts of the western mainland and the Hebrides, are in the habit of using nets, and illegally taking salmon and sea-trout, within the limits from low water mark, over which the rights of the Crown and its grantees extend.

According to the law of Scotland, no one has a right to fish for salmon or sea-trout in the narrow or territorial seas—which are held by the best legal authorities to extend to three miles seawards from low-water mark—except the Crown and its grantees, and those who have permission from them ; and by special Statute (7 & 8 Vict. c. 95), it is provided that—'Whereas an Act was passed in the ninth year of the reign of His Majesty King George the Fourth, intituled, An Act for the preservation of the salmon fisheries in Scotland ; and whereas it is expedient to prevent the destruction of salmon, or fish of the salmon kind, in the sea or shores thereof ; and whereas doubts are entertained of the provisions of the said Act being applicable to the sea or sea-shore : Be it therefore enacted by the Queen's most excellent Majesty, by and with the advice and consent of the Lord's Spiritual and Temporal and Commons in this present Parliament assembled, and by the authority of the same, as follows : That if any person not having a legal right or permission from the proprietor of the salmon fishery, shall, from and after the passing of this Act, wilfully take, fish for, or attempt to take, or aid and assist in taking, fishing for, or attempting to take, in or from any river, stream, lake, water, estuary, frith, sea-loch, creek, bay, or shore of the sea, or in or upon any part of the sea, within one mile of low-water mark, in Scotland, any salmon, grilse, sea-trout, whitling, or other fish of the salmon kind, such person shall forfeit and pay a sum not less than 10s. and not exceeding £5, for each and every such offence, and shall, if the sheriff or justices shall think proper, over and above, forfeit each and every fish so taken, and each and every boat, boat tackle, net, or other engine used in taking, fishing for, or attempting to take fish as aforesaid ; and it shall be lawful for any person employed in the execution of this Act to seize and detain all fish so taken, and all boats, tackle, nets, and other engines so used, and to give information to the sheriff or any justice of the peace, and such sheriff or justice may give such orders concerning the immediate disposal of the same as may be necessary.'

The above statute has since been amended and made more stringent by the 25th section of 'The Salmon Fisheries (Scotland) Act, 1868,' which provides that, 'In order the better to carry out the provisions of the Act of the seventh and eighth years of her present Majesty, chapter ninety-five, it shall be lawful for any water-bailiff, constable, watcher, or officer of any District Board, or any police officer, to search all boats, boat tackle, nets, or other engines, and all receptacles, whether at sea or on shore, which he or they may have reason to suspect may contain salmon captured in contravention of the said last-mentioned Act, and to seize all salmon found in the possession of persons not having a right to fish salmon, and the possession of such salmon shall be held *prima facie* evidence of the purpose of the possessor to contravene the provisions of the said last-mentioned Act.'

From the foregoing statement you will at once see, that all yachtsmen who have neither a title to salmon fishings nor permission from one who has a title, but who, notwithstanding, fish for or take salmon, grilse, or sea-trout, in the narrow seas around the coast of Scotland, within the limits over which the rights of the Crown and its grantees extend, infringe the law and render themselves liable to prosecution and punishment.

The Fishery Board for Scotland, established by the Fishery Board (Scotland) Act, 1882, has now the general superintendence of the salmon fisheries in Scotland, and I am instructed to request that you will be so good as to take an early opportunity of bringing this matter prominently under the special notice of the members of your club.—I am, your obedient servant, DUGALD GRAHAM, *Secretary*.

To the Secretary of Yacht Club.

When it is taken into consideration that, in 1888, there were 62 yacht clubs in the United Kingdom, and 5174 yachts, and that English and Irish yachtsmen, who have not paid special attention to the subject, can scarcely be expected to know that the law in Scotland differs so much from that which applies to England and Ireland,—where salmon fishing in navigable rivers, in estuaries, and in the narrow seas is, as a rule, a public right,—it will be generally admitted that these circulars were not uncalled for.

'SCRINGING.'

The great evil against which the Awe District Board and the proprietors of salmon fisheries—from Loch Crinan to the head of Loch Etive, on the Linnhe Loch and lochs opening into it, on the Sound and Island of Mull—have to contend, is the practice of what is locally termed 'Scringing,' which has been fully described in my third and sixth Reports to the Board. Scringing for sea-trout and salmon—chiefly for the former—is prosecuted in the above-named localities by means of nets used by fishermen who have no title to fish for salmon in their own persons, nor permission from one who has a title; and, occasionally also, by fishermen who rent a small salmon fishing from a proprietor, and use this as a pretext to capture salmon and sea-trout where they have no right to fish. The scringers and their boats are well known, and yet they land their poached fish openly at the quays at Oban without being stopped by the police, although the 25th section of 'The Salmon Fisheries (Scotland) Act, 1868,' provides that:—

In order the better to carry out the provisions of the Act of the seventh and eighth years of her present Majesty, chapter 95, it shall be lawful for any water-bailiff, constable, watcher, or officer of any District Board, or any police officer, to search all boats, boat tackle, nets, or other engines, and all receptacles, whether at sea or on shore, which he or they may have reason to suspect may contain salmon captured in contravention of the said last-mentioned Act, and to seize all salmon found in the possession of persons not having a right to fish salmon, and the possession of such salmon shall be held *prima facie* evidence of the purpose of the possessor to contravene, the provisions of the said last-mentioned Act; provided also that the words 'the said-recited Acts,' contained in the second section of the last-mentioned Act, shall be read and construed as if they meant and included this Act and the Acts recited therein.

To me it seems that there could scarcely be a more stringently worded section than the above, and that it throws upon the scringers, as strongly and clearly as words can do, the *onus* of proving that they got, legally, the sea-trout or salmon found in their possession. If not, the words 'and the possession of such salmon shall be held *prima facie* evidence 'of the purpose of the possessor, to contravene the provisions of the said 'last-mentioned Act,' have no meaning whatever. I was told, last summer, at Oban, that the reason why the police are not allowed to prevent the scringers from landing their poached fish at the Oban quays is, that the late Sheriff Cleghorn and Sir George Home, the Sheriff-Substitute at Inveraray, when consulted by the Commissioners of Supply, stated, at a county meeting in 1869, that in their opinion it was necessary for the prosecutor under the above-quoted 25th section of the Act of 1868, to prove the *locus* where the sea-trout or salmon were caught—a thing practically impossible to do; and, in accordance with this opinion, no steps have since been taken against the poachers, who are allowed to carry on their illegal fishing with impunity. I have already said, that I think this was a wrong reading of the section; but, if it was a right one, it is to be hoped that, in the event of any future salmon fishery legislation, the section will be so amended as to make it clear that the *onus* shall rest on the scringers, to prove legal possession, and not on the District Board or the police to prove the *locus*.

The following amendment of the clause would probably be found sufficient. I put the additional words in italics:—

And the possession of such salmon shall be held *prima facie* evidence of the fact that the possessor has contravened the provisions of the said last-mentioned Act; *that is to say, that the onus of proving that such salmon were taken outside and beyond the limit of one-mile seaward from low-water mark, shall be upon every person having such fish in his possession, and not having a legal right in his own person or permission from the proprietor of a salmon fishery.*

SALMON FISHERY LEGISLATION.

Such a provision as that contained in clause 45 of the Salmon Fisheries Consolidation and Amendment Bill recently laid before Parliament would probably be sufficient, if passed, either to put a stop to scringing, or, at all events, greatly to diminish it.

But that bill, which has now been withdrawn, was, to some extent, an attempt to reconcile the almost irreconcilable claims and interests of upper and lower proprietors; and it, therefore, not unnaturally, excited an amount of opposition which proved fatal to it. But there are many provisions which would be unquestionable improvements to our Salmon Fisheries in Scotland about which both upper and lower proprietors are agreed. Might it not, therefore, be worth trying the experiment of embodying these in a new bill, without touching upon those matters with regard to which there is no chance of securing unanimity? For example, a bill providing for the following points would probably unite the suffrages of upper and lower proprietors, and would have a good chance of passing through Parliament. These points are the prohibition of the sale of salmon caught during the extension of time for rod-fishing; granting additional powers of search and seizure to water-bailiffs, &c.; provisions for District Boards remaining in office until their successors are appointed; for removing diseased fish from rivers and waters; for making obstructions in rivers passable for salmon; for effectually preventing the pollution of rivers; for prohibiting the use of the cleek for landing salmon until the 1st of May; for fixing minimum as well as maximum penalties for offences; for the prevention of 'sniggling;' for fixing a close time and a gauge, or both, for trout; for smolt-guards in the case of turbine wheels and similar engines; for giving District Boards additional powers to rent, lease, or purchase any salmon fishing, fixed engine, &c., for the benefit of the fishings in their respective districts; and for conferring powers on the Fishery Board for Scotland to enforce the provisions of the Salmon Fishery Acts in those districts where there are no District Boards. Such a bill, it humbly seems to me, would have a fair chance of passing. Whereas a bill providing for lengthening the annual and weekly close times; for regulating and restricting the working of draft nets; for allowing District Boards to elect their own chairman, irrespective of rental; for prohibiting netting within a certain distance above and below dam-dikes; for further regulating and restricting the construction and working of stake, fly, and bag nets; and for altering estuary lines; would, almost certainly, be rejected.*

ILLICIT TRAFFIC IN SALMON FROM SCOTLAND TO FOREIGN MARKETS.

Although we are not to have a general Salmon Fisheries Bill during the present session of Parliament, it would certainly be very desirable, and greatly for the benefit of the Scotch Salmon Fisheries, as well as agreeable to both upper and lower proprietors, to pass a short, sharp, and simple bill to prevent 'scringing' and other forms of salmon poaching which at present result in an immense illicit traffic in Scotch salmon to the home market, and to England, France, and elsewhere. It need only be a short bill, and if properly drawn, so as to amend the deficiencies in the existing salmon fishery legislation in Scotland, it would soon prevent, or at least greatly diminish, this illegal traffic, which has now assumed almost gigantic proportions owing to the inefficiency of the present Salmon Fishery Acts. Probably more than 100 tons of unseasonable salmon are annually sent to England, France, and elsewhere from Scotland. In Scotland, the powers of search and seizure possessed by water-bailiffs, constables, officers of district boards, &c., have proved utterly inadequate to check the evil. What is chiefly wanted are powers of search and seizure in the case of unseasonable salmon, such as are conferred with regard to game, by the second section of the Poaching Prevention Act of 27th August 1862; the prohibition of the sale, offering for sale, or having in possession for the purpose of sale, of salmon caught during the extension of time for rod fishing; and the throwing on persons in whose possession salmon are found, in a district where the annual close time has commenced, the *onus* of proving that they got them in a district where it was still legal to take them.

All these things are provided for by the English Salmon Fishery Acts; that is to say, they have had in England for many years past what we in Scotland are still striving to obtain. Yet our salmon fisheries are three times as valuable as those of England, but, owing to the remoteness of many of them, the want of fishery boards, and other causes, the facilities for poaching are much greater. It is time, therefore, that measures should be taken to make our laws as stringent as those of England. Since 1861, it has been illegal in England to sell or offer for sale salmon caught during the extension of time for rod fishing; and the Select Committee of the House of Lords who reported on the Scottish salmon fisheries in 1860, gave a strong opinion against the sale of fish caught during the extension of time for rod fishing, recommending on page 11 of their Report, 'that the annual close time be from the 20th August 'until the 1st February, rod fishing to continue till the 15th of October; 'but that no salmon, the produce of any fishing in Scotland, be sold after the 1st September.'

As to the *onus* of proof, it may almost be said that the English Acts generally throw it, to a great extent, on the persons in whose possession unseasonable salmon are found; while the Scottish Acts, as interpreted by the decisions of the Courts, throw it on the prosecutor. For example,

* For a full consideration and discussion of the alterations in the existing Salmon Fishery Acts, which would be generally approved of, and of those with regard to which there would be great difference of opinion, see my Annual Report to the Fishery Board in 1883, on the Salmon Rivers on the East Coast of Scotland, pages 39 to 65.

the 19th section of the English Salmon Fishery Act of 1873, which provides penalties for the sale of fish during the annual close time, is in the following terms :—

No person shall buy, sell, or expose for sale any salmon, or part of a salmon, between the 3d day of September and the 1st day of February following, both inclusive. And any person acting in contravention of this section shall forfeit any salmon, or part of any salmon, so bought, sold, or exposed for sale, or in his possession for sale, and shall incur a penalty not exceeding £2 for every such salmon or part of any salmon. But nothing herein contained shall apply to any person buying, selling, or exposing for sale, or having in his possession for sale, any salmon which has been cured, salted, pickled, or dried beyond the limits of the United Kingdom, or if within the limits of the United Kingdom between the 1st day of February and the 3d day of November in any year, or any clean fresh salmon caught within the limits of the Act, provided its capture by any net, instrument, or device other than a rod and line, if within the United Kingdom, was lawful at the time and in the place where it was caught ; but the burden of proving that any clean salmon so bought, sold, exposed for sale, or in the possession of any person for sale, was captured abroad, or lawfully captured within the United Kingdom, shall lie on the person selling, or exposing for sale, or having in his possession for sale any such salmon ; and the burden of proving that any cured, salted, pickled, or dried salmon was cured, salted, pickled, or dried elsewhere than in the United Kingdom, or if within the United Kingdom, then between the 1st day of February and the 3d day of November in any year, shall lie upon the person in whose possession for sale such salmon is found.

The Tweed Fisheries Act of 1859, section 10, also throws the burden of proof on persons selling or offering for sale salmon caught during the annual close time, that such fish were not taken contrary to the provisions of the Act.

It would not be difficult, if it were thought convenient and desirable, to frame a short Act for the special purpose of preventing the illicit traffic in unseasonable salmon, which should apply, not only to Scotland, but to Great Britain, or even to the United Kingdom. For though in England, as has been shown, they have more stringent laws against salmon poaching than we have, they might still wish to extend, for example, the powers of search and seizure of unseasonable fish which the Fishmongers Company already possess in London, to the whole of England ; to require the market authorities to enforce within their jurisdiction the Acts relating to the sale of fish ; to strengthen the hands of the Fisheries Department of the Board of Trade, especially with regard to places not included in any fishery district ; and to apply the Acts restraining the exportation and sale of salmon to trout, wherever a close time for that fish exists.

AWE DISTRICT BOARD.

I give the following extracts from the answers to the printed queries sent me by a member of the Awe District Board :—

The fishermen all say that the take of fish has decreased—cause, destruction of immature fish by 'scringing,' consequently the fish are not there to catch ; also the destruction of spawning fish in the upper waters of the Nant, Lonan, Feochan, and Euchar by crofters and farmers. They are sold in Oban, or salted. I see little prospect of stopping this, as people have become lawless through land agitation. With regard to District Boards, he suggests 'that owners under £10 rental should not be excluded, as they mostly stay at home and would look after work.' He is also in favour of amalgamating the small fishery districts on the West Coast into larger districts, and so enabling them to maintain a steam launch for the prevention of poaching ; and he would have dealers in salmon and sea-trout obliged to take out licenses in the same way as the salesmen of game are. He would, likewise, regulate the working of draft nets, as in the Tweed Acts and the English Acts. As to illegal fishing by yachtsmen, he states 'I have seen them at it, there is little disguise in the matter.' 'Scringing' is increasing greatly. But if the nets were destroyed and the owners fined, provided the mesh was not the legal size, they would soon give it up as it would not pay.

FAILURE OF THE SYSTEM OF DISTRICT BOARDS ON THE WEST COAST.

One of the most valuable suggestions in the above answers is that regarding the necessity of amalgamating the small fishery districts on the West Coast into larger districts, in which the assessment levied on the fishings would be sufficient to pay a clerk, river-watchers, and the other machinery necessary for a practically useful District Board. Any one who will take the trouble to glance over the map prefixed to my Third Annual Report to the Fishery Board, in which the boundaries of all the fishery districts are marked; the districts which have no District Boards being left white, and the districts where there are District Boards being coloured pink; will be at no loss to see why there are scarcely any District Boards on the West Coast; whereas on almost all the East Coast rivers there are Boards. This map shows, what I afterwards point out at some length in the course of my Report, that the question of District Boards is very much a question of expense. It is not the apathy of the proprietors, but the poverty of the fishings, in the small rivers and districts of the West Coast, that accounts for the almost total absence of District Boards in that part of Scotland. The two largest rivers on the West Highland Coast, indeed the only two large rivers, the Lochy—with its tributary the Spean—and the Awe have both got District Boards; and when we come to the East Coast, where are all the great rivers of Scotland, with the exception of the Clyde, we find that nearly all these rivers, from the Forth to the Kyle of Sutherland, both inclusive, have, and have long had, District Boards. They can afford it, and find it worth while to have them. The West Coast rivers in Ross-shire, Inverness-shire, and Argyllshire, on the other hand, cannot afford them, even in the simplest and most rudimentary form. How can a river with a catchment basin of 8, or 10, or 20 square miles, and with, perhaps, half-a-dozen bag-nets within the limits of the district, afford, by an assessment on the fishings within that district, to pay a clerk to the District Board and watchers? So far as these rivers are concerned, the system of District Boards has proved a failure, and either some other system must be devised, or else a number of these small districts must be combined into larger districts, in which the assessments on the fixed nets and the river fishings will be sufficient to maintain the necessary machinery for a District Board. A very brief inspection of the map will show that, though only about one-third of the Fishery Districts in Scotland have District Boards, this one-third has a larger watershed than that belonging to the remaining two-thirds of the fishery districts which have no District Boards. The average drainage area of the West Coast rivers (including the Clyde), where there are scarcely any District Boards, is hardly 80 square miles; whilst that of the East Coast rivers (not including the Tweed), almost all of which have District Boards, is upwards of 350 square miles.

The following counties have no District Boards, namely:—Dumbarton, Kinross, part of Fife, Midlothian, Renfrew, Linlithgow, Caithness, Ross and Cromarty; yet the last-named county has no fewer than thirty-two salmon rivers on the mainland and in the Hebrides. Argyllshire, also, with thirty-two salmon rivers, has only two District Boards, that of the Island of Mull and that of the Awe, which was reconstituted by the Court of Session a few years ago.

In the English Salmon Fisheries Act of 1873 the amalgamation of districts is provided for by section 5, which is as follows:—

A board of conservators of any fishery district may, after giving three calendar months' notice in writing to any other board or boards of conservators affected by such alteration, or, in case there is no board, to the justices of the peace of any county in quarter-sessions assembled, the whole or any part of which shall be affected by such alteration, apply to the Secretary of State to enlarge, reduce, or alter the limits of such district, or to combine two or more districts or parts of districts; and, after such notice has been previously advertised for two successive weeks in one or more local newspapers, published or circulating within the district or districts affected by such alteration, the Secretary of State may thereupon by his certificate enlarge, reduce, or alter such district, either by uniting it with any other district or districts, or combining it with any other part or parts of a district or districts, or by severing any part from such district and forming it into a separate district, or uniting it with any other district, or by adding to such district any place not yet included in any district; and the certificate of the Secretary of State embodying all such alterations shall be granted in accordance with the provisions of 'The Salmon Fishery Act, 1865,' and shall transfer and apportion any existing contracts, debts, mortgages, liabilities, and assets among such altered boards. But no alteration of any district shall affect the power of any existing board or boards until the new districts are fully constituted.

The 8th subsection of the 23rd section of the Consolidation and Amendment Act, recently before Parliament, empowers the Secretary for Scotland 'To amalgamate any district, or part of a district with any 'other district, or to divide any district or districts into two or more districts, and to fix the limits thereof.'

RECONSTITUTION OF FISHERY DISTRICTS IN THE WEST HIGHLANDS AND ISLANDS.

A pretty accurate and extensive acquaintance with the salmon rivers and fishery districts in the Western Highlands and Islands emboldens me to make some suggestions for their reconstitution. In several of the Hebrides, there are two or more separate districts in a single island—Mull, for example, has three—and it would be better, in general, to have only one Fishery District in each island. To the Clyde Fishery District, which at present includes the Leven and the Eckaig, there might perhaps be added the Ruel and the Coe; the former falling into the head of Loch Ridden, and the latter into the side of Loch Long. Then the Nell, Feochan, and Euchar, and possibly the Creran, should be united to the district of the River Awe. The Shiel, Moidart, Kinloch Aylort, and Morar districts might be combined; also those of the Inverie, Guseran, Arnisdale, Glenbeg, and Glenelg; and those of the Shiel (Loch Duich), the Luing, and Elchaig, and the Carron. Going still farther north, the districts of the Kishorn, the Applecross, the Balgy, the Torridon, the Kerry, and the Badachro might likewise be amalgamated, and those of the Ewe, the Gruinard and Little Gruinard, and the Broom. North of these last-named streams, all the salmon rivers in Cromarty and Sutherland belong to the Earl of Cromartie and the Duke of Sutherland.

The list of rivers and districts given above, which it is proposed to amalgamate, may be susceptible of modification and amendment. But, as previously stated, it is quite certain that District Boards cannot be supported, and can, therefore, scarcely be expected to be constituted, in the poor and small fishery districts into which the Western Highlands and Islands have been divided.

NESS AND NAIRN.

At Inverness, I found considerable diversity of opinion prevailing with regard to the fishing season best suited for the Ness, which is undoubtedly one of the earliest salmon rivers in Scotland. One member of the District Board, who has had great experience of salmon fishings, thinks that the angling season should be from the 18th January to the 1st October, instead of, as at present, from 11th February to 15th October. Another gentleman, also of great experience, is of opinion that the netting season should extend from the 27th June to the 10th December, instead of, as at present, from 11th February to 27th August.

As to the fishing in the Nairn district, I was told by the superintendent of the Ness fishings that the value of the net fishings, on either side of the mouth of the Nairn, has greatly increased since the proprietors on the Nairn bought up and demolished the dam near the mouth of the river, which used to be a terrible barrier in the way of ascending fish; the increase in the capture by these fixed nets arising from the greatly augmented number of spawning fish.

With regard to the estuary line for the Ness and Beauly, fixed in 1865 by the Commissioners of Scotch Salmon Fisheries, under the powers conferred by 'The Salmon Fisheries (Scotland), October 1862,' I still continue of the opinion, which I have formerly expressed, that it ought to be altered and amended. It is far too large an estuary, being 'a straight 'line drawn due south-east, true meridian, from the centre of the three 'burns to the southern shore, thus cutting the Black Buoy as at present 'placed on the north end of the Whiten Ness Sands.' This line, as will be seen at once by any one who takes the trouble to consult the map, is outside Chanonry Point and Fort George—the natural *Fauces Terræ*—and is actually twenty-four miles below the mouth of the Beauly and nearly twelve miles below the mouth of the Ness; and it inflicted a great injustice and a heavy loss (£500 a year) on the proprietor of the stake and bag nets at Chanonry Point, for which he never received any compensation. I may mention that the Ness District Board are of opinion that the estuary of the Ness and Beauly is too far extended and that it ought to be amended and abridged, and some of the members think that the line should be from Munlochy Point on the north to Altarlie Point on the south. This line is about seven miles within the present estuary line and is rather more than three miles below Kessock Ferry. After a careful examination of the localities, I am of opinion that it would be a fair and equitable estuary line for the rivers Beauly and Ness.*

So far back as 1870, this estuary line question was carefully examined and considered by the late Mr Frank Buckland and myself; and on page 26 of our Report of 1871 on the effects of recent legislation on the salmon fisheries in Scotland, we write as follows:—

As regards the question of the re-adjustment of the boundaries between river and sea, the evidence laid before us and our own personal investigations lead us to conclude that it is advisable that the Secretary of State should be empowered, after due inquiry, to alter the existing estuary lines, on the application of a District Board; or in those districts where no District Board exists, on the application of two proprietors of salmon fishings; or on the application of a single salmon fishery proprietor, where there is only one proprietor in any district. We are also of opinion that the Secretary of State should have power, under the same conditions, to re-adjust the boundaries between sea and river, in the case of rivers which have no estuary, but fall directly into the sea.

The bye-laws of the Commissioners, drawn up under the powers conferred by the Salmon Fishery Act of 1862, which fix fishery districts, estuaries, annual and weekly close-times, and regulate the use of movable and fixed nets, cruives, mills and mill dams, water-wheels, lades,

* See Note II. for a sketch map of the present estuary line of the Rivers Ness and Beauly and also of the proposed estuary line from Munlochy Bay to Altarlie Point.

&c., are all in the same position; that is to say, they are all drawn up by the Commissioners and approved by the Secretary of State, and all equally form parts of the general Salmon Fishery Acts of 1862 and 1868. If one set of these bye-laws may be subjected to alteration by an Act of Parliament so may another; as no one of the bye-laws is more a part of the statute than another. The 9th section of the Act of 1868 empowers the Secretary of State, on the petition of a District Board, to vary the bye-laws fixing the annual and weekly close-time, and the regulations with regard to cruives and weirs, framed under the previous Salmon Fisheries Act of 1862. There seems, therefore, no reason why, if it should be deemed expedient, the Secretary for Scotland, who has come in place of the Secretary of State, should not be authorised to alter and amend estuaries.*

SALMON RIVERS ON THE NORTH AND WEST COASTS OF SUTHERLAND.

After leaving the Ness and Nairn, I proceeded to inspect the salmon rivers on the north and west coasts of Sutherlandshire.

LOCH SHIN.

On my way north to Tongue, I stayed a short time at Lairg, which is situated at the foot of Loch Shin, an extensive sheet of water, 16½ miles long and averaging upwards of a mile in width. This spacious lake receives, at its head, the waters from Loch Griam and Loch Merkland, and, on its north-eastern side, the Fiag, which rises in the lofty Ben Hee, and the more important stream of the Tirry, whose source is not far from the hill known as Lord Reay's Green Table. Its waters are discharged into the Kyle of Sutherland, through the channel of the Shin, one of the largest and best angling rivers in the north of Scotland which has a course of between 6 and 7 miles. March, April, and May are the best months for salmon on the Shin, and June and July for grilse.

Lairg Hotel is one of the principal localities in Sutherland where there is free angling; and there were twenty fishermen in it when I was there. Fifteen miles distant, along the north-eastern shore of Loch Shin, is Overscaig Inn, another great angler's resort, from which Loch Griam and Loch Merkland may be more conveniently fished than from Lairg.

The following is an account of the fishing in this district during the season of 1888 :—

On the Overscaig Hotel waters, which include several lochs and tributaries of the Shin, the fish caught by anglers between the 8th June and 14th September were as follows, viz.:—Loch Shin, which was fished on 66 separate days, yielded 1 grilse of 4½ lbs.; 10 salmo ferox, 47 lbs. in all; and 2786 trout, weighing 1276 lbs. Loch Merkland (fished 33 days), yielded 4 salmo ferox, 18 lbs.; and 1298 trout, weighing 455¾ lbs.

Loch Griam (fished 35 days) produced 1 salmo ferox of 3 lbs., and 943 trout,

* In the 'Remarks by the North Esk District Board on the Salmon Fisheries 'Consolidation Bill,' a copy of which was sent to the Fishery Board for Scotland, it is stated that 'this power of alteration is far too general, is not required, and will 'be strenuously opposed;' and the reasons for adhering to the existing estuary bye-laws are given as follows:—'All the bye-laws made and published by the three 'Commissioners defining the limits of estuaries and determining other matters, have 'been declared by the Act of 1868 to be as valid and binding as if they had been 'expressly enacted in that Act. In the spirit of the Act of 1862, the existing limits 'should, therefore, be held as "defined by statute" and should not be subject to 'revision, and far less to extension, unless it can be shown that some gross error 'was committed in their definition by the original Commissioners, or that some 'important change has subsequently taken place.

weighing $473\frac{3}{4}$ lbs. Loch Gorm gave 615 trout, weighing 167 lbs. Including minor lochs and streams on this beat, such as Loch Fionn, Fiag, and Merkland river, the total number of fish caught by anglers at this hotel, including grilse, salmo ferox, and trout, was 5823, of the aggregate weight of $2399\frac{1}{2}$ lbs., or considerably over a ton. The heaviest month was July, during which 2159 trout, &c., weighing 879 lbs. were landed. The greatest sport on any one day was that of the 25th June, when six boats landed between them 290 trout and 1 salmo ferox. On the waters connected with the Sutherland Arms Hotel, Lairg, which include Loch Shin, Loch Beannoch Fourloch, and Loch Cragail, the sport obtained was on the whole very good; and, though the fish caught were not so numerous as at Overscaig, the average weight of each was considerably higher—the Lairg trout being upwards of 2 oz. per head heavier, taking them all over. In the course of the season, anglers at the Lairg Hotel landed 5 grilse and salmon weighing $46\frac{1}{4}$ lbs. in all, 105 salmo ferox weighing 141 lbs., and 1994 trout weighing 1061 lbs. The total number of fish was thus 2104, with an aggregate weight of $1248\frac{3}{4}$ lbs.—equal to 11 cwts. $14\frac{1}{4}$ lbs. At the Sutherland Arms Hotel, Inveran, the salmon angling on the Shin during the past season was rather poor, being fully a third less productive than the previous season. This is partly accounted for by the abnormal coldness of the season and other climatic conditions. Only 72 salmon, weighing $894\frac{1}{2}$ lbs., and 25 grilse, weighing $132\frac{1}{2}$ lbs., were landed, or a total of 97 fish and 1027 lbs. for the season, as compared with 162 fish and 1551 lbs. for the corresponding period of 1887. A vast improvement is, however, anticipated this season, owing to the recent abolition of the net fishings at Invershin. From the above, it will be seen that the total number of fish landed last season with the rod by anglers staying at Overscaig, Lairg, and Inveran was 8024, and the total weight $4675\frac{1}{4}$ lbs., or 2 tons $1\frac{3}{4}$ cwts.

The following return, for which I am indebted to Mr Box, factor to the Duke of Sutherland at Tongue House, gives the yield of the net fishing in the districts of the Halladale, Strathy, Naver, Borgie, Kyle of Tongue, and Hope, from 1885 to 1887, both inclusive:—

TONGUE MANAGEMENT SALMON FISHINGS.

Station.	1885.		1886.		1887.	
	Salmon.	Grilse.	Salmon.	Grilse.	Salmon.	Grilse.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Hope,	1,570	11,782	589	1,844	1,987	5,073
Kyle of Tongue,	826	4,855	432	2,315	655	2,471
Borgie, }	2,935	16,187	886	4,012	1,705	3,737
Naver, }			2,117	8,964	2,490	6,979
Strathy }	8,649	50,309	5,944	17,484	4,989	12.521
Halladale }			5,682	19,839	6,752	19,252

TONGUE SALMON FISHINGS, 1888.

Station.	Salmon.		Grilse.		Trout.	
	No.	lbs.	No.	lbs.	No.	lbs.
Talmine (bag-nets fished by tenant),	14	215	378	2,201	31	74
Borgie (draw-nets and coble),	49	613	358	2,032	...	...
Naver (fished by estate),	164	2,085	720	4,071	...	...
Armadale (bag-nets),	71	889	445	2,280	8	18
Strathy (bag-nets),	574	7,226	3,626	19,326	45	71
Bighouse (bag-nets and draw-nets),	615	7,549	3,818	20,183	109	146
(The last 3 stations fished by tenant).						

I give below the returns from the Naver, Borgie, and Hope, from 1865 to 1872, both inclusive :—

NAVER.

Year.	Salmon.	Grilse.	Year.	Salmon.	Grilse.	Year.	Salmon.	Grilse.
	lbs.	lbs.		lbs.	lbs.		lbs.	lbs.
1865	3,787	4,140	1869	3,304	3,262	1873	3,372	10,086
1866	2,340	6,242	1870	2,953	4,901	1874	5,977	18,771
1867	3,334	14,965	1871	2,955	6,216	1875	6,309	13,408
1868	3,908	2,421	1872	3,700	8,067	1876	5,076	10,137

BORGIE.

Year.	Salmon.	Grilse.	Year.	Salmon.	Grilse.	Year.	Salmon.	Grilse.
	lbs.	lbs.		lbs.	lbs.		lbs.	lbs.
1865	3,611	3,731	1869	2,460	4,173	1873	1,576	5,376
1866	1,747	5,977	1870	1,211	2,865	1874	4,189	15,765
1867	1,697	5,969	1871	1,449	2,963	1875	2,408	5,566
1868	1,995	1,777	1872	862	1,970	1876	1,273	3,944

HOPE.

Year.	Salmon.	Grilse.	Year.	Salmon.	Grilse.	Year.	Salmon.	Grilse.
		lbs.		lbs.	lbs.		lbs.	lbs.
1865	2,468	5,314	1869	1,871	4,352	1873	1,799	3,356
1866	1,905	8,776	1870	2,396	2,756	1874	2,250	9,434
1867	2,544	8,359	1871	2,653	3,941	1875	2,301	3,246
1868	3,395	3,395	1872	not	fished	1876	1,894	6,031

The netting was carried on in the Kyle of Tongue by bag-nets; in the districts of the Borgie, Naver, Strathy, and Halladale by both bag-nets and draft-nets. The number of bag-nets has decreased in the Naver and Borgie districts; has increased in those of the Halladale and Strathy, and also in Armadale Bay. The system of protection might be more effective than it is at present, which would be to the advantage of the fisheries. The river watchers are men employed by the Duke of Sutherland, and paid by him. There are no District Boards on any of the above rivers; but the Duke of Sutherland, being the sole proprietor, is entitled to act as a District Board, under the 19th section of 'The Salmon Fisheries (Scotland) Act, 1862,' which provides that 'if 'there shall be only one proprietor in any district, such proprietor shall 'have and may exercise all the powers by this Act conferred on the 'District Board.'

I select the following from the answers to the printed queries with which I have been favoured by Mr Box :—

I.

Annual Close Time.

From Loch Erriboll to the Sutherland and Caithness boundary :—

1. The River Hope not fished with net and coble, nor any fixed nets contiguous to the river.

Talmin Bay, Kyle of Tongue, four fixed nets. Fishing begins on the 1st May, closes 26th August.

The River Borgie, net and coble, from 1st May till 26th August.
The River Naver, net and coble, from 1st May till 26th August.
The River Strathy, fixed nets in the bay, from 1st April till 26th August.
The River Halladale, fixed nets in the bay, from 1st April till 26th August.
The River Halladale, net and coble in river mouth, from 15th April till 26th August.

2. Nevertheless, I would add 11 days to the annual close time from the 15th August, as very few spawning fish enter the rivers after the 15th September.
3. The close time for trout to be the same as for salmon. Rod fishing for salmon, and trout as well, commences on 10th January, ends on 31st September.

Weekly Close Time.

4. The present weekly close time is quite sufficient.
5. The weekly close time, by net and coble, is strictly observed on the coasts.
6. The weekly close time, by bag-nets, is not so strictly observed.

II.

Take of Fish.

1. The take of fish has diminished since 1862, more especially in the Hope, Naver, and Borgie rivers, where no fixed nets are set within 7 miles of said rivers, and net and coble fishing does not begin till the 1st May. So that those rivers are not closely fished, and this is the most unproductive season in the memory of the oldest fisherman in the district. It appears that the less the rivers are netted, the fish decrease in numbers. When cruives, net and coble, were in full swing from November till 15th August, the fishings were more productive.
2. About an average of 600 salmon and 6000 grilse by net and coble.
About an average of 700 salmon and 7000 grilse by fixed nets.
Cannot state the number of fish caught by rods.

III.

Run of Fish.

Hope River.—Clean salmon taken by rod in February ; main take in May.
Borgie River.—Clean salmon in January ; main take in May.
Naver River.—Clean salmon in October, November, January ; main take in May.

Grilse are generally got about the 1st May. Some years, in April, in the Naver and Halladale ; main run of grilse from the 22nd June till the 25th July.

Hope River and the Kyle of Tongue are the only rivers in this district where sea-trout are at all abundant. May, June and July are the best months.

VII.

Regulation of Draft Nets.

The English Salmon Fisheries Act, I consider not adapted for Scotland. With the exception of a few rivers, such as the Forth, Tay, Spey, Ness, and perhaps the Kyle of Sutherland, most of the rivers in Scotland are too narrow and small for such an Act to deal with in a proper and just manner. By only three-fourths of a river to be enclosed by net from either side would enhance the value of one fishing at the expense of the one opposite. What is at present a valuable fishery, would in many cases become of no value whatever.

VIII. and IX.

No dams, weirs, or cruives on any of the rivers in this district.
No waterfalls to obstruct the run of salmon to the upper waters.

X.

Penalties for Offences.

I do think there should be a minimum as well as a maximum penalty for offences under the Salmon Fishery Act.

XI.

I approve of an Act to prohibit the sale of salmon during the annual close time for net fishing.

XII.

Pollutions.

Sheep washing is the only pollution we have to contend against in our rivers. Since the smearing of sheep with tar has been dropped, and M'Dougall's sheep-dip used instead, the washing does not appear to have the injurious effect it formerly had. No dead trout or fish of any kind are now to be seen in the washing pools; for most of the sheep are washed in off-burns, and artificially made ponds.

XIII.

Salmon Disease.

No salmon disease has as yet made its appearance in any of the rivers in this district.

XIV.

There is no doubt but in remote localities spears are used for killing salmon on small streams, where the fish are sometimes left after a spate in shallow pools, where they are easily seen and captured. Otters are not now in use.

Fishing at Tongue.—The fishing at Tongue was fairly good during the few days I spent there. On the best day, six anglers brought into the hotel a grilse and 70 lbs. weight of yellow trout, captured in the fresh-water lochs, and 13 sea-trout, weighing 19 lbs., caught in the salt-water of the Kyle by spinning with the natural sand eel.

Harbour at Island Talmine.—An admirable fishing-boat harbour might be constructed in the Kyle of Tongue, where the largest sized fishing boats could be perfectly sheltered and in deep water at all times of the tide, by joining Talmine Island on the west side of Kyle to the mainland, from which it is not far distant. It is about 50 miles from Scrabster Roads, near Thurso, to Loch Erriboll; and, at present, throughout the whole stretch of that rocky and tempestuous coast, there is not a single harbour. Yet there is great plenty and variety of fish, and the want of such a harbour is deeply felt. Mr Box, the factor of Tongue House, told me that there are whiting, haddock, herrings, turbot, ling, and cod to be found in the seas near Tongue, and dwelt strongly on the advantages which the establishment of such a harbour would have in developing and encouraging the fishings.

Since then, Mr Box has written me a letter on the subject, dated 9th February 1889, from which I extract the following:—

There can be no doubt about the great importance and usefulness of a deep water pier or jetty in this district. There is nothing of the sort between Scrabster and Loch Inver; the pier in Loch Erriboll not being available at low water, and there is no harbour or pier of any sort between Scrabster and Loch Erriboll. The consequence is that the fishing in the district can only be carried on in a very limited manner, principally for home consumption; because, as there are no railways within 50 miles of Talmine, any fish for market must go by sea—and there is now no means of communication. There is a large fishing population on both sides of the Kyle of Tongue and in the surrounding district, and the fishing grounds are among the best in the kingdom, containing the finest fish of all sorts. If there were landing accommodation, stores and curing premises would soon spring up. Regular steam communication with the rail at Thurso would follow, and a large and valuable industry would be created, providing work for a large class of men, with numerous dependants, who cannot now follow the fishing because of the want of harbour accommodation. At present there are 64 boats employed at the local fishings with crews of over 400 men, very hardy enterprising men; but the industry is now sadly cramped and the lives of the men endangered by the absence of any harbour accommodation whatever along the north coast of Sutherland.

Sea-trout Fishing in Kyle of Durness.—Though the fishing for sea-trout in the salt water of the Kyle of Tongue is good, it is not by any means equal to that in the Kyle of Durness, into which the river Grudie or Dionard, the westmost of the salmon rivers on the north coast of Scotland, flows. The day I arrived at the inn at Durness, 16 sea-trout, weighing 22 lbs., had been brought in; and, on a previous day, a single rod killed 33 lbs. Even better sport than this was had in the Kyle some eight or nine years ago; one gentleman having four capital days, the worst producing 13 sea-trout, weighing 20 lbs., and the best 40, weighing 68 lbs.

Bag-nets near the Grudie.—When I first inspected the Grudie, there were bag-nets in Ballnakill Bay, near its mouth, which, of course, lessened the number of salmon captured by the angling lessees of the river. Before these nets were put on, the fishing in the Grudie was wonderfully good, for a comparatively small river. At that time, the keeper at Gualin House told me he had seen 14 salmon taken and 9 lost by one rod in a single day, and also that he had seen Mr Trevillian, the former lessee, who had the angling on the river for upwards of twenty years, take 8, 10, and 12 fish in a day when the river was in good order. He imputed the subsequent falling off in the angling to the placing of the bag-nets too close to the mouth of the river. Now that there are no bag-nets between Loch Erriboll and Loch Inchard, on the other side of Cape Wrath, the angling on the Grudie should improve rapidly.

There are several good lochs in the wild country between the west side of the Kyle of Durness and Cape Wrath; such as Loch Ari-na-bein, Loch Inishohar, Loch Keisgag, and some others. All these lochs communicate with the sea by small streams. In the last-named loch, which is about 11 miles from Durness, one gentleman, staying at the hotel while I was there last summer, killed, with the fly, 12 trout averaging 1 lb. weight each. There is no boat on this loch, so that he had to wade in order to reach the fish.

Loch Craspul.—Close to Durness Hotel there is a loch called Loch Craspul, which has evidently at one time had a communication with the sea, and contains trout as silvery as sea-trout, which might almost be mistaken for land-locked sea-trout. They are shy, and tender in the mouth, and require very delicate tackle and small flies. Some years ago I saw 20 of these trout, the produce of two days' fishing, weighing about 30 lbs. These trout, along with the so-called gillaroo trout, found in Loch Mulack Corry on the skirts of Benmore in Assynt, are the most beautiful trout to be found in Sutherland. There are plenty of char in Loch Borley, a loch not far from Loch Craspul, as in many other Sutherland lochs; but, as a rule, they will not rise to the fly. I once killed 3 in Loch Borrolan, near Altnakealgach, while fishing for trout; but this is rare. There is, however, one small loch of the purest spring water, 2000 feet above the sea-level, on the shoulder of Ben Hope, where char take the fly freely, and a small grey fly is said to be the most deadly. The late factor at Tongue House told me that he and his son once killed 6 dozen char about herring size, in this lofty and remote mountain tarn in a single day.*

* They do not seem to have been acquainted with char in this part of Sutherland in the end of last century. For, in the account of the parish of Durness, in the old *Statistical Account of Scotland*, written in 1792, the following passage occurs:—'Loch Borley affords, in great abundance, a species of trouts called *red-bellies*, and in Gælic, *Tarragan*. They are caught in October when they repair to the shallow water to deposit their spawn.'

The Grudie a Late River: Cause of its Lateness.—The Grudie is a later river than any of those that run into the Pentland Firth to the east of it. Indeed, it may be said that with it the late rivers begin; as all the rivers westward from it to Cape Wrath, and southward from Cape Wrath along the West Coast of Scotland and up to the head of the Scotch shore of the Solway Firth, and in the Inner and Outer Hebrides, are, with scarcely an exception, late; whereas, almost all the rivers eastward of the Grudie, between it and Duncansby Head, and southwards between Duncansby Head and the Tweed are early. The cause of this lateness or earliness I believe to arise from the relative temperatures of the fresh water of the rivers, and of the sea into which they fall. I stated this theory in letters to the *Scotsman* in October and November 1875; and afterwards more fully in my Treatise on *Salmon Fisheries*, in Stanford's series of *British Industries*, and in the *Journal of the Scottish Meteorological Society* in 1878. The Scottish rivers running into the German Ocean are almost all early rivers. They have comparatively long courses, and fall into the sea at considerable distances from their mountain sources, after running during some part of their career through districts not greatly elevated and possessing a moderate climate. But the German Ocean, into which these rivers flow, is a cold sea; and in winter and early spring the river temperature is, in ordinary seasons, probably higher than that of the sea, and therefore salmon ascend these rivers early in the season. Take the Tay, for example. It is well known that salmon run into it in great numbers in the months of December and January, so that, when the fishing begins in February, Loch Tay is stocked with clean and heavy salmon. On the West Coast, on the other hand, the rivers that fall into the Atlantic are nearly all late. They have short courses, and their fountain heads are much tilted up, as they rise in that lofty and singularly picturesque chain of mountains which, beginning not far from Cape Wrath, skirts the shores of Sutherlandshire, Ross-shire, and Inverness-shire for more than 100 miles, at distances varying from 5 to 20 miles from the western sea. In winter and spring, and sometimes even in early summer, these mountains are snow-clad or partly covered with snow, and every partial melting of their snows brings down torrents of ice-cold water, which rush through the short channels of these rivers into the sea. But the water of that sea, unlike that of the German Ocean that washes our eastern coasts, is warmed by the soft influence of the Gulf Stream, and the salmon, consequently, prefer to remain in it until the snow water has run off, and the milder weather of June and July has raised the temperature of the river waters, and then they begin to ascend. In order to test the correctness of the theory above stated, careful and prolonged observations on the relative temperatures of several late and early rivers, and of the sea into which they flow, would be necessary. A very ingenious apparatus was devised by the late Thomas Stevenson, C.E., and figured and described in the *Journal of the Scottish Meteorological Society*, for observations of sea and river temperatures by means of thermometers continuously immersed. If the result of such observations, carried on for a sufficient length of time, should be to prove the correctness of the theory above stated, we should obtain something approaching to a scientific method of determining the annual close-time suitable for each river. Another result would be to prove the futility of all attempts to change late rivers into early ones by stocking them with salmon bred from ova taken from early rivers. For, if the theory with regard to the constant and invariable effects of the relative temperatures of the sea, and of the rivers which fall into it, upon the earliness or lateness of the ascent of salmon be correct, it seems quite clear that all such attempts are a mere waste of time and money. As long as the physical characteristics of the river, proposed to be converted from a late into an early salmon river, and of the sea at its mouth remain unchanged, the mere introduction into a late river of fish taken from an early river will have no effect. The river will modify the habits of the fish; but the fish will never change the character of the river.

The Grudie has a course of about 15 miles from its mountain source, 1500 feet above the sea, to the Kyle of Durness. There are some good pools below the bridge on the high road on the way to Riconich, which the fish frequent in the earlier part of the season. But after May, they leave these pools and ascend to the higher portions of the stream between the bridge and Loch Dionard.

After leaving Durness, I drove to Riconich Inn at the head of Loch Inchard, about 15 miles south of Cape Wrath.

The River Inchard and Adjacent Lochs.—The river Inchard, a brawling rocky stream, little more than a large burn, falls into the head of the loch close to the inn. It has a course of a couple of miles and drains Loch Garbetbeg and Loch Garbetmore; the former of which frequently affords good salmon fishing late in the season. A large burn with waterfalls which prevent the ascent of salmon, connects Loch Garbetbeg with a series of lochs which stretch all along the west side of Foinaven to the foot of Arkle, one of the Stack Deer Forest mountains. Boats have now been placed on three of these lochs and the fishing for yellow trout is occasionally very good.

Statistics of Angling at Riconich.—It was the middle of July when I was at Riconich; but, owing to the dryness of the season, scarcely any salmon had ascended to Loch Garbetbeg. Up till 19th July, only 2 salmon and 6 sea-trout had been captured. But to make up for this, more yellow trout had been taken than during the whole of the season of 1887; between 1700 and 1800 having been caught. The following were the best takes I heard of during 1888:—On the 19th June two gentlemen captured on Loch No. 3—the best of the Foinaven lochs—120 trout weighing 26 lbs.; on the 21st, three gentlemen, in the same loch, had 103; and, on the 28th, two gentlemen had 144, weighing 36 lbs.

From the Anglers' Diary kept at Riconich I take the following returns for 1887:—

31 salmon, ...	208½ lbs.
17 grilse, ...	77¼ „
549 sea-trout, ...	477¼ „
1076 yellow trout, ...	376¼ „

Achriesgill Burn.—A considerable stream called the Achriesgill Burn falls into the north side of Loch Inchard a little more than a mile from Riconich. Just where it joins the loch, there is a wide, deep pool, where, after a flood, I should think there would be a good chance of getting sea-trout in July and August. But about half-a-mile above this there is a waterfall 12 or 13 feet in height, though somewhat broken and sloping, which at present effectually prevents the ascent of salmon and sea-trout. On the left bank of the stream, however, there is a sort of natural salmon-ladder, which by a little judicious blasting and the forming of a couple of resting-pools, would afford a practicable passage for the migratory salmonidæ. Or a subsidiary dam might be formed about 60 yards below the main fall at a point where a perpendicular rock 10 or 12 feet high projects above the left bank. Four, or four and a half feet, would be quite sufficient height for this subsidiary dam. Both salmon and sea-trout have been killed in the pool below the fall. Above the fall, there is at least a mile of magnificent gravelly spawning beds. These were quite covered with water when I visited them, even after the prolonged drought of an exceptionally dry season, so that they would always be available for breeding purposes.

Lochs near Riconich opened up.—There is, not far from Riconich, a chain of fresh-water lochs connected with Loch Laxford, but the channel which connects them used to be very much impeded and choked up. Some years ago, I recommended its being cleared out. This has now been done and a number of sea-trout have since been caught in these lochs.

Excellence of Sea-Fishing near Riconich.—The sea-fishing in Loch Inchard and elsewhere in the neighbourhood of Riconich is excellent, and I met a gentleman there who had a nice well-manned sailing boat for the purpose of prosecuting it. He was very successful and brought in some splendid cod to the hotel. By the people in the neighbourhood, however, this valuable industry seems to be much neglected.

Bag-net Fishings between Inshore near Riconich and Lochinver.—There are valuable bag-net fishings on the west coast of Sutherland, between these two places, which are let to Mr Speedie of Perth. The following is a return of their produce during the fishing seasons of 1885, 1886, and 1887:—

RETURN by Messrs Speedie, of the Salmon Bag-net Fishings, at the following Stations in the Scourie Management, for the Fishing Seasons of 1885, 1886, and 1887:—

Stations.	Salmon.		Grilse.		Trout.	
	No.	lbs.	No.	lbs.	No.	lbs.
Season 1885.						
Clachtoll,	304	3,515	2,792	15,211	47	94
Raffin,	82	977	884	4,836	32	64
Culkein,	94	1,123	1,066	5,812	44	88
Oldney,	82	988	882	4,842	24	48
Scourie,	20	241	631	3,235	35	70
Fanagmore,	19	230	393	2,160	17	34
Oldshoremore,	78	973	1,725	9,441	15	30
Total,	679	8,047	8,373	45,537	214	428
Season 1886.						
Clachtoll,	435	5,055	2,189	11,200	54	111
Raffin,	104	1,322	652	3,374	40	90
Culkein,	110	1,276	876	4,507	37	74
Oldney,	95	1,166	578	2,875	27	54
Scourie,	14	192	248	1,289	10	20
Fanagmore,	9	122	183	964	12	24
Oldshoremore,	116	1,460	1,219	6,201	11	22
Total,	883	10,593	5,945	30,410	191	395
Season 1877.						
Clachtoll,	634	7,078	2,929	15,046	77	154
Raffin,	110	1,296	911	4,759	69	138
Culkein,	101	1,200	667	3,425	59	120
Oldney,	91	1,112	574	2,988	49	98
Scourie,	10	127	349	1,884	26	52
Fanagmore,	10	129	207	1,025	31	62
Oldshoremore,	94	1,213	1,160	6,258	27	54
Total,	1,050	12,155	6,797	35,385	338	678

Scourie.—From Riconich I went to Scourie, where there is a comfortable inn and where Mr M'Iver, the factor for this district of Sutherland, has his residence. Close to Scourie there is a large and apparently deep loch called Loch Baddidarroch, which discharges its superfluous waters through a short stream which falls into the head of Scourie Bay. When I was at Scourie some years ago there was an obstruction connected with a mill near the mouth of this stream, which prevented the ascent of salmon or sea-trout into the loch. This, however, has now been removed, as I recommended, and there is nothing to prevent fish getting up, when there is sufficient water in the burn, except a dark passage about 20 yards long near the sea. It would be easy to place a dam and sluices at the outlet of the loch and so send down a spate when fish are in the bay wishing to ascend, but are unable to do so owing to want of water.*

There are now more attractions for the angler near Scourie than there used formerly to be, as boats have recently been placed on Loch Claisfearn, a pretty loch with wooded islands between Scourie and Laxford; on one of the Duartmore lochs; and on another loch in the Kylesku direction. There is a small loch near the Free Church manse, which is said to contain trout of excellent quality and of an average size of quite half-a-pound.

Duartmore River and Lochs.—In addition to yellow trout, the lochs connected with the Duartmore River contain sea-trout and grilse since the fall near the mouth of the river has been opened up. I recommended this to be done several years ago and it has now been most skilfully carried out. In the end of last July I went to inspect the river and lochs along with Mr Louis M'Iver. A long passage, not much short of 150 feet, has been blasted and cut round the main fall, forming a series of streams and pools well calculated to facilitate the ascent of salmon; and a little below, a subsidiary dam has been formed, which raises the water on the main fall.

There are two lochs on the Duartmore between the high road and the sea; the uppermost almost covered with reeds, so that there are but few clear spaces of water where it is possible to fish; the lower loch is much clearer. A little way above the bridge on the road there is a second fall on the Duartmore, but it also has been blasted, and I do not think that sea-trout or grilse can have much difficulty in ascending when the water is in such a state as to induce them to run. Above this fall is the largest loch in the Duartmore basin, about a couple of miles in circumference, in which sea-trout and grilse are frequently caught.†

Sea Fishing in Loch Kylesku.—From Scourie I travelled to Lochinver, stopping at the inn at Kylesku Ferry by the way. The scenery here is magnificent and the sea-fishing, like that near Riconich, excellent; and while comparatively neglected by the natives, it seems to be appreciated and enjoyed by strangers. From the fishing record in the inn, I find that

* About fifty years ago salmon appear to have been both plentiful and cheap in the extensive parish of Edderachillis, in which Scourie is situated; as, in the description of the parish in the *New Statistical Account of Scotland*, it is stated that, in 1839, 4400 salmon and grilse were captured and sold at 4½d. the pound.

† The Duartmore is within the district of the River Laxford, and its annual close time is the same as that of the Laxford. But it is not a tributary of the Laxford, and it has recently had a separate estuary fixed for it by a Bye-law which was published in the *Edinburgh Gazette*, and which took effect from 20th February 1885. By the said Bye-law, the limits which divide the Duartmore River, situated between Scourie on the north and Kylesku Ferry on the south, including the estuary thereof, from the sea, are declared 'to be a straight line drawn from the Point called the 'Point of the Raven's Rock, at the south end of the island of Calvamore on the 'west, to Duartmore Point on the south side of Loch Sark on the east.'

on the 5th September 1887, two visitors caught 194½ lbs. of coal fish, cod, lythe, &c.; on the 6th, 182 lbs.; and on the 7th, 452 lbs. On the 16th of the same month two gentlemen captured 226½ lbs., and on the 17th, 515 lbs.; while, on the last-named day, one gentleman caught 28 coal fish, weighing 377 lbs.; and on the 24th, a lady staying at the inn, took 3 coal fish weighing 51 lbs.

Estuary of the Kirkaig.—From Lochinver, I went to inspect the estuary of the River Kirkaig at the special request of Mr M'Iver, the experienced factor at Scourie. At present, as defined by the Bye-law, which took effect from 11th March 1865, it is 'a straight line drawn from Weather 'Lump on the North Shore, through Big Rock to the South Shore.' Mr M'Iver thinks these limits too narrow, and wishes to have them extended, which, however, could only be done in the event of the clause in the proposed Salmon Fisheries Consolidation Bill giving the Secretary for Scotland power to alter and amend estuaries, becoming law.

On the 23d July last Mr M'Iver wrote me from Scourie as follows on the subject:—

Dear Mr Young,—I was anxious to enlarge the estuary of the Kirkaig River, and applied to have this done, but was refused a few years ago. When you are at Loch Inver, I wish you would take a look at it. At present it matters very little, for there are no bag-nets set near it either on the Assynt or on the Coigeach side of the estuary, but this may not be long the case, and if you can help me I am very desirous to get it extended. There is very little spawning ground on the Kirkaig, and on that point I wish to give it every advantage. My wish was to have the estuary extended to Rhu-Kirkaig on the north, and Rhu-na-briag on the south. The estuary is within these points, and I think too near the mouth of the river.

I may say, that after a careful inspection of the locality, I am entirely of Mr M'Iver's opinion and think that a line from Rhu-Kirkaig on the north to Rhu-na-briag on the south is the natural and appropriate estuary, but as I have already stated, there is no power to alter or amend estuaries, as the law at present stands.

When I inspected the Kirkaig it was at its lowest. I should say almost 2 feet lower than I had ever before seen it; and there had been no successful angling either in it or in the Inver, which has also been injuriously affected by the prevailing drought. There is not much good spawning ground on the Kirkaig, a great proportion of its bed between the sea and the falls being rocky. It has, however, many beautiful streams and pools and it occasionally affords good angling. One of the most experienced ghillies at Lochinver told me that he attended a gentleman one year, who in 11 days captured 24 salmon weighing 241 lbs.; and he also stated that 100 fish have been taken out of it in a single season.

After leaving Lochinver, I proceeded to Ullapool by the beautiful road that passes Loch Skinaskink; skirts the foot of the singular serrated mountain called Stack Polly and the margin of Lochs Baddagyle and Lurgan; and nearer Ullapool, commands splendid views of the precipices of Ben More Coigeach, rising like a wall from the sea.

About 8 miles from Lochinver, there is a hill whose summit is a couple of hundred feet above the road, from which there is one of the finest views on this part of the West Coast. You look out upon the wide islanded expanse of Loch Skinaskink with its many peninsulas and winding bays, and on the ring of magnificent mountains that surround it, including Stack Polly, Coulbeg, Coulmore, and Suilvean.

Falls of the Polly.—The little river Polly which flows into Loch Polly, a branch of the spacious Bay of Enard, is the outlet of Loch Skinaskink and of the numerous chain of lochs connected with it. But there are falls upon it which at present prevent the ascent of salmon to Loch Skinaskink, which is nearly as large as Loch Leven in Fife, and to eight other lochs. No experiment in opening up obstructions would pay better than this. The falls, though a serious barrier, are by no means insurmountable. They are somewhat over 20 feet high. On the left bank, the rock projects over the stream, rather overhanging its base; on the right it falls slightly back. I think a subsidiary dam, 4 or 4½ feet high, should be made about 40 yards below the main fall, where the stream is narrowest, and the top of the fall should be blasted extensively and carried back. The whole fall, when I inspected it—and the river was at its lowest—was white water and totally inaccessible for salmon or sea-trout.

Over-fishing in Scotch Lochs.—In the course of the inspection above narrated, I was much struck with the almost total absence of any attempts to counteract, by an improved system of fish-culture, the immense destruction of trout caused, during several months of every summer and autumn, by the shoals of anglers brought by rail, steamer, and coach from every part of the United Kingdom to such fishing centres as Loch Awe, Loch Shin, Tongue, Inchnadamph, and many other places that might be mentioned. There is no restriction on these anglers either as to the number or the size of the trout they kill; no attempt to establish and maintain hatcheries; no endeavours to get the anglers to subscribe to a fish-culture fund. Every effort of skill is exerted to destroy; while scarcely anything is done to restore and restock the exhausted waters. I have fished most of these lochs before the days of railways, and I know that the trout were then twice as numerous as at present, and, on an average, considerably larger. But there was not one angler then for twenty that there are now. The fixing of a gauge under which no trout should be basketed and the establishment of a hatchery on a tolerably extensive scale at the chief fishing centres seems to me imperatively called for in order to prevent the depletion or impoverishment of our lochs. We have fixed by law a gauge under which no crab or lobster may be taken; why not fix a similar gauge for trout? It is shameful to see, especially on an unfavourable day, when the fish are taking badly, small trout, not the length of one's hand, consigned to the basket instead of returned to the loch, because it has taken so much trouble to catch them.

In Loch Awe, probably from 10,000 to 12,000 trout are annually captured by the anglers from the half-dozen hotels on its banks; and such an immense annual destruction would inevitably depreciate the fishing even in a sheet of water so extensive as Loch Awe. But, fortunately, there is an Awe District Fishery Improvement Association which has been doing good service in striving to counteract the effects of such severe and protracted fishing by killing down the pike and stocking the loch with trout. It is satisfactory to know, not only that its efforts have been attended with a gratifying measure of success, but also that its funds are at present in a flourishing condition. From August 17, 1887, to December 5, 1888, it has destroyed 638 pike, and has distributed 60,000 Loch Leven fry from Howietoun.

A similar Association is much needed at Loch Shin, with its two considerable hotels at Lairg and Overskaig. The fishing is not what it used to be, and steps would require to be taken to counteract the annual drain upon the fish in the loch. Tongue also, on the north coast of Sutherland, is another place of the same description. How much may be done by thorough protection and artificial stocking on a large scale, is admirably exemplified in the case of Loch Leven in Fife, from which upwards of 21,000 lbs. weight of trout were taken last year, and where the Association which leases the loch, after paying the proprietor £1000 a year for the fishing, has paid a dividend of 25 per cent. to its shareholders.

SALMON ANGLING IN 1888.

The salmon angling in Loch Tay was fairly good in 1888. The total number of salmon killed was 378, and the total weight was 7006 lbs.; giving an average weight of 18 lbs. 8 oz. per fish. The heaviest fish caught weighed 37 lbs.; the lightest 12 lbs.

The following are the results of the salmon fishings in Loch Tay for the last six years :—

Year.	No. of Fish.	Weight in lbs.	Average Weight.
1883	461	9679	19 lbs. 11 oz.
1884	240	4710	19 „ 10 „
1885	398	8167	20 „ 8 „
1886	379	7652	20 „ 3 „
1887	227	4385	19 „ 5 „
1888	378	7006	18 „ 8 „

Both on the Tay and the Earn the rod-fishing season of 1888 was a bad one. After the nets were off, the rivers were too low, until a freshet in the end of September brought up a good many fish, when some fair angling was had on the Stobhall water at Isla Mouth and elsewhere; 45 lbs. was the weight of the heaviest fish caught by the rod during the season.

On the Aberdeenshire Dee, usually so productive a river, the angling was disappointing, though in autumn there was some fair fishing on several of the beats. One salmon of 36 lbs. was captured.

On the Forth the angling was likewise poor; the rain coming too late. The largest salmon was captured by Sergeant Tait. It weighed 37 lbs.

On the Spey the angling season was fairly good. The largest fish (40 lbs.) was caught by Lord Leconfield on the Gordon Castle water.

The fishing on the Nith was very poor; but some fine salmon were landed from the Annan late in the season. A fish of 44½ lbs. was taken in the nets in August; and in November one of 46 lbs., and another of 41 lbs., were captured by the rod.

In the little River Urr, which falls into the Scotch side of the Solway Firth not far from Dalbeattie, an unusually large salmon was captured in a somewhat singular manner. The keeper of Mr Thomas Gladstone was dragging a pool with an artifical minnow, with the view of recovering a lost cast of flies, when the bait was seized, and, after a fight of 3 hours, a male salmon weighing 43 lbs. and measuring 4 feet 2 inches in length was landed.

But, unquestionably, the greatest angling performance in 1888 was at the wonderfully productive fishing at the Grimersta, in the Island of Lewis, a fishing which will be found fully described in my Fourth Report to the Board. Last year, Mr A. M. Naylor, in 19 days fishing in the month of August, killed, to his own rod, with fly, 214 salmon weighing 1307 lbs., besides 304 sea-trout weighing 161 lbs. His best days were as follows :—

August 23, . . .	31 Salmon	weighing	183 lbs.
„ 28, . . .	54 „	„	314 „
„ 31, . . .	45 „	„	269 „

The best two days made by Mr Naylor's two companions were 36 and 46 salmon.

Mr Naylor states that he has not a record of the total kill of the three rods during the month of August; but he gives the following summary of the take during the last 6 consecutive days of August:—

No. I. Rod, .	143 Salmon,	856 lbs.,	31 Sea-Trout,	23 lbs.
No. II. Rod, .	106 "	680 "	26 "	19 "
No. III. Rod, .	84 "	490 "	14 "	10 "

Mr Naylor states that the time he took to kill the 54 salmon on the 28th August was nine hours, or an average of ten minutes per fish. The average weight (a little under 6 lbs.) was small, but notwithstanding, he was quite tired at the end of the time; although, as there were two hours more of daylight, he could certainly have killed at least 10 more fish if he had gone on.*

TROUT FISHING IN LOCH LEVEN.

Loch Leven in Fife continues to show what great results may be attained by artificial stocking on a large scale, and by careful watching of the spawning beds, as the following Report of the Loch Leven Angling Association for 1888 proves:—

The gross receipts for the year, including bank interest on the revenue account, amount to £2431, 11s. 4d., and after providing for the maximum rent of £1000, and paying all charges and expenses, there remains a clear balance of £390, 18s. 10d. on revenue account. After adding to this £23, 5s. 8d. of interest on the capital called up and invested, and the balance of £93, 19s. 9d. carried forward from last account, there is a disposable balance of £508, 4s. 3d. The directors recommend the declaration of a dividend at the rate of 25 per cent. on the paid up capital, which will amount to £295, 10s., leaving a balance of £212, 14s. 3d. to be carried forward to next account.

With the special permission of Sir G. Graham Montgomery, Bart., the proprietor, the loch was kept open for anglers for a week beyond the usual period. During the whole of the past season excellent sport has been enjoyed by anglers, and both as regards the number and weight of trout captured, and financially, the season has been the most successful since the formation of the Association.

The table on the following page shows the number and weight of trout killed in each month during the past six years.

Vigorous measures for keeping down the pike have been continued, and 308 have been killed during the year.

The hatching operations have again been most successful, and last spring about 280,000 well-grown healthy fry were deposited in North Queich and Gairney.

THE ESK (MIDLOTHIAN) ANGLING IMPROVEMENT ASSOCIATION.

The Esk (Midlothian) Angling Improvement Association have also been doing good work during 1888. They have acquired 3 miles of the Musselburgh Esk, extending from Musselburgh to the Duke of Buccleuch's policy wall near Cowpits and seawards to low-water mark. They hold regular leases of the salmon fishings from Sir John D. Hope, Bart., of Pinkie, both in the fresh and tidal waters, and from the Earl of Wemyss

* The Grimersta lochs and river are probably, as regards the number of fish caught by the rod, the most productive in the United Kingdom. From a return kindly furnished to me by Mr Mackay, Chamberlain of the Lews, it appears that 1873—the best season on the Grimersta between 1871 and 1884, both inclusive—yielded 1000 salmon and 1073 sea-trout; and that 1883, the next best, yielded 855 salmon and 1339 sea-trout. The yield of the whole fourteen years amounted to 7643 salmon and 13,509 sea-trout; or an annual average of 545 salmon and 964 sea-trout, fairly caught by casting with rod and fly.

Number and Weight of Trout killed in Loch Leven during the six years 1883–88.

Month.	1888. Number.	1888. Weight.	1888. Average of Each.	1887. Number.	1887. Weight.	1887. Average of Each.	1886. Number.	1886. Weight.	1886. Average of Each.	1885. Number.	1885. Weight.	1885. Average of Each.	1884. Number.	1884. Weight	1884. Average of Each.	1883. Number.	1883. Weight.	1883. Average of Each.
		lbs.	lbs.		lbs.	lbs.		lbs.	lbs.		lbs.	lbs.		lbs.	lbs.		lbs.	lbs.
April..........	1025	997½	·972	1559	1434½	·919	706	570¼	·867	1204	1070	·888	2319	1964¾	·846	335	352¼	1·050
May...........	4456	2992¼	·671	3175	3587	1·127	2465	2071¾	·840	3676	3026	·823	3220	2742¼	·851	3838	2998¾	·781
June..........	7811	6669	·853	3285	3071¾	·934	3282	2907½	·885	5540	4412½	·796	5292	4318¾	·815	5301	4391⅓	·828
July	3992	3889¾	·974	2960	2986¼	1·008	1943	1991¾	1·025	1634	1524¼	·932	1384	1306	·943	1335	1296¼	·970
August	4833	5046¼	1·044	6688	6171	·922	3422	3630½	1·060	4331	4232¼	·977	3211	3040½	·946	3124	3595	1·150
September..	1399	1479	1·057	235	219	·931	120	128	1· 06	165	1600	·969	208	160½	·769	129	117¾	·906
Total.......	23,516	21,073¾	·896	17,902	17,464	·975	11,938	11,299¾	·946	16,550	14,425	·871	15,634	13,532½	·865	14,062	12,742	·906
Netted	90	114	1·266	178	256	1·438	219	325	1·484	225	327	1·453	306	400	1·307	165	248	1·503
Total.......	23,606	21,187¾	897	18,080	17,720	2·413	12,157	11,624¾	·956	16,775	14,752	·873	15,940	13,932½	·874	14,227	12,990	·913

and other riparian proprietors of the trout fishings *ex adverso* of their respective lands.

Statistics of Fish taken.—The following table of fish captured during the past angling season has been compiled from the water-bailiff's book. Along side of it there are placed the similar tables for 1886 and 1887, a comparison with which shows that the total take during the season ended is greater than either of the previous years. The main causes of the continuing rise in the catch are believed to be the still improving condition of the river water, and the increasing numbers of river and migratory trout. It is proper to state that the figures given in the tables are *under the mark*, the water-bailiff not having been always able to obtain the particulars of every basket.

	1886.		1887.		1888.	
	Fish.	Weight.	Fish.	Weight.	Fish.	Weight.
		lbs.		lbs.		lbs.
February (from 11th, Opening Date),	39	$28\frac{1}{2}$	240	$151\frac{3}{4}$	80	46
March,	34	26	153	$85\frac{1}{2}$	79	$51\frac{1}{4}$
April,	137	117	80	$35\frac{1}{4}$	350	$238\frac{1}{2}$
May,	37	31	70	$29\frac{1}{2}$	33	$18\frac{1}{4}$
June,	9	$5\frac{3}{4}$	85	32	15	$9\frac{1}{4}$
July,	1	$\frac{1}{2}$	56	23	555	207
August,	63	$36\frac{3}{4}$	143	59	814	303
September,	184	$103\frac{1}{4}$	568	375	224	$86\frac{1}{4}$
October,	158	$116\frac{1}{4}$	217	125	112	$51\frac{1}{2}$
Approximate Totals,	662	465	1612	916	2262	1011

The average weight of each fish, as shown by the foregoing totals for 1888, is $7\frac{1}{3}$ oz., but fish of 1 lb. have been repeatedly captured, and a number have been taken scaling $1\frac{1}{2}$ lbs. In August, in particular, a number of sea-trout were taken in the lower water scaling $1\frac{1}{4}$ to $2\frac{1}{2}$ lbs.

Stocking.—The operations of the Committee towards replenishing the stock of fish in the Association's waters are as follows :—

1886.

April. A purchase was made from the Howietoun Fishery of two-year old 'Loch Leven,' which were placed in the Upper Water, . 300

May. Dr. Thos. F. Spence, Edinburgh, kindly presented a lot of young salmon, hatched out by himself from Esk (Dumfriesshire) ova. These were placed in the rill of the water running into the Upper Water above the Inveresk Weir, . . 500

Sept. A purchase of very fine yellow trout, taken from the Salton Water Reach of the River Tyne, Haddingtonshire, was distributed at various points in the Upper Beat, . . . 850

Oct. Mr A. G. Anderson, Edinburgh, presented 30,000 young Tay salmon, reared in his hatchery at Linlithgow Loch. These were distributed as follows:—

South Esk—	1. Arniston Policies,	12,000	
	2. Newbattle Policies,	6,000	
North Esk—	3. Penicuik Policies,	6,000	
	4. Melville Castle Policies,	6,000	
			30,000

1887.		
April.	A further purchase was made from Howietoun Fishery of common trout ova, which were hatched out successfully by the water-bailiff, and put into the small rill above mentioned and the Smeaton Burn, ...	2,000
June.	Dr. Thos. F. Spence made another present of young fish, reared by himself —American Brook Trout—which were also placed in the Smeaton Burn, ...	500
1888.		
May.	2000 eyed-ova of 'Loch Leven,' from Howietoun Hatchery, and 2000 eyed-ova common trout, from Mr Armistead's hatchery at the Solway, were hatched out by the water-bailiff during the winter, and the fry were placed in the rill above mentioned and the Smeaton Burn during this month, .	4,000

It seems clear, from the above statement, that there are many rivers in Scotland now neglected and uncared for, and to a great extent depleted of fish, which might be improved and restored if taken in hand by active and energetic associations for the improvement of the angling.

UNCHARTERED SALMON WATERS IN SCOTLAND.

Much has been spoken and written about the unchartered salmon waters in Scotland in connection with the late Salmon Fisheries Consolidation Bill.

The following recommendation, agreed to at a meeting of the Forth District Board, dated 4th March 1870, and published on page 86 of the Report of 1871 by Messrs Buckland and Young, Special Commissioners appointed to inquire into the effects of recent legislation on the Salmon Fisheries in Scotland, is worthy of attention as containing practical suggestions for the disposal and taxation of all the ungifted Salmon Waters in Scotland. This recommendation is supported by Messrs Walpole and Young in their Report of 1875 on the operation of the Tweed Fisheries Acts of 1857 and 1859, in which they write as follows, under the head of 'Unchartered Waters on the Tweed':—'This recom-'mendation was supported by the District Boards of the rivers Spey, 'Deveron, Annan, and Lochy. It is at all events clear and definite, and 'proposes to give, in the first place, to the riparian owners who have no 'title, the power of buying from the Crown the right of salmon fishing 'in the waters *ex adverso* of their properties. On the other hand, the 'proposals made with regard to this subject by most of the witnesses who 'gave evidence before us had for their principal object the depriving of 'these riparian proprietors of any chance of acquiring the right of salmon 'fishing in the ungifted waters—except as members of the public—and 'the conferring of that right on the public generally. This, we venture 'to think, would be an intolerable hardship on these proprietors, and a 'very doubtful boon to the public; and we cannot, therefore, recommend 'that any such proposals should be adopted.'

Recommendation by Forth District Board.—'In the event of any 'amended Act being introduced, it would be highly desirable to have 'clauses in it constituting a right of property in salmon, as vested 'in some one or other throughout the whole extent of salmon-waters, 'and the power of taxing such a property. The Crown should have 'the ungifted portions of these waters valued, and offered at such valuation 'to the parties whose lands are *ex adverso* such fishings, confirming the right 'by Act, and if the proprietors of the lands refuse, then the said fishings 'should be sold by public roup; but whether so gifted or sold, or reserved 'by the Crown, the party in whom such property is vested, whether it be 'used or not, should be made to bear a proportion of the cost of 'taxation.

'No portion of a salmon-water would then be untaxed unless it be the 'parts where the proprietors have not registered and yet have the right to 'fish. To meet this, suppose that the period for registration were extended, 'and that all proprietors of salmon fishings be compelled to register within 'that period, or in the event of their not doing so, right to lapse to Crown, 'and to be disposed of as above. All registered proprietors to be assessable 'either according to frontage or according to valued rent, as per County 'Assessment Roll. Crown to bear burden of taxation of water not gifted 'and still held by it.

'No one to have a right to fish for salmon unless he is a registered pro-'prietor, or possesses a written authority from such proprietor, or is a tenant 'of fishings under such proprietor, and such right to be limited to the 'waters in which such registered proprietor has a legal right to fish for 'salmon, and to be always exhibited when required by the District Board, 'or by those officially appointed by them; penalties in breach thereof to 'be enforced as other penalties of Act.'

I have the honour to be,

Your obedient Servant,

ARCHD. YOUNG,

Inspector of Salmon Fisheries for Scotland.

THE FISHERY BOARD FOR SCOTLAND,
EDINBURGH, 4*th April* 1889.

NOTE I.

ANNUAL CLOSE TIME APPLICABLE TO THE SCOTCH SALMON RIVERS.

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

Name of River.	Annual Close Time.	Extension of Time for Rod-fishing.
ADD, ...	From Sept. 1 to Feb. 15, both days inclusive.	From Sept. 1 to Oct. 31, both days inclusive.
ALINE, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
ALNESS, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
ANNAN, ...	From Sept. 10 to Feb. 24.	From Sept. 10 to Nov. 15.
APPLECROSS, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
ARNISDALE (*Loch Hourn*), . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
AWE, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
AYLORT (*Kinloch*), . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
AYR, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
BAA AND GLENCOILLEADER, . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
BADACHRO and KERRY (*Gairloch*), .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
BALGAY and SHIELDAG, . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
BEAULY, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.
BERRIEDALE, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
BERVIE, ...	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
BLADENOCH, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
BROOM	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
BRORA	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
CARRADALE (*in Cantyre*), . .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
CARRON, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.

Name of River.	Annual Close Time.	Extension of Time for Rod-fishing.
CLAYBURN, FINNISBAY, AVEN-NAN-GEREN, STRATHGRAVAT, NORTH LACASTILE, SCALLADALE, and MAWRIG (*East Harris*).	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
CLYDE and LEVEN, . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
CONON, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
CREE, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
CREED or STORNOWAY, and LAXAY (*Island of Lews*).	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
CRERAN (*Loch Creran*), . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
CROWE and SHIEL (*Loch Duich*), .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
DEE (*Aberdeenshire*), . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
DEE (*Kirkcudbright*), . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
DEVERON, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
DON, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
DOON, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
DRUMMACHLOY or GLENMORE (*Isle of Bute*).	From Sept. 1 to Feb. 15.	From Sept. 1 to Oct. 15.
DUNBEATH, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.
EARN, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
ECKAIG, ...	From Sept. 1 to Feb. 15.	From Sept. 1 to Oct. 31.
ESK, NORTH, ...	From Sept. 1 to Feb. 15.	From Sept. 1 to Oct. 31.
ESK, SOUTH, ...	From Sept. 1 to Feb. 15.	From Sept. 1 to Oct. 31.
EWE, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
FINCASTLE, MEAVEG, BALLANACHIST, SOUTH LACASTILE, BORVE, and OBB (*West Harris*).	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
FINDHORN, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 10.
FLEET (*Sutherlandshire*), . .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
FLEET (*Kirkcudbrightshire*), . .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
FORSS, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
FORTH, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
FYNE, SHIRA, and ARAY (*Loch Fyne*), .	From Sept. 1 to Feb. 15.	From Sept. 1 to Oct. 31.
GIRVAN, ...	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
GLENELG, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
GOUR, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
GREISS, LAXDALE, or THUNGA, . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.

Name of River.	Annual Close Time.	Extension of Time for Rod-fishing.
Grudie or Dionard, . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Gruinard and Little Gruinard, .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Hallaeale, Strathy, Naver, and Borgie.	From Aug. 27 to Feb. 10.	Close time for Rod-fishing from 1 Oct. to Jan. 10.
Helmsdale, ...	From Aug. 27 to Feb. 10.	Close time for Rod-fishing from 1 Oct. to Jan. 10.
Hope and Polla or Strathbeg, .	From Aug. 27 to Feb. 10.	From Jan. 11 to Feb. 10, and from Aug. 27 to Sept. 10.
Howmore, ...	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
Inchard, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Inner (*in Jura*), ...	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
Inver, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Iorsa (*in Arran*), . . .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
Irvine and Garnock, . . .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
Kennart, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Kilchoan or Inverie (*Loch Nevis*), .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Kinloch (*Kyle of Tongue*), . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Kirkaig, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Kishorn, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Kyle of Sutherland, . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.
Laggan and Sorn (*Island of Islay*), .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
Laxford, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Leven, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Little Loch Broom, . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Lochy, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Loch Duich, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Loch Luing, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Loch Roag, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Lossie, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.
Luce, ...	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
Lussa (*Island of Mull*), . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Moidart, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
Morar, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.

Name of River.	Annual Close Time.	Extension of Time for Rod-fishing.
MULLANAGEREN, HORASARY, and LOCH-NA-CISTE (*North Uist*),	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
NAIRN, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.
NELL, FEOCHAN, and EUCHAR, . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
NESS, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.
NITH, ...	From Sept. 10 to Feb. 24.	From Sept. 10 to Nov. 15.
ORKNEY ISLANDS (River from Loch of STENNESS, &c.),	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
ORMSARY (*Loch Killisport*), LOCH HEAD, and STORNOWAY (*Mull*),	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
PENYGOWAN or GLENFORSA, and AROS,	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
RESORT, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
RUEL, ...	From Sept. 1 to Feb. 15.	From Sept. 1 to Oct. 31.
SANDA, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
SCADDLE, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
SHETLAND ISLANDS (River of SANDWATER, &c.,	From Sept. 10 to Feb. 24.	From Feb. 1 to Feb. 24, and from Sept. 10 to Nov. 15.
SHIEL (*Loch Shiel*), . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
SLIGACHAN, BROADFORD, and PORTREE (*Isle of Skye*),	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
SNIZORT, ORLEY, OZE, and DRYNOCH (*Isle of Skye*),	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
SPEY, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.
STINCHAR, ...	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
TAY, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
THURSO, ...	From Aug. 27 to Feb. 10.	From Jan. 11 to Feb. 10, and from Aug. 27 to Sept. 14.
TORRIDON, BALGAY, and SHIELDAG, .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
UGIE, ...	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.
ULLAPOOL (*Loch Broom*), . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
URR, ...	From Sept. 10 to Feb. 24.	From Sept. 10 to Nov. 30.
WICK, ...	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.
YTHAN, ...	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.

NOTE II.

SKETCH MAP OF THE PRESENT AND OF THE PROPOSED ESTUARY FOR THE RIVERS NESS AND BEAULY.


SKETCH SHOWING
LIMIT OF ESTUARY OF RIVER NESS
AS FIXED BY SALMON FISHERIES COMMISSIONERS, 7th MARCH 1865, AND PROPOSED AMENDED ESTUARY.
NOTE.—The Limit of the Estuary is described in the Bye Laws as follows:—
"A straight line drawn due South-east, true meridian, from the centre of the Three Burns to the Southern Shore, thus cutting the black Buoy as at present placed on the North end of the Whiten Ness sands."
North
Munlochy
Munlochy Bay
BEAULY FIRTH
Kessock Ferry
Kilmuir
Avoch
Fortrose
Rosemarkie
Three Burns
Ethie Burn
Ethie Fishing Station
INNER MORAY FIRTH
OR FIRTH OF INVERNESS
MORAY FIRTH
Proposed Limit of Estuary
Present Limit of Estuary
11 miles
Chanonry Point
Fort George
Black Buoy
Whiten Ness
INVERNESS
RIVER NESS
Low Water Mark O.S. Tides
Alterlie Point
Station
Culloden House
Petty Church
Castle Stuart
Dalcross Station
Railway
Campbelltown
Carse of Ardersier
Fort George Station
Railway to Nairn
Scale
Furlongs 8 7 6 5 4 3 2 1 0 1 2 3 4 Miles
Prepared from Ordnance Map
20th March, 1883.
By James Fraser, C.E
Inverness.

NOTE III.

SALE OF SALMON SMOLTS.

NOTICE BY THE FISHERY BOARD FOR SCOTLAND.

Complaints having, on several occasions, been made to the Fishery Board for Scotland that salmon smolts are exposed for sale and sold, the Board hereby give notice that such sale, or exposing for sale, is illegal, and renders the seller or exposer liable to severe pecuniary penalties; the 19th section of 'The Salmon Fisheries (Scotland) Act, 1868,' providing that 'every person who shall wilfully take or destroy any smolt or salmon 'fry, *or shall buy, sell, or expose for sale, or have in his possession, the* '*same*, or shall place any device or engine for the purpose of obstructing 'the passage of the same, or shall wilfully injure the same, or shall 'wilfully injure or disturb any salmon spawn, or disturb any spawning bed, 'or any bank or shallow in which the spawn of salmon may be, or during 'the annual close time shall obstruct or impede salmon in their passage 'to any such bed, bank, or shallow, *shall be liable to a penalty not exceed-* '*ing £5 for every such offence, and shall forfeit every rod, line, net, device,* '*or engine used in committing any such offence, and shall forfeit any smolt* '*or salmon fry that may be found in his possession.*'

The word 'salmon' in the Salmon Fishery Acts of 1862 and 1868 means and includes 'salmon, grilse, sea trout, bull trout, smolts, parr, 'and other migratory fish of the salmon kind.'

All offences under the Salmon Fishery Acts of 1862 and 1868 may be prosecuted, and all penalties incurred may be recovered 'before any 'Sheriff or any two or more Justices acting together, and having jurisdic- 'tion in the place where the offence was committed, at the instance of the 'Clerk of any District Board, or of any other person.'

By Order,

(Signed) DUGALD GRAHAM, *Secretary.*

FISHERY BOARD FOR SCOTLAND,
EDINBURGH, *2nd May* 1889.

NOTE IV.

RECENT HATCHERIES IN SCOTLAND.

Two hatcheries on a small scale have been established in Scotland since 1887. One of these is on the Durris property, on the Aberdeenshire Dee. The object of the proprietor is, in the first place, to increase the number of fish, and, in the second place, to improve the breed. Ova have been got from the Spey and Deveron, but it seems not a little doubtful whether this is a wise choice, and whether it would not be better to stick to the Dee fish; or, if it be wished to increase the size of the fish—which, however, we do not believe in—to have got ova from the Tay, a river quite as early as the Dee and where the spring salmon are twice as large.

The other hatchery has been started on the Deveron by Mr Bisset, the lessee of the fishings. It is on a small scale, containing about 50,000 ova.

The advantages of the artificial culture of salmon and trout seem to be gradually, and year by year, better understood and appreciated. Besides the new hatcheries above mentioned, there are several others, in different parts of Scotland, that have been in operation for a longer or shorter period of years. In the extreme north, on the little River Forss, which falls into the Pentland Firth about 6 miles westward of Thurso, there is, and has been for the last ten years, a hatchery on a small burn running into the Forss, which turns out about 200,000 salmon fry every year, to the great benefit of the fishing in the Forss, on which—small river though it be—as many as 200 salmon and grilse have been taken by the rod in a single season since the institution of the hatchery; and it is stated that the adjacent net fishings in the sea are also much more productive than they were before the hatchery was established. The fry in this hatchery enjoy specially favourable conditions; as, when they leave it, instead of having at once to face the danger of being devoured by larger fish in the main stream, they are put into a burn, carefully cleared of trout and eels, and are kept there and fed until they are able to take care of themselves. This hatchery is described in my Third Report to the Board, page 125.

Then, in the extreme south of Scotland, besides Mr Armistead's well-known and extensive Solway Fishery, there is a hatchery at Craigielands in Dumfriesshire, started a few years ago, with the view of improving the fishing in the lochs and streams of Annandale. In this hatchery, Loch Leven trout have been crossed with the almost equally beautiful trout from the wild and remote Loch Skene on the borders of Dumfriesshire and Selkirkshire.

At Fasnacloich, on Loch Creran, there is also a hatchery from which from 60,000 to 80,000 salmon fry are turned out annually. At Loch Buie in Mull, there is another, capable of hatching out 60,000 eggs annually, from which many of the lochs and streams on the estate have been supplied with salmon fry, *salmo fontinalis*, and great Swiss lake trout. Several of the hill lochs on the estate, formerly untenanted by fish, have been successfully stocked from this hatchery.

The most recent hatchery established is that at Taymouth Castle, for the purpose of hatching out a large consignment of the land-locked salmon from the United States of America.

The famous establishment at Howietoun still stands in the foremost rank of hatcheries, both from its great extent and the perfection of its arrangements for hatching, feeding, packing, and distributing. In an interesting paper from the *Proceedings of the Cotteswold Club*, 1888–9, entitled 'Notes on Hybridization,' Dr Day of Cheltenham details some of the instructive and carefully conducted experiments on the Hybridization of the Salmonidæ that have been carried on at Howietoun during recent years.

EDINBURGH: PRINTED BY NEILL AND COMPANY,
FOR HER MAJESTY'S STATIONERY OFFICE.

SEVENTH

ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND,

WITH APPENDIX CONTAINING REPORT TO THE BOARD
BY THE INSPECTOR OF SALMON FISHERIES,

Being for the Year 1888.

IN THREE PARTS.

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

PART II.—SALMON FISHERIES.

Presented to both Houses of Parliament in pursuance of
Act 45 and 46 Vict., cap. 78.

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1889.

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1889.

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SEVENTH
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1889.

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CONTENTS.

	PAGE
General Statement	1
1. The Influence of Beam Trawling	2
The Trawling Experiments of the 'Garland'	3
The Spawning Grounds of Plaice and other Food Fishes	4
The Capture and Destruction of Immature Fish	5
The Fishing Grounds on the West Coast	5
2. Fishery Statistics	6
3. Special Inquiries	8
Inquiries into the Food, Maturity, and Habits of the Food Fishes	8
Inquiries into the Supplies of Bait	10
Inquiries in connection with Inland Waters, &c.	12
Physical Observations	13
4. Contemporary Fishery Work	13

SECTION A.—GENERAL REPORTS.

I. Report on the Trawling Experiments of the 'Garland,' and on the Statistics of East Coast Fisheries.—Part III. (Plates I. and II.)	15
I. Introductory	15
II. The Work of the 'Garland'	16
1. The Firth of Forth	16
2. St Andrews Bay	18
3. Other East Coast Districts	18
III. Special Statistics of Fish caught by Line Fishermen and Beam-trawlers	18
1. Buckhaven Haddock and Cod Line Fishery	19
2. Relative Quantities of Fish taken by Line and by Beam Trawl	20
3. Statistics showing the Quantities of Line caught Fish obtained from the Areas where Trawling is prohibited, and the adjacent Areas where Trawling is allowed	22
4. Special Statistics of Fishing Boats	26
IV. Summary and Conclusions	27
Table A.—Summary of Fish taken by the 'Garland' on the East Coast in 1888	30
Table B.—Analysis of the 'Garland's' Statistics	34
Table C.—Record of Observations made on Board the 'Garland' on the East Coast	37
Table D.—Buckhaven Haddock and Cod Line Fishing	103

PAGE

Table E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats 104

Table F.—Showing the Monthly Takes of Line and Net Boats from Inshore Grounds in the Leith, Anstruther, Montrose, Stonehaven, and Aberdeen Districts . 118

Table G.—Showing the Monthly Takes of Cod, Haddock, and Whiting by Forty-one East Coast Fishing Boats in 1888 155

Table H.—Showing the Monthly Amounts in cwts. of Round and Flat Fish Landed by Line Fishermen and Beam Trawlers on the East Coast of Scotland during 1888 . 157

II. Reports from Her Majesty's Diplomatic and Consular Officers abroad on the best means of increasing the demand in Foreign Countries for Scotch Cured Herrings and other Fish. By T. Wemyss Fulton, M.B. 158

III. Abstract of Reports by Mr Thomas Scott on his Special Investigations on board Steam Trawlers. By T. Wemyss Fulton, M.B. . 171

IV. Solway Shrimp and Flounder Fishings. By J. H. Fullarton, M.A., B.Sc. 175

V. Abstract of a Report by Dr Alfred Daniell on the Fishery Statistics of Scotland. By T. Wemyss Fulton, M.B. . . . 178

SECTION B.—BIOLOGICAL INVESTIGATIONS.

I. Inquiries into the Nature of the Food, the Spawning, Habits, &c. of Marine Food Fishes. By T. Wemyss Fulton, M.B. . 182

II. Report on the Spawning of the British Marine Food Fishes. By J. C. Ewart, M.D., and T. Wemyss Fulton, M.B. . . 186

III. On the Food of Fishes. By W. Ramsay Smith, B.Sc. . . 222

IV. On the Pelagic Fauna of the Bay of St Andrews during the Months of 1888. By W. C. M'Intosh, M.D., LL.D., F.R.S., Professor in the University of St Andrews. (Plates III.-VI.) . 259

V. Some Additions to the Fauna of the Firth of Forth, with Notes of some Rare East Coast Forms. By Thomas Scott . . 311

VI. Mussel Farming at Montrose. By J. H. Fullarton, M.A., B.Sc., and Thomas Scott. (Plate VII.) 327

VII. On the Habits of Pecten, and on the Clam Beds of the Firth of Forth. By J. H. Fullarton, M.A., B.Sc. (Plate VIII.) . 341

VIII. Report on Bait Experiments. By J. H. Fullarton, M.A., B.Sc. . 352

IX. Notes from Personal Observation on the Habits of the Greenland Whalebone Whale. By D. G., Peterhead . . . 365

X. On the Saprolegnia of Salmon Disease and Allied Forms. By Alexander Edington, M.B., C.M. (Plate IX.) . . . 368

XI. Note on the Intercrossing of Members of the Genus Salmo. By J. R. G. M. 382

XII. Notes on Contemporary Work relating to Fisheries in this and other Countries. By T. Wemyss Fulton, M.B., and J. H. Fullarton, M.A., B.Sc. 384

Great Britain 386

United States 388

France 389

Spain 396

Holland 399

Italy 401

	PAGE
Norway	402
Sweden	405
Denmark	405
Russia	408

SECTION C.—PHYSICAL INVESTIGATIONS.

I. Report on Observations relating to the Physics and Chemistry of the North Sea during 1888 and 1889, and including a review of the Analytical Work hitherto undertaken for the Fishery Board for Scotland. By John Gibson, Ph.D. (Plates X.–XIII.) . 409

II. Note on the Carbonic Acid and Micro-organisms in the Air at Various Stations during the Cruise of H.M.S. 'Jackal.' By Charles Hunter Stewart, M.B., B.Sc. 472

SEVENTH ANNUAL REPORT.

TO THE MOST HONOURABLE

THE MARQUIS OF LOTHIAN, K.T.,

Her Majesty's Secretary for Scotland.

Fishery Board for Scotland,
Edinburgh, 1*st May* 1889.

My Lord Marquis,

We, the Members of the Fishery Board for Scotland, have the honour to submit the Board's Seventh Annual Report, being for the year 1888.

The subject matter of the Report has been arranged, as was done last year, in three parts, under the following titles:—

Part I.—General Report.
Part II.—Report on Salmon Fisheries.
Part III.—Scientific Investigations.

We have the honour to be,

My Lord Marquis,

Your Lordship's most obedient Servants,

THOMAS J. BOYD, *Chairman.*
JOHN GUTHRIE SMITH, *Deputy-Chairman.*
GEO. H. M. THOMS.
ALEXR. FORBES IRVINE.
J. R. G. MAITLAND.
J. COSSAR EWART.
JAMES JOHNSTON.
WILLIAM BOYD.
W. ANDERSON SMITH.

PART III.—SCIENTIFIC INVESTIGATIONS.

GENERAL STATEMENT.

This, the Third Part of the Seventh Annual Report, deals with the results of the Trawling Experiments, and of the Special Statistics, and with the Biological, Physical, and other Investigations undertaken during 1888. An account is also given of the contemporary scientific work in connection with Fisheries in this and other countries.

The Scientific Report has been prepared by a Committee of the Board, consisting of Professor Cossar Ewart (Convener), Sir J. R.-G.-Maitland, Bart., Mr William Boyd, and Mr W. Anderson Smith. Professor Ewart and Sir James Maitland have continued to act in the direction of the Scientific Investigations, and have had the assistance of Dr T. Wemyss Fulton, the Secretary of the Scientific Report Committee.

Since the Scientific Investigations were organised on a special basis, and as far as possible separated from the administrative duties of the Board, the work has undergone considerable expansion both in extent and direction. The Scientific Staff, continuously employed in the inquiries instituted by the Department, now consists of three trained naturalists, and an assistant naturalist—namely, John Beard, B.Sc., Ph.D., lately Assistant Professor in the University of Freiburg, Baden; Mr J. H. Fullarton, M.A., B.Sc., previously assistant to the Professor of Zoology in Glasgow University; Mr Thomas Scott, and Mr Peter Jamieson. The supervision of the physical inquiries carried on is in the hands of Dr John Gibson of the Chemical Laboratory, University of Edinburgh; and Mr Duncan Matthews, F.R.S.E., and Mr W. R. Smith, B.Sc., have been engaged in the study of the extensive statistical information collected. Dr Edington has been engaged in a special investigation into the organisms connected with salmon disease.

Owing to the rapid development of the Scientific Department of the Board, and the numerous and complex questions which require consideration and treatment, the Committee have felt it desirable to be placed in a position to obtain the advice and co-operation of a number of gentlemen of recognised authority in special branches of inquiry connected with fisheries. At the invitation of the Secretary for Scotland the following gentlemen have courteously agreed to associate themselves with the Department as a Committee of Advice and Reference:—Professors

Bayley Balfour, F.R.S., Crum Brown, F.R.S., D'Arcy Thompson, Dittmar, F.R.S., M'Intosh, F.R.S., M'Kendrick, F.R.S., M'William, Traill, and Young; Major-General Sir R. Murdoch Smith, C.B., Director of the Edinburgh Museum of Science and Art, and Mr G. Auldjo Jamieson.

This Committee includes representatives from all the Scottish Universities, and in addition a representative from Anderson's College, Glasgow, and one from the University College, Dundee.

During the year the following, amongst other investigations, have been carried on with the assistance of the sum of £2000 voted under the Sub-head Scientific Investigations:—The influence of beam trawling, especially in territorial waters; surveys of the clam and mussel beds in the Firth of Forth, and of the mussel beds at Montrose; experiments to determine the relative value of different kinds of baits; the distribution of small fish, especially flat-fish, in inshore and offshore waters, and the capture and destruction of immature fish; the food, spawning, and habits of the food fishes; special inquiries into the pelagic fauna, which forms the chief food supply of young fishes; the organisms associated with salmon disease; the physics and chemistry of the North Sea.

During the financial year 1889–90, it is proposed to expend the sum voted for scientific work as follows:—(1) For the trawling experiments and apparatus, £350; (2) for the collection of special statistics, £200; (3) for inquiries, &c., in connection with bait, £100; (4) for work and appliances in connection with the spawning and development of food-fishes and shell-fishes, £550; (5) for physical investigations, £240; (6) for investigations in connection with the inland waters, £150; (7) for report on the pelagic fauna of St Andrews Bay, &c., £135; (8) for illustrations for Part III., £50; (9) for special books and periodicals, £25; (10) for secretarial work, £200.

1. The Influence of Beam Trawling.

The influence of beam trawling has for the past few years been made a leading subject of inquiry and investigation by the Scientific Department of the Board; the Special Report embodying the results of these inquiries will be found at page 15. During 1888 no change was made in the extent of territorial waters set apart for experimental investigation, and in which beam trawling was suspended. On the 28th of February of the present year (1889), however, the limits of the restricted area were extended to embrace that part of the territorial zone stretching between Red Head in Forfarshire and Kinnaird Head, and a number of experimental Stations have been selected in this area for periodic examination by the 'Garland.' The region, therefore, from which the practice of beam trawling is at present excluded comprises the greater portion of the territorial waters of the East Coast, namely, from Tantallon Castle on the south side of the mouth of the Firth of Forth in the south to the Ord of Caithness in the north.

The measures adopted by the Scientific Department in the course of the inquiry have consisted chiefly of:—(1) the trawling experiments of the 'Garland'; and (2) the collection and analysis of special statistics. But, in addition, systematic inquiries have been carried on into the more important points connected with the food, migrations, spawning, and distribution of mature and immature fish, which are so closely related to the condition and productiveness of inshore fishing grounds. These investigations are embodied for the most part in Special Reports referred to in more detail below.

From the knowledge acquired during the biological investigations in the inshore waters, it was found necessary to extend the inquiries to the offshore fishing grounds. Hitherto this has been impossible, owing to the fishery cruisers being unsuitable for carrying on scientific work; but this year, through the courtesy of Messrs Johnston & Sons, Montrose, it has been possible to carry on systematic investigations into the condition of certain of the great fishing grounds lying off the East Coast, beyond the limit of the territorial waters. These banks are largely resorted to by shoals of various food-fishes, such as plaice, cod, and haddock, for the purpose of spawning, while most of the inshore waters, more especially in the Firth of Forth, seem to form great nurseries for the rearing of young and immature fish. The recently discovered fishing grounds in the Pentland Firth, the well known Smith Bank, situated in the Moray Firth, and other offshore grounds, have been specially examined physically and biologically. The physical observations were made on board H.M.S. 'Jackal,' while the biological inquiries were carried on on board Messrs Johnston's steam trawler 'Southesk.' The 'Garland' has recently been sent to make a more thorough examination of the Smith Bank and other fishing areas on the East Coast, and a series of experimental trawlings have been arranged for in the waters around the Orkney Islands.

It has not been found possible for the 'Garland' to make similar systematic investigations on the West Coast of Scotland, the vessel having been fully employed in the inquiries associated with the closed waters on the East Coast, and the 'Vigilant' and the other fishery cruisers being quite unsuitable for taking part in trawling and other experiments, the Scientific Department of the Board were again able, through the courtesy of Messrs Johnston and Sons, Montrose, to avail themselves of the services of the powerful and well-equipped steam trawler, the 'Southesk,' which has accordingly been employed in testing some of the more important fishing banks in the vicinity of the Western Islands. The results of these operations are referred to below.

Already a preliminary survey of the more important fishing grounds in the Clyde area has been made, and it is now a matter of the greatest importance that a fishery cruiser be provided, which, in addition to the ordinary work of superintendence, will be adapted for making a thorough examination of the fishing grounds around both the Inner and Outer Hebrides, with the special view of opening up and promoting as rapidly as possible the fisheries on the West Coast.

(1) *The Trawling Experiments of the 'Garland.'*

The results of the trawling operations of the 'Garland' during the year will be found fully discussed in the Special Report (p. 16).

On the East Coast 29 Stations have been formed for experimental trawlings, and these have been examined from time to time throughout the year. The Stations in relation to the closed waters of the Firth of Forth, and those in St Andrews Bay, have been very carefully and systematically investigated. The general results do not show the same increase in the proportions of fish caught by the 'Garland's' trawl as in 1887, but they are superior to the results of the experiments of 1886 (the first year in which beam trawling was suspended in these waters) so far as concerns the relative abundance of flat-fish. The takes of line fishermen from these waters, in which the 'Garland's' operations have been chiefly carried on, have, however, shown a considerable increase in 1888 over the previous year, and this has been especially marked in the case of flat-fish, which, being less migratory than round-fish, afford a better indication of the extent to which the fishing grounds may recover after the closure of the waters to beam trawling, the amount taken by line fishermen having been rather more than doubled. The low temperature of the bottom water in 1888 (1°·6 F. less than in 1887), and the generally tempestuous character of the weather, have probably a more or less close connection with the diminution in the takes of the 'Garland.' There is also reason to believe that, partly owing to the entire absence of fishery cruisers from the East Coast during a considerable portion of the year, and partly owing to the 'Jackal' being altogether unsuitable for fishery work, the results of the 'Garland's' experiments have been seriously interfered with. Large beam trawlers are often engaged in fishing operations near the mouth of the Firth of Forth and in the adjoining waters, and it is of essential importance that constant supervision should be exercised in this region, from which apparently the restocking of the Forth almost entirely depends.

Besides the trawling operations, concurrent inquiries have been carried on on board the 'Garland' into the food of the edible fishes, the maturity and spawning, and the proportional abundance of immature and adult fishes in the territorial and offshore waters. The results of these investigation are referred to below.

(2) *The Spawning Grounds of Plaice and other Food Fishes.*

Since the discovery by Sars, in 1864, that the eggs of several of the more important food fishes floated at the surface of the sea, a number of investigations have been made on this subject which confirmed and extended the observations of Sars. The results of these experiments and investigations having rendered it possible to study what actually takes place in nature during the spawning period of the large shoals of plaice and other food-fishes frequenting the open sea, it was decided to carry on a series of inquiries on board steam beam trawlers working on the fishing grounds off the East Coast. At the end of winter and the beginning of spring, immense shoals of plaice and haddock, as well as cod and gurnard, were discovered in the actual process of spawning, at several of the offshore fishing grounds in the Moray Firth and elsewhere;

and the constant use of the tow-net revealed the presence of myriads of eggs floating at or near the surface, which were derived from the ripe fish congregated on the bottom. A large number of eggs were also artificially fertilised and their development studied.

(3) *The Capture and Destruction of Immature Fish.*

The question of the capture and destruction of immature fish by the various modes of fishing practised round our coasts is one of great importance in regard to the future productiveness of the fisheries. Special inquiries have been made by the aid of a small meshed trawl-net into the relative abundance of immature fish, and especially flat-fish, in the inshore waters. In some cases about seventy per cent. of the flat-fish obtained were under 3½ inches in length; these observations, which are still in progress, serve to show to what degree the inshore waters act as nursing grounds for flat-fish, and thus aid in the stocking both of the territorial and extra-territorial waters. Professor Ewart recently submitted a short Report on this subject which was published in *Nature*, pointing out the great abundance of small flat-fish in inshore waters. This question continues to engage the attention of Professor Ewart, who will submit a Special Report dealing with it as soon as the necessary data have been obtained.

(4) *The Fishing Grounds on the West Coast.*

As was mentioned above, the steam beam trawler 'Southesk' has been recently employed under the direction of the Committee in examining the condition of some of the fishing grounds on the West Coast. Trawling operations were carried on to the west of Skye, between Skye and the Shiant Banks, to the west of the Lews, in the vicinity of the Flannan Islands, in Broad Bay, off Loch Ewe, and on the Stor Banks. At all these places, with the exception of Broad Bay, the ground was found to be too rough and rocky for ordinary trawling to be carried on. The trawl frequently caught on rocks and had to be hauled. In the Minch the net was torn almost from end to end, and in Broad Bay the bridles parted from the trawl catching on what was supposed to be a sunken wreck. It is not possible, in the meantime at least, to work safely on these grounds with a large beam-trawl; but when the grounds have been carefully examined by means of a naturalists' trawl and dredge, a number of banks may be discovered where even a large trawl could work.

From the information already obtained there seems little probability that beam-trawling can ever be extensively prosecuted on the West Coast beyond the area of the Firth of Clyde. It is worth mentioning, however, that in the only place where the trawl was able to work for about an hour, a good catch of both flat-fish and round-fish was obtained, there being 156 large plaice and 58 haddocks, in addition to skate, gurnard, lemon soles, and dabs. In all probability further investigations will show that many of the fishing grounds around the Lews are capable of yielding considerable supplies of halibut, plaice, and other valuable food-fishes.

2. Fishery Statistics.

For the first time it has been possible to analyse in a complete and scientific manner the special statistics collected relating to the fishing in several of the most important districts on the East Coast, in which beam-trawling has been suspended; and also in the areas where beam-trawling was permitted. The results of this analysis are detailed in the Special Report (p. 18), and it will be evident that they are of great importance and value as showing the relative takes of line fishermen and beam-trawlers in unprotected and protected waters, the proportional productiveness of the waters at different distances from the shore, and other points intimately associated with the judicious regulation of the fisheries.

The detailed statistics refer chiefly to those portions of the East Coast associated with the trawling experiments. These have been collected and analysed at considerable labour and expense, the whole of which has had to be met from the vote for Scientific Investigations. It may be mentioned that the statistics collected by the Board, being in certain important respects incomplete, it was found necessary to set apart a further sum from the vote for Scientific Investigations in order to supplement the statistical returns from some of the chief fishing stations on the East Coast. This has necessarily led to a considerable amount of unnecessary duplication of work, and as the Board has recently requested the Scientific Department to undertake the entire supervision of fishery statistics, it is hoped that in future this will conduce to a more complete and accurate statement being prepared without any great additional expenditure. The Committee were recently able to obtain the services of a trained statistician for the purpose of making an exhaustive examination of the fishery statistics published in this and other countries, and of elaborating a complete statistical system applicable to the requirements of the Scottish Fisheries. This inquiry has revealed certain defects in the statistics at present collected around the Coast, as compared with those now obtained by several other countries, and indicates the changes and modifications which it is desirable to introduce. An abstract of the Report on this subject will be found at p. 178.

Limiting attention to the statistics dealing with the East Coast fisheries, it appears that during 1888, 66,744 tons of white fish — exclusive of herrings, sprats, mackerel, and other net-caught fish—were landed on the East Coast of Scotland by line fishermen and beam-trawlers. Of this quantity by far the greater amount (54,535 tons) was landed by line fishermen. The round-fish —cod, ling, haddock, whiting, &c.—landed by line fishermen reached a total of 51,498 tons, and the flat-fish, a total of 3037 tons; giving respectively a monthly average of 4291½ tons and 253 tons. Beam-trawlers landed in the same period 8953 tons of round-fish and 3236 tons of flat-fish, or a monthly average respectively of 746 tons and 269 tons. When these statistics are compared with those for 1887 it will be found that 4419 tons were landed in 1888 in excess of the total for 1887. Further, in 1888, also, the amount landed on the East Coast by beam-trawlers was about 2000 tons less than in 1887; hence line fishermen landed during 1888 over 6000 tons more than in 1887. This great increase in the amounts of fish landed by line fishermen last year was not due to any increase in the number of men or boats employed. On the contrary, there were 156 fewer boats and nearly 1000 fewer men and boys than in 1887. The decreased takes of beam-trawlers on the East Coast in 1888 have been apparently chiefly due to the fact that, during considerable portions of the year, many of the boats which fished on the East Coast in 1887 were fishing in the Clyde and other parts of the West Coast. The increased amount landed by line fishermen is made up chiefly of round-fish, but in the southern area, where protection has been longest established, there is also a considerable increase of flat-fish.

The Board has not hitherto supplied information in the Annual Report as to the number of English trawlers that habitually work off the coast of Scotland and land their fish at Scotch ports. Such information would be of very great value. For instance, during 1888 it would appear that no less than 60 steam beam-trawlers were landing fish at Aberdeen; in the Boards' Report only 9 steam trawlers are described as belonging to Aberdeen.

The statistics referring to the amounts landed by line fishermen and beam-trawlers are graphically represented on Plate II.

The special detailed statistics which have now for two successive years been collected in the southern part of the East Coast, namely, the districts of Leith, Anstruther, Montrose, and Stonehaven, and which refer to the amounts of fish obtained by line fishermen from the closed and open portions of the territorial waters, also show that there occurred in 1888 a decided increase in the catches. These results are discussed at page 22.

In those portions of the territorial waters in which the practice of beam-trawling is prohibited, there was an increased catch of cod, haddock, and especially of flat-fish (lemon soles, dabs, and flounders). The average of all the fish per shot for the closed area was 1·83 cwts. in 1887, and 2·17 cwts. in 1888. In the open area where beam trawling is permitted the averages were 1·98 cwts. in 1887, and 3·55 cwts. in 1888. The open area in these districts is, however, of comparatively small extent, and in a considerable part of it the nature of the ground prevents beam-trawling being carried on.

Another group of statistics (p. 26) refers to the comparative amounts of fish taken at different distances from shore, both in the territorial and extra-territorial waters. As a general result, it appears that, while the proportions for different districts and for different kinds of fish varies, about 25 per cent. (above 13,000 tons) of the fish captured by line fishermen are obtained from the territorial waters.

In regard to the comparative size or quality of the fish obtained in 1887 and 1888, the statistics of the Buckhaven cod and haddock fishery (p. 19) are of much interest. From these it appears that in the neighbourhood of the Firth of Forth, at all events, while there has been a gross increase in the amount of haddocks captured, this increase was proportionately far greater in the case of the large haddocks than of the small haddocks and whiting.

3. Special Inquiries.

In addition to the general inquiries above referred to, special investigations have been carried on into various questions closely connected with fisheries. For want of space it has been found necessary to withhold several papers, and only the more important of the papers included in the present report are referred to here.

The Demand for Scottish Fish in Foreign Countries.—The great extent and value of the Scottish herring fishery renders it at all times worthy of special consideration, and since the prosperity of the large number of persons engaged in this industry depends so largely upon the exports of cured fish to the Continent, it is highly important that everything that influences this trade should be very carefully studied. This is particularly necessary at present when Norwegian and Dutch-cured herrings are competing so successfully with the Scotch-cured fish and driving them largely from the best markets. To admit of this being done, the Board, at the request of Professor Ewart, obtained a series of Reports through the Foreign Office from the British Ambassadors and Consuls abroad, as to the best means of increasing the demand for Scotch-cured fish in foreign countries. These Reports, which are most suggestive and valuable, have been of great assistance in showing the Board, as well as those practically engaged in the fisheries, in what respects the foreign trade may be best improved and developed. In a *résumé* of these Reports by Dr T. Wemyss Fulton, some of the causes which have led to the recent falling off in the export trade, and the requirements necessary to maintain and strengthen its hold in Foreign markets, are indicated. An account is also given, based on all the statistical information available, of the condition of the Scottish herring fishery in recent years.

Inquiries into the Food, Maturity, and Habits of the Food-Fishes.

Every one who has had to deal with the scientific or practical aspects of fishery questions has deplored the absence of accurate and extensive information as to the habits, spawning, and migratory movements of fish. In accordance with a scheme devised by Dr T. Wemyss Fulton, continuous and concurrent observations have been made at the request of the Committee on the following points:—(1) the food of the edible and other fishes at different seasons and places; (2) the maturity or immaturity of their reproductive organs in relation to their size during the several months of the year; (3) the duration and place of spawning; and (4) their migrations.

The observations have been made principally on board the 'Garland,' in the Firth of Forth and St Andrews Bay; but also in the Moray Firth, Montrose Bay, Aberdeen Bay, and on board trawlers working on offshore banks. Above 6000 fish, comprising all the kinds of edible fishes obtained, as well as several of the enemies of the food-fishes, have been already examined, and the main results as to the food, spawning, and maturity are given in separate Reports ~~(pp. 182, 222)~~.

The Food of Fishes is dealt with in a Report by Mr W. Ramsay Smith, B.Sc., which undoubtedly forms the most extensive contribution to this subject yet made. Although, probably, more information had been previously collected in regard to the food of fishes than on the other points of the inquiry, it was chiefly limited to round-fish. Mr Smith's Report for the first time gives a systematic record of the nature of the food at different times of the year of round and flat-fishes living together in the same locality. It has, therefore, great practical value as throwing light on the proportions in which the various kinds of marine animals participate in supplying the food of the different kinds of edible fishes, and as indicating the competition which goes on in the same locality, and also the influence which beam-trawling and other modes of fishing are likely to have upon the food of the various kinds of round and flat-fishes. The description of the food of flat-fishes, such as plaice and lemon soles, is especially valuable, inasmuch as our previous knowledge on this point was of the most meagre description. The inquiry also serves to show indirectly the distribution and movements of the invertebrate fauna, so far as it constitutes the food of fishes. This Report is accompanied by a series of Tables.

Observations on the Spawning of Fishes.—This subject—one of the most important in fishery inquiries—is dealt with in a Report by Professor Ewart and Dr T. Wemyss Fulton, which embodies the results of the examination of over 22,000 fish. When the scheme referred to above was begun, it was anticipated that a great deal of positive information in regard to the spawning of fishes in the territorial waters, would be acquired. But, although several thousands of fishes have been carefully examined at short intervals and at fixed stations, comparatively few have been found fully ripe or spawning. The reason for this paucity in the numbers of ripe fish obtained, constitutes, however, one of the most important results of the inquiry, and is of direct practical significance.

The great majority of the fish specially examined were obtained at the trawling stations of the 'Garland', *within the territorial waters*, and although considerable numbers were found with the roe or milt well developed and almost mature, very few, as has been stated, were found spawning in the territorial waters. It is pointed out, for instance, that of 814 plaice from St Andrews Bay and the Firth of Forth only one fully ripe specimen was got, and that in September; while only eight specimens were nearly ripe, and these were got between October and January. A striking exception to the absence of spawning plaice in the Forth and St Andrews Bay occurred last January in the Pentland Firth, where a large shoal of these fish were discovered spawning close inshore. The Master of the steam trawler 'Southesk' reported that the spawn was freely escaping from many of the plaice when landed on deck. There was also found in the Moray Firth, in January, about 15 miles from the shore, a shoal of plaice, all of which were either engaged in spawning or were fully ripe or spent.

Lemon soles, cod, haddock, whiting, and in fact the great majority of the fish, appear not to spawn in the Firth of Forth or

St Andrews Bay; but long rough dabs, common dabs, and gurnards spawn to at least a considerable extent in the inshore waters of the Firth of Forth. From these investigations it appears:—(1) that the territorial waters of the Firth of Forth, St Andrews Bay, and the Moray Firth do not serve as spawning places, for either flat-fish or round-fish, except to some extent in the case of long rough dabs, common dabs, and gurnards in the Firth of Forth; (2) that shoals of plaice and haddock spawn in the offshore waters of the East Coast; (3) that the general absence of spawning fish from the territorial waters on the East Coast appears to be due to their congregation in the waters offshore as they reach maturity; (4) that plaice appear to spawn in the Pentland Firth in inshore waters; (5) that plaice, cod, and haddock select among other places for spawning the ground near the Bell Rock, the Smith Bank and other portions of the Moray Firth.

The Report is accompanied by a series of tables.

The Pelagic Fauna of the Bay of St Andrews during the Months of 1889.—The first part of a long and elaborate Report on this subject by Professor W. C. M'Intosh, F.R.S., will be found under Section B. Many points arising from a systematic study of the pelagic organisms have a close relation to fishery questions—as, for instance, the presence of floating fish eggs and young fishes, the food of the edible fishes in their larval and post-larval stages, &c. In this part of his Report Professor M'Intosh, after referring to the method adopted in the investigation, gives a separate detailed account of the pelagic organisms obtained during each month of the year in the Bay of St Andrews. He then describes the various floating fish eggs which were obtained, and also the larval and post-larval forms of the food-fishes. One of the most interesting points brought out is the gradual advent in the early part of the year of the larval fishes, and their great abundance in March, April, and May. After this the predominance of the post-larval types is the main feature. Among others, the floating eggs of plaice, turbot, sole, flounder, cod, and haddock were obtained; while the larval and post-larval forms of the food-fishes included those of the turbot, brill, cod, and whiting. This Report is illustrated by four plates.

Some Additions to the Fauna of the Firth of Forth.—In this Report Mr Thomas Scott describes a large number of marine organisms, belonging to almost every group, not hitherto recorded for the Firth of Forth. Some of the forms which Mr Scott discovered have turned out to be new either to the East of Scotland or to Britain. The fishes new to the Forth are the sail-fluke (*Arnoglossus megastoma*), the greater fork beard (*Phycis blennoides*), and *Lumpenus lampetræformis*, which has also been found in the stomachs of cod.

Inquiries into the Supplies of Bait.

Several of the papers deal with the question of bait for line fishermen, a subject which has recently and deservedly attracted much attention. In Scotland a very large proportion of the fishermen prosecute line fishing, either continuously throughout the year or during a large part of it; and they landed on the East Coast alone, in 1888, a total of 54,535 tons of fish which were entirely caught by the use of bait. In the case of mussel bait it has been recently shown that in some districts it takes very nearly a ton of mussels to catch a ton of fish, and the expense of providing bait forms a serious item in the expenditure of the fishing population. It is, therefore, evident that everything that relates to the supplies of bait merits constant attention, and that accurate knowledge should be obtained of the various sources of the present supply.

Mussel Farming at Montrose.—In last year's Report attention was directed to the importance of an abundant supply of bait for line fishermen, and attention was called elsewhere to the methods adopted at Montrose for the cultivation of mussels. Quite recently the Montrose mussel beds have been specially referred to by the Committee appointed by the Marquis of Lothian to inquire into the condition of the Scotch mussel and bait beds. With the view of enabling fishermen and others desiring to engage in mussel culture to become acquainted with the system followed at Montrose, a Report has been prepared by Mr Fullarton and Mr Scott, which deals with the position, extent, &c., of the Montrose beds. The systematic cultivation was begun at Montrose 36 years ago by Mr James Johnston, now a member of the Fishery Board. The operations at Montrose have been conspicuously successful in leading to the stocking of previously barren areas and the increase of the yield. The work is conducted on the bed system, the young mussels, when about half an inch long, being transferred from the seed-beds in the channel, to beds in the Montrose Basin. Here they generally grow to saleable size within about three years, but if not they are transferred to banks further down the stream, so that they may attain to the best size within a few years. The beds, the method of cultivation, and the fauna living alongside of them, are described; the 'growing' and 'seed' beds have been mapped out, and are represented on the large chart which accompanies the Report.

What has been found possible at Montrose, where the conditions are by no means the most favourable, can doubtless be done in many other places in Scotland.

On the Habits of Pecten, and on the Clam Beds of the Firth of Forth.—Mr J. H. Fullarton, M.A., B.Sc., furnishes a Report on this subject, based upon a survey made by himself and Mr Thomas Scott of the important clam beds in the Firth of Forth, and on his personal observations on the habits of *Pecten*, the conditions under which it flourishes, and the methods of working the beds. From the chart which accompanies this paper it will be seen that the clam beds in the Forth are of great extent, the chief bed extending for a distance of about 12 miles, from Inchmickrie on the west to the neighbourhood of Gullane Ness on the east. The fishermen along the south shore of the Firth derive by far their greatest supply of bait from these clam beds, which also provide large supplies to the fishermen on the north side. These beds have increased in extent and productiveness within the past few years. In 1886 they yielded 400 tons of bait, in 1887, 860 tons, and in 1888, no less than 1033 tons, valued at £2918. This exceedingly rapid increase in productiveness is apparently largely attributable to the cessation of beam trawling in the estuary.

Report on Bait Experiments.—Mr Fullarton also furnishes a Report on the results of a series of experiments, devised by Dr T. Wemyss Fulton and carried out on board the 'Garland' in the Firth of Forth, on the relative efficiency of different kinds of bait, the preference by different fish for different baits, and the possibility of discovering a cheap substitute for the forms of bait commonly used. It appears that this subject has not been previously treated in a scientific manner, and the results are therefore of much interest. The baits used consisted of mussels, clams, lug-worms, and other baits generally employed, and also earth-worms, garden snails, bullock's liver, mussels preserved in boracic acid, and a variety of artificial substances variously coloured, and flavoured with fish extracts; but none of these artificial baits were successful. The general result of all the experiments is to show that the chief best baits in the Firth of Forth stand in the following order:—lug-worm, mussel, clam, horse-mussel, and limpet. Cockles and garden snails were also very successful. A series of tables accompany this Report.

Inquiries in Connection with Inland Waters, &c.

The Saprolegnia of Salmon Disease and Allied Forms.—The pathology of salmon disease, and the many problems associated with it, form one of the most important and difficult questions in connection with our inland fisheries. In this preliminary Report Dr Alexander Edington, after giving a sketch of the first appearance and extension of salmon disease in our rivers, and a review of the principal previous inquiries and investigations into the subject, describes the pathological conditions of the diseased fish at different stages, and the microscopical appearance of the fungus. The effects of overcrowding are discussed, it being shown from an experiment with a Char that the disease may occur although no overcrowding exists. Dr Edington also describes his experiments in the artificial cultivation of the fungus. It has been held that the disease always existed in a sporadic form in all rivers, and the problem was to find out the conditions under which it became epidemic. The experiments made by the author strongly suggest that there are at least two forms of *Saprolegnia* associated with the disease. It has also been shown that the true salmon fungus can grow to a certain extent in air and develop 'resting spores,' which indicates the possibility of their being normally a terrestrial form. The Report is illustrated by a plate.

On Intercrossing in the Genus Salmo.—In this paper a brief account is given of some of the experiments which have been made by Sir James Maitland, Bart., at the well known Howietoun establishment, in regard to the crossing of various members of the genus *Salmo*.

Besides the more important Reports above referred to, a short description is given by Mr Fullarton of the Shrimp and Flounder Fisheries, as carried on in the Solway Firth, and the results of his inquiries into the young flat-fish captured in the trawl nets are described. There is also a paper describing the habits of the Greenland whale, containing careful observations on the nature of the food of these animals, their size at different ages, and their habits generally.

Physical Observations.

Report on Observations relating to the Physics and Chemistry of the North Sea.—The mass of data regarding the physics and chemistry of sea water which are embodied in previous Reports relate almost entirely to the waters lying more immediately off the Coast of Scotland. It was therefore decided to extend the area investigated to that of the North Sea generally. Such extension seemed all the more desirable as the analytical results arrived at in different years were apparently contradictory.

Dr Gibson was accordingly requested to undertake the direction of an expedition during September and the early part of October on board H.M.S. 'Jackal' in order to investigate the physical and chemical conditions existing in the North Sea.

The Report gives an account of the observational work accomplished during the cruise, and also of a series of observations made during January and February off the Northern Coast of Scotland and in the Moray Firth. These observations were supplemented by the examination in the Chemical Laboratory of the University of Edinburgh of the large number of samples of sea-water collected in 1888 and 1889.

The results of this laborious analytical investigation, in which the author was assisted by several fellow-workers, are given in detail in Part II. of his Report. After an exhaustive discussion of the more recent results taken in conjunction with those published in previous reports, the very important and quite unexpected conclusion is reached that two chemically distinct kinds of sea-water are present in the North Sea, and that the apparently contradictory results obtained in previous years were due to the coming and going of these different waters.

The nature of the influence of admixture of sea-water with land water is discussed, and the conclusion is arrived at that mere admixture with land water cannot possibly be the cause of the difference between the two kinds of water, but that two distinct kinds of ocean water penetrate into the area of the North Sea, the one being probably of arctic or northern, and the other of southern origin.

Whatever may prove to be the true explanation of these differences, the recognition of the fact of their existence is of very great interest, as it may be related to the migrations of herrings and other fishes.

4. Contemporary Fishery Work.

An account is given under Section B of the scientific fishery work carried on elsewhere in this country, on the Continent, and in America. We are much indebted for the information obtained to the courtesy of a number of foreign gentlemen connected with marine investigations, and to several British ambassadors abroad, who have transmitted through the Foreign Office a series of valuable Reports. Among those who have sent memoirs and other publications—sometimes of great interest and value—or who have otherwise assisted us, we have to thank Professor Giglioli, Florence; Colonel Marshall Macdonald, the Fish Commissioner for the United States; Professor Brown Goode of the Smithsonian Institution; Professor A. F. Marion, of the Marine Laboratory at Marseilles; Professor Pouchet, of the well-known Zoological Laboratory at Concarneau; Dr Sauvage, of the Marine Laboratory, Boulogne-sur-mer; His Highness Prince Albert of Monaco; M. Raveret Wattel, Secretary to the Société Nationale D'Acclimatation de France, Paris; Captain G. M. Dannevig, of Flödevig, Norway; Mr Buch, of Bergen; Dr P. P. C. Hoek, Scientific Supervisor of the Netherland Fisheries; Lieutenant Drechsel, Superintendent of the Danish Sea Fisheries; Dr C. G. Joh. Peterson, of the Danish Scientific Fisheries Department; and Professor Hensen, of the Kiel Commission.

From the fact that a larger number of copies of our Annual Report have now been placed at our disposal, we have been enabled to arrange with various fishery authorities and scientific institutions for an exchange of publications. Amongst them may be named, the Minister of Marine, Canada; the Royal Academy of Science, Berlin; the Imperial Academy of Science, Vienna; the Royal Meteorological Society, London; the Royal Society of Edinburgh; the Scottish Meteorological Society; the Kiel Commission; and Johns Hopkins University, Baltimore. Copies have also been sent to each of the Scottish Universities.

It will be seen from the account given of the scientific fishery work being carried on, that considerable activity is being displayed in other countries in connection with fishery inquiries. Laboratories are being in some places provided and subsidised by the Government for the purpose of prosecuting systematic fishery investigations.

SECTION A.—GENERAL REPORTS.

I.—REPORT ON THE TRAWLING EXPERIMENTS OF THE 'GARLAND,' AND ON THE STATISTICS OF EAST COAST FISHERIES.* PART III.

I. INTRODUCTORY.

In the previous parts of this Report the objects and methods of the inquiry undertaken by the Scientific Department of the Fishery Board into the influence of beam-trawling on the productiveness of fishing grounds, have been set forth in detail and need not now be repeated. The trawling operations of the 'Garland' during last year were conducted on the same general lines as formerly, the stations selected in the waters set apart for experimental purposes having been periodically examined, and the results tabulated in detail. These results are discussed below, and the tables are given *in extenso* (p. 30).

Besides the waters mentioned in last year's Report in which the prosecution of beam-trawling has been suspended, it was decided to recommend that the territorial waters between Red Head in Forfarshire and Kinnaird Head in Aberdeenshire should also be closed against this mode of fishing. A bye-law for this purpose was accordingly drawn up, and after confirmation by the Secretary for Scotland, came into operation on the 28th of February of the present year. In addition to the stations previously formed in this area, namely, in the neighbourhood of Aberdeen Bay, and which are described in a former report, three other stations were selected. Two of these are in the vicinity of Montrose, and the other is in Cruden Bay; they are described on page 18.

It was considered advisable, in order to obtain information supplementary to that obtained by the 'Garland' in the inshore waters, to acquire some knowledge of the offshore fishing grounds frequented by beam-trawlers. Through the courtesy of Mr James Johnston, a member of the Fishery Board, Mr Thomas Scott was enabled to accompany the large and powerful steam-trawler, the 'Southesk,' belonging to Mr Johnston's firm, on several of its expeditions on the East Coast. The important observations of Mr Scott are referred to below, and an abstract of his Reports on this branch of his work will be found at p. 171. Our knowledge of the conditions of these offshore fishing grounds has been so scanty hitherto, and Mr Scott's investigations have proved so interesting, that the 'Garland' has been sent to the Moray Firth to make a careful survey and examination of the well-known Smith Bank and other offshore fishing grounds lying in that region. It will be thus possible to institute a comparison between these grounds and the experimental trawling stations of the 'Garland' in the inshore waters of the Moray Firth.

It was intimated in last year's Report that systematic investigations had been begun, in connection with the trawling experiments, into certain important relations of the food-fishes, such as the proportional distribution of round and flat-fishes in the inshore and offshore waters, the time and place of spawning, the migratory movements, &c. The information thus obtained on several of these points is so extensive and

* The Stations of the 'Garland' are described in previous Reports (*vide* p. 184).

important that it has been necessary to incorporate it in special Reports, which will be found under Section B. Some of the results, however, will be referred to in the concluding section of this Report on the Trawling Experiments.

One branch of inquiry, closely associated with the trawling experiments, concerns the capture and destruction of immature fish. A large number of experimental observations have been made with a shrimp trawl net, fixed to an 18-feet beam, in various parts of the Firth of Forth, in order to test the relative distribution of small and large fish in different areas. The general results are referred to below. In connection with the subject of the capture and destruction of immature fish, it has been deemed desirable to test experimentally certain trawl-nets, placed at our disposal, specially designed to allow small fish to escape capture. These have been tried in the Firth of Forth and St Andrews Bay, and the results of the trials are described later on.

The statistics which have been collected in regard to the productiveness of the territorial waters in the closed and open area, and the relative quantities of fish landed in the various districts of the East Coast by line fishermen and beam-trawlers, are fully discussed below. We have to thank the fishery officers for much statistical and other information in connection with the trawling experiments. In March 1889, the Fishery Office in the Leith District was transferred from Leith to Newhaven; the change has given greater facilities for information being obtained as to the fishings in the Firth of Forth area, and we have to express our indebtedness to Mr John Murray, the fishery officer there.

II. THE WORK OF THE 'GARLAND.'

1. The Firth of Forth.

Plate I.

The trawling experiments in the Firth of Forth during last year began in June, and have since been continued at monthly intervals. Forty trawlings were made at the stations in the closed area, and ten at those outside. The Tables (almost entirely kept by Mr T. Scott) will be found at page 37. As a general result, it is found that the great increase in the abundance of fish in the Firth in 1887 has not been maintained in 1888. This appears to be largely due to the exceptional severity and stormy character of the weather during last year; the trawling operations being frequently conducted under considerable difficulties.

Taking the total number of trawlings in the closed area in 1888, it is found that the average number of fish of all kinds captured amounted to 211 per 'shot.' In 1887 the corresponding average was 351, and in 1886, 251. When these figures are compared with the averages for the open area, it will be seen that the diminution has been very considerable there also. In 1886, the average was 85; in 1887, 211; and in 1888, 151. The reduction in the average in the offshore waters is thus less than in the Firth proper. In regard to the part taken by the flat-fish and round-fish respectively in the general diminution, an examination of the figures shows that there has been in the closed area a greater proportional decrease of flat-fish than of round-fish, and this is still more marked in the open waters. The figures are given in the following table :—

		Flat-Fish.	Round-Fish.
Closed Area,	1886,	112·8	131·8
	1887,	203·1	144·1
	1888,	117·0	92·1
Open Area,	1886,	47·5	36·7
	1887,	89·8	123·4
	1888,	34·4	114·7

When the inquiry is pushed further, it is shown that the decrease is shared, but very unequally, by all the various kinds of fish, except cod and whiting; and this observation applies both to the closed and the open areas. Among flat-fish the greatest relative diminution is in the case of lemon dabs, which gave an average in 1887 of 48 in the Firth proper, while the corresponding figure for 1888 is 21. In the open waters the decrease is even more marked, the respective figures for 1887 and 1888 being 8·6 and 1·5. The takes of haddocks were also much smaller in 1888. At the stations in the Firth, the average in 1887 was 99·5, and in 1888, 41·8, and at the stations outside 91·6 and 54·9 respectively. On the other hand, as has been said, there has been a considerable increase in the more migratory cod and whiting. In the closed waters the average number of whiting, per 'shot,' obtained in 1886 was 11; in 1887, 14; and in 1888, nearly double—namely, 24. Cod during these three years gave also a gradually increasing average of 10, 11, and 12. In the open waters the increase of whiting is relatively more marked than in the case of cod. In 1886 the average take of whiting was only 2·7, and in 1887, 6·2; while in 1888 it was no less than 40·9. It was pointed out in last year's Report that the distribution of these two fish semed to depend upon similar causes, and the investigations of 1888 show that this is the case. Hitherto the combined results for the whole of the stations have been considered. When the average takes at the individual stations are examined, it is made evident that while there has been a decrease both of round and flat-fish at each of them, the diminution is very unequally apportioned. It is noteworthy that the greatest decrease has been in the central stations, most exposed to the influence of storms, namely, at Stations I., III., V., and VI. At Station IV., which lies inshore, and curves round the great south bay of the Forth, the decrease is comparatively trifling; and at Station II., which occupies a corresponding position on the north side of the Firth, the decrease is also slight. At some stations the flat-fish have diminished in greater ratio than the round; at other stations the contrary is the case, but a careful scrutiny of the figures shows that no general explanation can be given. At all the stations, except Station V., whiting have increased; at most of the stations cod, and at several stations gurnard, likewise increased. Except at Station IV., where there occurred a slight increase, haddock were taken in diminished numbers at all the stations, as were also the various flat fishes, with the exception of skate, which increased slightly at a few of the stations.

It may be desirable to institute a comparison between the results of the 'Garland's' operations in the various months of 1887 and 1888. In the closed area, while there was a large decrease of flat-fish in June of the latter year, as compared with the corresponding month of 1887, this decrease was very much less in August, and in September there was an actual increase. In the case of the round fish caught in these months of the two years, the decrease in August and September was much less marked than in June; while in the open area there was a considerable increase of round fish in September 1888, as compared with the same month in the previous year.

In regard to the fluctuations in the kinds of fish obtained, the returns show that in June of last year all the fish were less abundant in the closed waters, except gurnard; in August there was a slight increase of plaice and dabs, and a considerable increase of whitings, as compared with 1887; while in September the increase was mainly in plaice and less markedly in lemon dabs.

2. St Andrews Bay

Plate I.

In St Andrews Bay, the fishing grounds within the protected area were tested on twenty occasions, and those in the open waters beyond on five. As in the Firth of Forth, there was a general decrease in the catches, both in the open and in the closed area. In the latter, the general average per 'shot' for all kinds of fish was 286 in 1888, and 435 in 1887. But while the very great increase of 1887 has not been maintained in these waters, the average is still very far above what it was in 1886, when it was only 177·7. In the open area the same thing is observable. In 1887 the average catch was 309; in 1888, 221; and in 1886 only 169.

The diminution of the average in St Andrews Bay in 1888 was due, as in the case of the Firth of Forth—but to a much greater degree—chiefly to decrease in the numbers of flat-fish. In the open waters outside the Bay the opposite condition prevailed, there being a great decrease of round fish, accompanied by an increase of flat-fish. The decrease in the closed area is shared by all the different kinds of fish, except whitings, which increased considerably, and cod, which gave an average the same as in 1887. The average in all cases, however, is greater than it was in 1886, and this is especially the case with plaice and haddock. In the open waters there was an increase in plaice, dabs, cod, and especially whiting, and a great decrease in lemon soles, flounders, and haddocks. While there has been a general decrease within the restricted waters, there has been an actual increase at some of the stations. At Station III., the increase was participated in both by flat-fish and round-fish; at Station IV., it was limited to round-fish. As in the case of the Firth of Forth, the increase in flat-fish when it occurred was made up entirely of plaice.

3. Other East Coast Districts.

As previously mentioned, new stations have been formed in the neighbourhood of Montrose Bay and at Cruden Bay. The station at Cruden Bay is crescent-shaped, and begins about two and a half miles south-east from Cruden Scars, curves in towards the shore, the course of which it follows for about a mile, and then runs east by south. The total length is about five and a half miles, the bottom consisting of sand and shells, and the depth varying from 4 to 30 fathoms. At Montrose, Station I. begins off the mouth of the North Esk, at a distance of one mile from the shore, and runs for a distance of two and a quarter miles in a south-easterly direction. The bottom consists of sand, and the depth varies from 4 to 13 fathoms. Station II. lies in Lunan Bay, and begins at a distance of a mile from the shore at Redcastle, passes parallel with the shore towards Bodden Point, and curves out south-east by east. The total length is 4 miles, the bottom being composed of sand, and the depth varying from 5 to 17 fathoms. These three stations were examined in July, and the results are given in detail at pp. 97, 99.

The old stations in Aberdeen Bay were also examined in July, and those in the Moray Firth in May, the results being given at pp. 97, 100.

III. SPECIAL STATISTICS OF FISH CAUGHT BY LINE FISHERMEN AND BEAM-TRAWLERS.

The statistics specially obtained for comparison with the results of the trawling experiments of the 'Garland' relate to the amounts of fish caught in the waters where trawling is prohibited and in the adjoining waters in the following districts :—Leith, Anstruther, Montrose, Stonehaven, and Aberdeen. Certain of the returns, however, refer only to some of these districts or to parts of them, as will be described below. It is obvious, therefore, that the statistics of the fish obtained in the waters lying off so large and varied a part of the East Coast deserve careful consideration.

The statistical information obtained is embodied in four different series of Tables. Table D. (p. 103), represents the quantities of large haddocks, small haddocks, and whiting, and of cod landed monthly by the Buckhaven boats in 1887 and 1888, and gives the average amount of each kind of fish per trip or 'shot.' Table E. (p. 104) shows the relative amounts and value of fish landed monthly by net and line boats and by steam beam-trawl boats in the Leith, Anstruther, Montrose, Stonehaven, and Aberdeen districts. These returns have been supplemented by returns from all the other districts on the East Coast of Scotland; the information thus obtained is summarily set forth in Table H. (p. 157), and graphically represented on Plate II. Table F. (p. 118) gives the monthly quantities of net and line fish caught within the territorial waters (where beam-trawling may or may not be prohibited) in the Leith, Anstruther, Montrose, and Stonehaven districts, with particulars as to the number and size of the boats fishing in the territorial and extra-territorial waters, the kind of bait used, &c. Table G. (p. 155) shows the monthly takes of cod, haddock, and whiting by 40 East Coast boats distinguishing the distance from the shore where the fish were obtained. This Table is an epitome of the returns for 1888, corresponding to Table G. of the Sixth Annual Report. For want of space it has been found impossible to publish these records in detail.

1. Buckhaven Haddock and Cod Line Fishery.

The statistics referring to this fishery are given at page 103, and show the takes of small haddocks and whiting, of large haddocks, and of cod, the number of days' fishing per month, and the total number of 'shots' per month; the average number of fish per 'shot' in each month of the year is also given. Although these statistics refer only to the fish caught by the boats of one fishing village, they are of special value as showing the relative proportions of large and small fish captured. When the total catch of large haddocks is compared in 1887 and 1888, it will be seen that in 1888 there was a great increase, the average per 'shot' being 42·8 and 62·6 respectively.

The increase was not, however, uniform during the various months of the year. In fact, during each of the first six months, January to June, the amounts landed were less, and sometimes considerably less, than in 1877. On the other hand, during the last six months, July to December, the monthly average in 1888 was very much greater than in the corresponding months of 1887.

In 1888 the highest monthly average was reached in October (99·4 fish per 'shot') and the lowest in March; in 1877 the highest average was in June (97·4) and the lowest in December.

The takes of small haddocks and whiting (under 12 inches) also increased in 1888, but not to the same degree as the large haddocks. The average was 208·9 per 'shot' in 1887, and 228·4 in 1888. The somewhat remarkable fact is brought out, that the average number of small haddocks and whiting taken in each of the first six months of 1888 was much greater than in the same months of 1877; while in each of the last six months of 1888 it was less than in the corresponding months of 1887—the reverse of what occurred in the case of the large haddocks.

In 1888 the largest number of small fish taken was in June (390·7) and the smallest number in December (58·3). In 1887 the largest average was in August (436) and the smallest in April (13·3). In regard to the relative proportions of large and small fish captured in each month of the two years, these statistics show that in 1887 the takes of large fish exceeded the takes of small fish in April and May, while in February and March they were about equal. In 1888, on the other hand, the takes of small fish exceeded the takes of large in every month except December.

The statistics in regard to the cod fishing show that in 1888 there was a great increase in the amounts of fish landed as compared with 1887, the averages being 0·45 per 'shot' and 0·23 per 'shot' respectively. This increase occurred in eight months of the year, the takes in January, February, July, and August being less than in the same months in 1887.

2. Relative Quantities of Fish taken by Line and by Beam Trawl.

The statistics dealing with this subject are given in detail for each fishing port or village in the Leith, Anstruther, Montrose, Stonehaven, and Aberdeen districts. Table E. represents the monthly totals of the various kinds of fish landed in the districts, the quantities of shell-fish, and the total value. In Table H. the relative monthly amounts of round and flat-fish landed by line fishermen and by beam-trawlers in 1888 in the northern and southern group of East Coast districts, and the monthly and yearly totals for the whole East Coast, are given.

The leading features of this Table are represented in the graphic diagram on Plate II. It appears from the statistics, that fish caught by beam trawl are landed only in three of the five districts comprising the southern group, and in five of the ten districts comprising the northern group.

Taking the southern group of districts first, we find that the line fishermen land by far more round-fish than do the beam-trawlers, and this is true of every month of the year, although in July, August, and September, when the fishermen are largely engaged in the herring fishing, the amounts are more equal.

The total amount of round-fish landed in 1888 in the southern section of the coast was 430,566 cwts. by line fishermen, or a monthly average of 35,880 cwts.; and 93,193 cwts. by beam-trawlers, or a monthly average of only 7766 cwts. The line fishermen also landed a larger monthly average of flat-fish than did the beam-trawlers, and hence a larger yearly total; but in July, August, September, October, and December, the quantities of flat-fish landed by beam-trawlers exceeded the amounts landed by line fishermen. The totals for the year for this group of districts are:—line fishermen, 20,172½ cwts., or a monthly average of 1681 cwts.; beam-trawlers, 17,037¾ cwts., or a monthly average of 1410 cwts.

In the northern section, which, as has been stated, includes ten districts, the line fishermen landed during the year a total quantity of 599,395 cwts. of round-fish, giving a monthly average of close upon 50,000 cwts., while beam-trawlers landed only 85,881 cwts. throughout the year, or a monthly average of only 7156 cwts., and in no month did the amount landed by trawlers approximate to that landed by line fishermen. In the case of flat-fish, the line fishermen during five months of the year landed a larger quantity than beam-trawlers. The total amounts for the year are :—beam trawlers, 47,686 cwts., or a monthly average of 3973 cwts. ; line fishermen, 40,579¾ cwts., or a monthly average of 3381 cwts.

Considering now the two sections together, that is to say, the whole of the East Coast of Scotland, we find that the total amount of round-fish landed by line fishermen last year was no less than 1,029,961 cwts. (51,498 tons), or a monthly average of 85,830 cwts. (4291½ tons). Beam-trawlers landed only 179,074 cwts. (8953 tons), or a monthly average of 14,922 cwts. (746 tons). Of the flat-fish landed on the whole East Coast during 1888, line fishermen supplied 60,752¼ cwts. (3037 tons), or a monthly average of 5062 cwts. (253 tons) ; and beam-trawlers 64,723¾ cwts. (3236 tons), or an average per month of 5393 cwts. (269 tons). Considering all kinds of fish together, then, these statistics show that line fishermen during 1888 landed on the East Coast of Scotland the enormous quantity of 54,535 tons of cod, ling, haddocks, whiting, and other round-fish, and of flat-fish; while beam-trawlers landed during the same period only 12,209 tons.

When these totals are compared with the statistics for the previous year, it is found that the line fishermen landed in 1888 a much greater quantity of fish than in 1887, while the amount landed by beam-trawlers was diminished. The total quantity of fish landed on the East Coast in 1888 was 4419 tons greater than in 1887; and since the amount landed by beam-trawlers has decreased by close upon 2000 tons, it will be seen that the line fishermen have landed over 6000 tons more fish than they did in 1887. The increase in the case of line caught fish was made up chiefly of round-fish, but also of flat-fish. The decreased amount landed by beam-trawlers consisted in a decrease both of round-fish and of flat-fish. It is interesting to compare how far the two sections of the coast participate in this decrease of trawl caught fish and the increase of line caught fish. In the southern section the increase of line caught fish in 1888, over the amounts landed in 1887, is naturally less than in the northern section. In the southern section the increase was chiefly an increase of round-fish, the increase in flat-fish being much less. In the case of the general decrease in the fish landed by beam-trawlers the same proportional diminution is not observable. In the northern section there was indeed an increase of round-fish, but this was much exceeded by the decrease of round-fish in the southern section. The decrease of flat-fish in the southern section was also very much greater than in the northern.

In the Leith district alone, beam-trawlers landed in 1888 over 1300 tons less of round-fish and nearly 500 tons less of flat-fish than they did in 1887.

The very great increase in the quantity of fish landed by line fishermen on the East Coast during 1888, might be supposed to be chiefly due to an increase in the number of boats and men, but this is not the case. In 1887 there belonged to the East Coast 7691 boats, while in 1888 there were only 7535; in 1887 there were 27,106 fishermen and boys, while in 1888 the number was reduced to 26,136. Thus there was a decrease of 156 fishing boats and of nearly 1000 men and boys, and yet the increase in the amount of fish landed by them was over 6000 tons.

The above statistics, which indicate the relative quantities of round and flat-fish landed by line fishermen and beam-trawlers in two successive years along a great stretch of the Scottish Coast—from Berwick-on-Tweed to Duncansby Head—are of great interest and importance, but in their consideration it is necessary to bear in mind one or two circumstances. In the first place, the figures referring to the fish landed by fishermen, relate merely to line caught fish, and do not include the fish, such as herring, sprat, &c., caught by net; and, of course, no cognisance is taken of the shell-fish and other products of the shores and territorial waters, the harvest of which is reaped by the line fishermen alone. During a large portion of the year the East Coast fishermen, especially those with the best equipped boats, are engaged in the great herring fisheries, frequently at quite other parts of the coast, and to a large extent the line fishing is carried on for a considerable portion of the year by the smaller fishing boats, which cannot venture far to sea, and are often prevented by the vicissitudes of the weather from fishing at all. On the other hand, the steam-trawlers, large powerful vessels, are in a great degree independent of the weather, and can pursue their calling when the fishermen's boats are lying idle on the beach or in harbour. As a consequence the trawlers may, and do obtain a considerable quantity of fish at great distances from shore; and although particulars as to the fishing grounds are wanting, it is safe to assume that fishermen obtain relatively a far greater proportion of their fish from inshore waters than do the trawlers.

It appears also that during 1888 a much larger proportion of the East Coast steam beam-trawlers were engaged in fishing on the West Coast than was the case in 1887; and this no doubt largely accounts for the falling off in the quantity of trawl caught fish landed on the East Coast during 1888.

3. Statistics showing the Quantities of Line caught Fish obtained from the Areas where Trawling is prohibited, and the adjacent Areas where Trawling is allowed.

The statistics set forth in Table F. (p. 118) may be considered of probably the greatest importance in relation to the question of the influence of beam-trawling in the territorial waters upon the productiveness of the line fishing in these waters. The area to which these statistics refer extends from the south side of the Firth of Forth in the neighbourhood of North Berwick to Skateraw, about 7 miles south of Aberdeen, and thus includes the Stonehaven, Montrose, and Anstruther districts, and the greater portion of the Leith district. Within this area certain portions of the territorial waters have been closed to beam-trawlers, and certain portions have remained open for the prosecution of that mode of fishing. The area where beam-trawling has been prohibited includes the whole of the Anstruther district, that portion of the Leith district from which these statistics were obtained, and the portion of the Montrose district south of Red Head in Forfarshire. The northern portion of the Montrose district, and the whole of the Stonehaven district, have been, on the other hand, left open to the operations of beam trawlers. The period over which these statistics have been collected has been the same, except in the case of the Stonehaven district. In the Leith, Anstruther, and Montrose districts the records have been kept since the 1st April 1887; the Stonehaven records refer only to 1888.

In order to institute a comparison between the different districts in the two years under review, it is necessary to limit attention to the corresponding periods in each of the two years. Thus when the year '1887' or '1888' is referred to, it will be understood to mean, not the whole year, but only the nine months, April to December inclusive.

The Table gives the monthly quantities of the various kinds of fish caught by line fishermen in the territorial waters of the districts above-named, in waters where trawling is prohibited and where it is permitted. For the sake of brevity, an area where beam trawling is not allowed will be designated a closed or restricted area; an area where beam trawling is permitted will be called an open or unrestricted area. The Table also gives details regarding the number and size of the boats fishing in the territorial waters, to which these statistics solely refer, and the number and size of those fishing beyond the territorial area; the average size of the fish, the kind of bait used, &c. The outstanding feature of the records is, however, as has been said, that it allows comparison to be made between (1) the quantity of fish caught by line in the restricted area and the quantity in the unrestricted area for two successive years; (2) the quantities caught in each year in the restricted and unrestricted areas. The Table also takes note of the amount of herring caught in the territorial waters of the districts mentioned; but in dealing with the statistics the figures relating to herring have not been considered, the comparisons being strictly limited to the fish caught by line.

The total quantity of fish caught by line in the territorial area of the various districts was, in 1887 and 1888, no less than 124,996 cwts., or 6249 tons. The number of trips of the fishing boats, while fishing in the territorial waters, or, in other words, the number of 'shots,' was in the eighteen months 57,381. In 1887, 26,867 trips or 'shots' were made, 20,871 being in the closed area and 5996 in the open area. In 1888, the number of 'shots' was 30,514, of which 19,540 were in the closed area and 10,954 in the open area, 4219 of the latter being in the Stonehaven district. The total amount of line fish caught in the closed areas in 1887 was 38,396 cwts. as compared with 42,466 cwts. in 1888; thus there was a considerable gross increase in the latter year. But it is necessary to take into consideration the number of 'shots' in the two years, and when this is done it is found that the average catch per 'shot' in 1887 for the total closed area was 1·83 cwts. as compared with 2·17 cwts. in 1888. There was accordingly a considerable increase in the average productiveness of the protected area in 1888.

In the unclosed portion of the Montrose district the amount of fish caught by line in 1887 was 11,832 cwts., and in 1888, 24,050, or rather more than double. The number of trips or 'shots' was 5996 in 1887, and 6755 in 1888. Accordingly, when detailed comparison is made, the average per 'shot' for the unclosed area is found to be for 1887, 1·98 cwt., or slightly over the average for the whole of the closed waters in the same year; in 1888 the average per 'shot' was 3·55 cwts., or considerably over the average for the whole of the closed area. Thus these figures show that there occurred in 1888 a general increase in the productiveness of the territorial waters; and that this increase has been more marked in the open than in the closed area. It is to be remembered, however, that the extent of the closed waters in the stretch of coast from which these statistics are drawn is much greater than the extent of the open waters. It is desirable, therefore, to make a detailed comparison between the different districts in each year and in both years. In 1887 the amount of fish caught by line fishermen in the closed area of the Leith district was 15,147 cwts. In 1888 the same area yielded 16,896 cwts., or an increase of 1749 cwts. over the total for 1887. When the number of 'shots' is taken into account, we get an average per 'shot' of 1·89 cwt. for 1887, and of 1·96 cwt. for 1888, showing therefore a slight increase. In the Anstruther district the amount of fish caught by line in the closed area was 20,326 cwts. in 1887 and

21,494 cwts. in 1888, or a gross increase of 1168 cwts. The average per 'shot' for this district was 1·73 in 1887 and 2·20 in 1888, showing a very considerable increase in the latter year. Thus in the region comprising the Firth of Forth and St Andrews Bay, the region where beam-trawling was first interdicted, there was in 1888 a considerable increase in the quantity of fish obtained.

In the closed portion of the Montrose district the quantity of line fish caught in 1887 was 2923 cwts., and in 1888, 3360 cwts., an increase of 437 cwts. When the number of trips is taken into account it is found that the average per 'shot' for 1887 was 2·37 cwts., and for 1888, 2·59 cwts., showing a fair increase per 'shot.' In the open area of the Montrose district the quantity of fish obtained in 1887 was 11,832 cwts., and in 1888, 24,050 cwts., an increase of 12,218 cwts. The average per 'shot' for the two years is 1·98 cwt. and 3·55 cwts. respectively.

In the Stonehaven district there are no records for 1887, but in 1888 the quantity obtained was 8970 cwts., giving an average per 'shot' of 2·12 cwts.

It is thus obvious that there occurred in 1888 a general increase in the productiveness of the territorial waters in all the districts, and that certain districts participated in this increase much more than others, as is shown in the following Table, which gives the average per 'shot' in cwts. for the two years.

	Leith.	Anstruther.	Montrose (closed).	Montrose (unclosed).	Stonehaven.
1887	1·89	1·73	2·37	1·98	...
1888	1·96	2·20	2·59	3·55	2·12

It is desirable now to consider to what degree the increased productiveness referred to has been brought about by an increase in the different kinds of fish obtained. Taking the fish given in the Table, it will be found that cod were caught in much greater numbers in the territorial waters in 1888 than in 1887, and this is true of all the districts. There was a considerable increase in the catch of cod in the Leith and Anstruther districts, a slight increase in the closed part of the Montrose district, and a great increase in the unclosed portion of this district (0·964 cwt. as compared with 0·125 cwt. in 1887). The averages per 'shot' for the two years in the whole closed area are 0·409 cwt. in 1877, and 0·608 cwt. in 1888. For the unclosed area the corresponding averages are 0·125 cwt. and 0·649 cwt.

Whitings were also as a rule obtained in greater numbers in 1888 than in 1887. There was a considerable increase in the Leith district, and in the closed portion of the Montrose district, but there was a decrease in the open part of this district, and in the Anstruther district, The average per 'shot' for the whole closed area in 1887 was 0·064 cwt., while in 1888 it was 0·15 cwt. For the unclosed area the average for 1887 was 0·447 cwt., and in 1888, 0·414 cwt. There was thus a considerable increase of whiting in the closed area, and a slight decrease in the open area.

Of haddocks there was a slight decrease in the Leith and Anstruther districts, a slight increase in the closed part of the Montrose district, and a considerable increase in the open part of this district. The average per 'shot' for the whole closed area was, for 1887, 1·15 cwt., and for 1888, 1·05 cwt., showing a slight decrease. For the open waters the average per 'shot' in 1887 was 0·985 cwt., and in 1888, 1·5 cwt., showing a considerable increase.

In regard to flat-fish the statistics relate to lemon soles, dabs, and flounders collectively, and to skate and turbot collectively. In 1888 there was a considerable increase in the former group in the Leith district (an average per shot of 0·231 cwt. as compared with 0·152 cwt. in 1887); there was also a large increase in the closed part of the Montrose district, and in the Anstruther district there was an increase from an average of 0·111 cwt. in 1887, to an average of 0·23 cwt. in 1888, or rather more than double. In the unclosed part of the Montrose district there was, on the other hand, a slight decrease, from an average of 0·038 cwt. in 1887, to an average of 0·032 cwt. in 1888. The average per 'shot' of lemon soles, dabs, and flounders was for the closed area 0·145 cwt. in 1877, and 0·295 cwt. in 1888, or an increase of rather more than double in the latter year. In the unclosed area the average for 1887 was 0·038 cwt., and for 1888, 0·039 cwt., or practically the same. In the Leith district the total quantity of these flat-fish landed in 1887 was 1213¼ cwts., while in 1888 it was 1870¼ cwts. In the Anstruther district the quantities in the two years respectively were 1299 cwts. and 2072½ cwts. In the whole of the closed area the amount of these flat-fish obtained was, in 1887, 3038¼ cwts., and in 1888, 5765½ cwts.

Skate and turbot form only a small portion of the catches in the territorial waters. In 1888 there was a considerable increase in the Leith district, a decrease in the Anstruther district, a very marked decrease in the closed part of the Montrose district (from an average of 0·342 cwt. in 1887 to an average of 0·013 cwt. in 1888). For the whole of the closed area the average 'per shot' of turbot and skate was 0·032 cwt. in 1887 and 0·014 cwt. in 1888, showing therefore a considerable decrease. For the open area the corresponding averages were 0·001 cwt. in 1887 and 0·0003 in 1888. No stress can, however, be laid on these figures, from the fact that the gross amounts are very small. In 1887 the amount of skate and turbot caught in the whole of the closed area was 674 cwts. as against 379½ cwts. in 1888.

Of fish classed as 'other white fish,' the quantities are too small to repay detailed examination of the figures. Taking the whole closed area they show a slight increase in the average per 'shot' in 1888 as compared with 1887. In the unclosed area there is also an increase, much greater in proportion.

The main results of the analysis of these statistics may be thus summarised:—(1) There has occurred, during the period these records have been kept, a considerable increase in the quantites of fish caught within the territorial waters. (2) This increase has been on the whole greater in the unprotected area than in the closed waters. (3) The principal factor of the increase in the closed area has been the increase of flat-fish, and in the unclosed area of cod and haddock, and 'other fish.'

It may be stated that from inquiries which have been made it appears that the amount of beam-trawling in the unprotected area of the territorial waters in the Montrose and Stonehaven districts is extremely small. In the Stonehaven district the ground is generally unfitted for this mode of fishing, and the local trawlers do not generally fish in the territorial waters of the Montrose district.

4. Special Statistics of Fishing Boats.

Table G. represents the monthly takes of cod, haddock, and whiting, of 41 East Coast fishing boats in 1888. The fishermen themselves, as was explained in last year's Report, keep a record of the results of each of their trips; but from the great length of the tables compiled from these records, it is not possible to publish them this year *in extenso.* Accordingly an epitome of the more important results has been given in Table G. One of the main results indicated is the proportional amounts of cod, haddock, and whiting obtained at different distances from the shore, both in the territorial and the extra-territorial waters.

For purposes of comparison the catches are classified into those under 2 miles, between 2 and 3 miles, between 3 and 6 miles, and over 6 miles.

In the Aberdeen district 832 trips were made by the 5 boats during the year, and the total catch was 3994¾ cwts., which represents an average per 'shot' of 4·8 cwts., consisting mainly of haddocks. Of this amount 1292¾ cwts., or about 30 per cent., was obtained from the territorial waters, and 2702 cwts. from beyond the 3-mile limit. Of the amount caught in the territorial waters, 653¾ cwts. were obtained within 2 miles from shore, and 639 cwts. between 2 and 3 miles from shore. Of the total catch beyond the 3-mile limit, 574 cwts. were obtained between 3 and 6 miles, and the remainder beyond 6 miles.

In the Stonehaven district the 11 boats which kept records captured altogether during 1888, 5821¾ cwts. of cod, haddock, and whiting, and since the number of 'shots' was 1345, this gives an average per 'shot' of 4·3 cwts. Of this amount 1624¼ cwts., or 27·8 per cent., were obtained in the territorial waters; 775¼ cwts. within a distance of 2 miles from shore, and 849 cwts. between 2 and 3 miles. Of the amount caught beyond the territorial waters (4197½ cwts.), 1272 cwts. were obtained within 6 miles of the shore, and the remainder beyond the 6-mile limit.

In the Montrose district the number of trips of the 12 boats was 1461, and the quantity caught 7928¾ cwts., or an average of 5·4 cwts. per 'shot.' 1293 cwts. were caught within 2 miles and 2295 cwts. between 2 and 3 miles from shore, giving a total of 1588 cwts., or about 20 per cent. for the territorial waters. Of the 6340¾ cwts. caught beyond the 3-mile limit, 1652 cwts. were obtained under 6 miles, and the remainder beyond 6 miles from shore.

In the Anstruther district the 12 recording boats caught during the whole year 4058¼ cwts., or an averrge of about 2 cwts. per 'shot,' the number of trips being 1970. In the territorial waters 1918½ cwts. were obtained; 1123½ cwts. within a distance of 2 miles from shore, and 795 cwts. between 2 and 3 miles. Of those caught beyond the territorial area 1908¾ cwts. were got within 6 miles from shore, and 229¾ cwts. beyond 6 miles.

In the Leith district the number of trips of the 3 boats was 158, and the amount caught 3128½ cwts., or an average per 'shot' of 20 cwts. per boat, all of which were obtained beyond the 3-mile limit, and chiefly beyond 6 miles. The records for this district, however, are so imperfect, and the number of boats so small, that little reliance can be placed upon these figures.

Probably a fairly good test, however, of the comparative productiveness of the territorial and extra-territorial waters, and of the zone immediately within and beyond the limit, may be obtained by combining the totals for the various districts, as has been done in the following Table.

No. of trips.	Under 2 miles.			2–3 miles.			3–6 miles.			Over 6 miles.		
	Cod.	Haddock.	Whiting.	Cod.	Haddock.	Whiting.	Cod.	Haddock.	Whiting.	Cod.	Haddock.	Whiting.
	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.
5766	262¾	3387¼	196¼	135½	2234¾	207¾	260½	5050¾	210¼	1499	10923½	563¼

From this Table we see that of the total catch of 24,932 cwts. of cod, haddock, and whiting, by the 41 boats in the five districts, 6424¼ cwts., or about a quarter of the whole amount, was obtained within the territorial waters; 3846¼ cwts. being obtained within 2 miles from shore, and 2578 between 2 and 3 miles from shore. Of the 18,507¼ cwts. captured in the extra-territorial waters, 5521½ were got between 3 and 6 miles from shore, and the remainder beyond the 6-mile limit. If we consider the comparative quantities of the different kinds of fish—cod, haddock, and whiting—obtained in the various areas, we find that of the 2157¾ cwts. of cod caught, 398¼ cwts., or a little over 18 per cent., were taken from the territorial waters—262¾ cwts. from within a distance of 2 miles from shore, and 135½ between 2 and 3 miles. Between 3 and 6 miles 260½ cwts. were obtained, and beyond 6 miles 1499 cwts., or nearly 70 per cent. In the case of the 21,596¼ cwts. of haddock captured, 5622 cwts., or above 26 per cent., were taken from the territorial waters—3387¼ within 2 miles from shore, and the remainder between 2 and 3 miles. 5050¾ cwts. were obtained between 3 and 6 miles, and 10,923½ cwts. beyond the 6-mile limit; *i.e.*, about half the total catch. Of the 1177½ cwts. of whiting, 404 cwts., or about a third, were taken from the territorial waters, 196¼ within 2 miles from shore, and 207¾ between 2 and 3 miles from shore. Of the 773½ cwts. taken from the extra-territorial waters, 210¼ cwts. were caught between 3 and 6 miles from shore, and 563¼ cwts. beyond the 6 miles. As to the proportion of the amounts of the different fish captured, cod averaged about 8½ per cent., whiting a little over 4½ per cent., and haddock a little over 86 per cent.

The proportions of the fish taken from the different zones, as above described, might be considered to roughly represent their relative abundance in these zones; but since the number of 'shots' in each area is not given, and since it is exceedingly probable that most of the fishing takes place near the shore, the proportions can only be approximate. Nevertheless, as matter of fact, they show the proportions in which the zones in these districts participate in providing the fish supplied by line fishermen.

IV. SUMMARY AND CONCLUSIONS.

It is desirable to put succinctly some of the main results derived from the analysis of the 'Garland's' observations and of the statistical data referred to above.

It has been shown that, judged by the trawling experiments of the 'Garland,' the very great increase, especially of flat-fish, which followed the suspension of beam-trawling in the Firth of Forth and St Andrews Bay has not been generally maintained; while, on the other hand, the takes of the line fishermen in the Leith and Anstruther districts, or, in other words, from the same waters, have been augmented. This increase also, of the fish caught by line, has been largely made up of flat-fish, which showed the greatest decline in the takes of the 'Garland.' It was for this reason, as well as for another connected with the general absence of spawning fish in the Firth of Forth and in St Andrews Bay, determined to test these grounds with one of the largest beam trawls used. Arrangements were accordingly made with Messrs Johnston of Montrose and Mr Gunn of Granton to admit of a large beam-trawler working along certain specially selected lines in the Firth of Forth and St Andrews Bay. The results of these special trawlings are referred to in the abstract of Mr Scott's reports (p. 171), but it may be here stated that they confirmed the results obtained by the 'Garland's' trawl. At first sight, the idea suggests itself that the excess of fish obtained by the line fishermen might account for the decrease in those obtained by the trawl. But careful consideration of the amounts of the fish landed by the fishermen from these waters tends to show that this cannot be the only explanation. It seems more probable that the diminution in the amount of fish obtained by the 'Garland's' trawl, and the comparatively small takes of the large trawlers, were largely due to the exceptional character of the weather during last year. A comparison of the temperature of the bottom water at all the stations in the Firth of Forth, for June, August, and September in 1887 and 1888 shows that in the latter year the average temperature of the bottom water was 1°·6 F. less than in 1887. In 1888 the temperature of the bottom water was lower than in 1887 at all the stations in each of the three months named, except during June and August at Station IV. At some of the stations the difference in the average temperature reached nearly 3° F. in 1888. We are not yet sufficiently acquainted with the influence which changes of temperature may have in regulating the movements of fish; but it is possible that the prevalence of colder water in 1888 may have caused the fish to move seawards. A reason probably more cogent, and more immediately apparent, was the generally disturbed and stormy weather. In a confined area like the Firth of Forth, or in a shallow littoral bay such as that of St Andrews, the effects of the agitation of the water by a storm soon spreads to the bottom and causes the fish to be disturbed and alert.

It has been stated by an experienced East Coast trawler that it was noticed on many occasions in 1888, that when the trawl and line boats were working on the same ground and the latter getting plenty of fish, the trawlers had very poor 'shots.'

It has been shown above that in 1888 there occurred a great increase in the productiveness of the line fishing along the East Coast. The line fishermen of this portion of the Scottish sea board landed in 1888 above 6000 tons of fish more than they did in 1887, and although the increase in a portion of the open waters immediately adjacent to the closed area was somewhat greater than in that area, it is noteworthy that this increase should succeed and be contemporaneous with the interdiction of beam-trawling in a considerable portion of the territorial waters. The increase has also, especially in the Leith and Anstruther districts, been largely due to an increase in flat-fish.

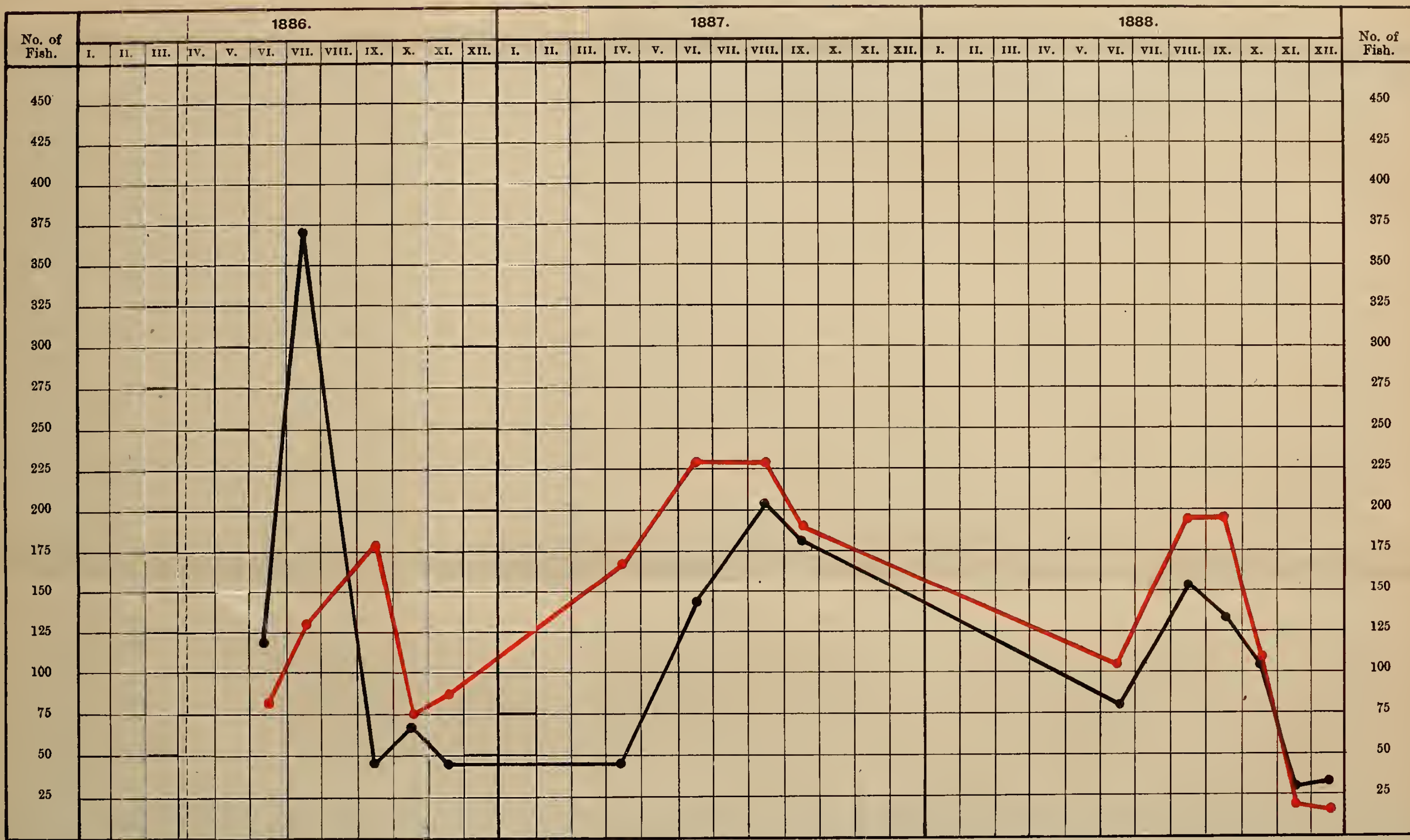
The increased amount of fish landed by line fishermen is also associated with a considerable reduction in the number of fishing boats and men; there having been 156 fewer boats, and about 1000 less men in 1888 than in 1887.

The opinion was expressed in the Report of last year that it was probable the inshore waters formed nurseries for young fish, and especially, where the physical conditions were suitable, for young flat-fish, and that the sexually mature fish congregate in offshore waters. The general result of the systematic investigations of the 'Garland' in the territorial waters has been

CHART showing the Results of the "Garland's" Trawlings.

The red line gives the average per "shot" of flat fish; the black line gives the average per "shot" of round fish. The vertical dotted line shows when beam-trawling was prohibited.

I. FIRTH OF FORTH—CLOSED AREA.



II. ST. ANDREWS BAY—CLOSED AREA.

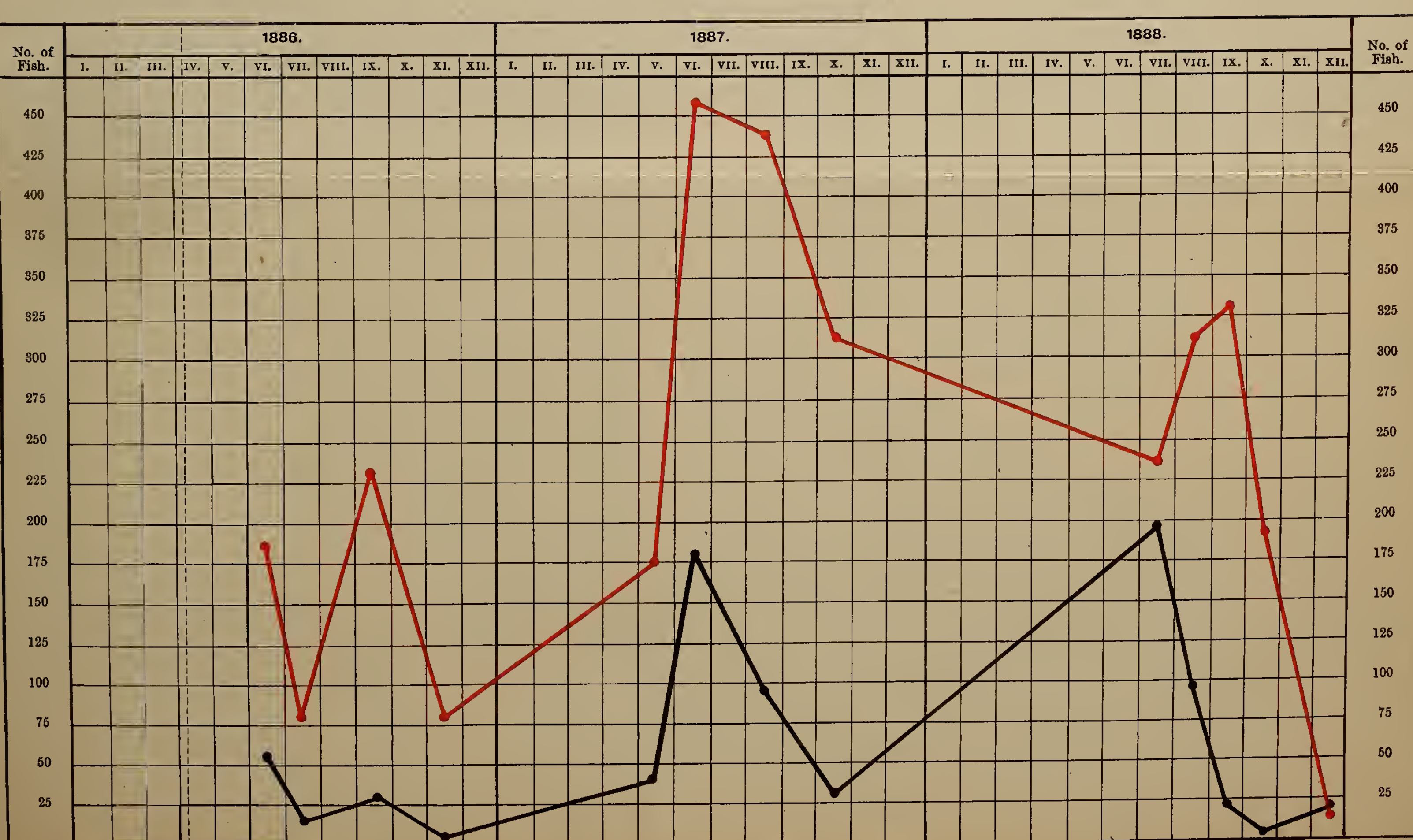
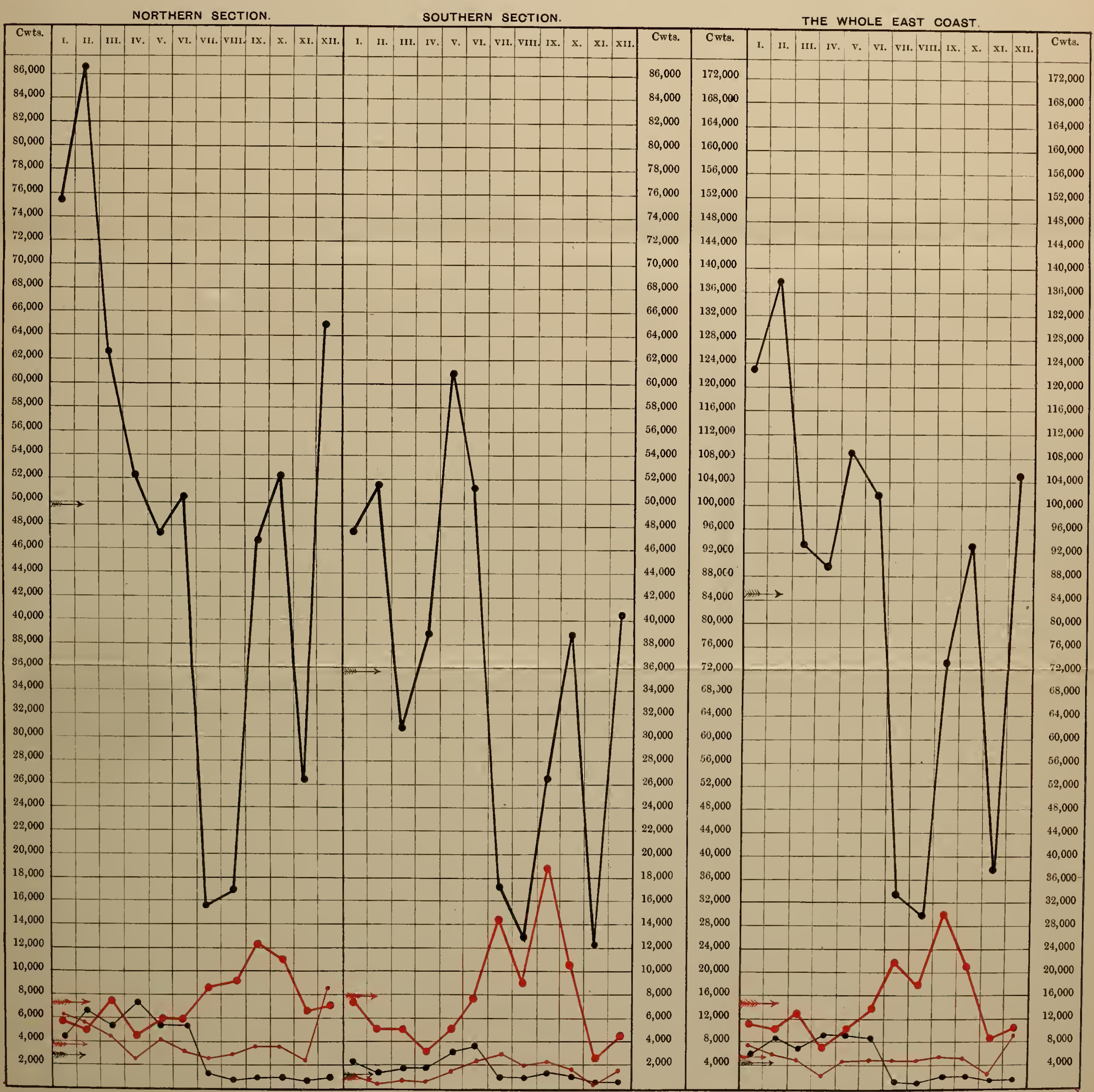


CHART showing the relative Monthly Quantities of Fish (exclusive of Herring, Sprats, and Mackerel) landed by Line Fishermen and Beam Trawlers along the East Coast of Scotland in 1888.

N.B.—The black lines represent fish caught by line; the red lines those caught by steam beam trawl. The thick lines indicate round fish; the thin lines flat fish. The arrows at the sides indicate the monthly averages.



to support this view. There is now a considerable body of evidence referred to in papers later on in this part of the Board's Report which goes to show that most fish as a rule do not spawn generally within the territorial zone. They appear to congregate at offshore grounds ; while, on the other hand, the young fish appear in large numbers close inshore.

A large number of experiments with a shrimp trawl net have been made recently in the Firth of Forth for the purpose of determining the proportional abundance of young flat-fish in different part of the inshore waters. These experiments are still in progress, but in many cases the results already obtained are of much interest. At Station I., out of a total of 277 fish obtained, 228 were flat-fish, and of these 60 per cent. were under $3\frac{1}{2}$ inches in length, 50 per cent. were under 3 inches, and 33 per cent. under 2 inches. At this station the immature fish were almost entirely common dabs. At Station II., of 271 flat-fish obtained, 48 per cent. were under $3\frac{1}{2}$ inches and 27 per cent. under 3 inches. In this case the small fish were almost entirely long rough dabs. At Station VIII. the flat-fish numbered 175, and 90 per cent. were under $3\frac{1}{2}$ inches, none being under 2 inches. At Station IX., of 162 flat-fish obtained 72 per cent. were under $3\frac{1}{2}$ inches, and none were under 2 inches. At these two stations the small fish were almost entirely long rough dabs.

Comparison has also been made as to the capture of small fish by different forms of trawl nets, some having wide meshes and others having small meshes. It is generally stated that the capture of small fish bears little or no relation to the size of the mesh owing to the drag on the net, as it passes along the bottom, closing the meshes, especially at the cod-end where the fish collect. The experiments which have been made with a trawl net having meshes of half an inch, and with the ordinary trawl net, show that this is not the case, and that the wider-meshed net catches far fewer small fish than the finer-meshed net.

Trials were also made with some of the trawl nets specially designed to allow of the escape of small fish. In one of these the cod-end consisted of a rigid frame covered with netting made of iron rings, similar to an oyster dredge. It seems, however, that this part soon got blocked up with fish, some of which were bruised by the iron netting, and that fish quite as small as those retained by the ordinary trawl net were caught. Another net, having a form very similar to the ordinary trawl net, but with a somewhat different arrangement of the meshes, was tried, but the result was much the same as with the ordinary trawl net. A third net, constructed on a plan different from that of the ordinary trawl net, was also tested. This net is oblong in shape, without the usual cod-end, and having arrangements for keeping the meshes to a large extent open. Several trials of this net were made in various depths of water and on different grounds, but in no instance did it on reaching the surface contain any small fish.

J. COSSAR EWART,
Convener.

J. R.-G.-MAITLAND.

T. WEMYSS FULTON,
Secretary.

TABLE A.—Showing Summary of Fish taken by the 'Garland' on the East Coast in 1888.

Note.—t. means turbot, *l.* means ling.

Station and Date.	Flat-Fish.								Round-Fish.					Other Fish.	Total.
	Plaice.	Lemon Sole.	Witch Sole.	Common Dabs.	Long Roughs.	Flounder.	Skate.	Total.	Cod.	Haddock.	Whiting.	Gurnard.	Total.		
Firth of Forth—															
Station I.															
June 11, .	74	66	.	24	16	.	1	181	34	21	10	72	137	2	320
Aug. 1, .	58	58	.	42	40	.	3	201	12	31	18	15	76	1	278
Sept. 10, .	80	85	.	4	1	.	1	171	65	18	86	8	177	4	352
Oct. 6, .	24	43	.	9	22	.	4	102	57	11	93	12	173	5	280
Nov. 8, .	.	4	.	1	9	.	2	16	5	.	5	.	10	.	26
Dec. 1, .	.	2	.	9	17	.	6	34	8	6	7	.	21	(in. 1 l.) 2	57
Dec. 20, .	.	20	.	3	31	.	3	57	47	8	14	.	69	.	126
	236	278	.	92	136	.	20	762	228	95	233	107	663	14	1439
Station II.															
June 12, .	25	26	.	76	20	.	.	147	4	41	16	122	183	1	331
Aug. 1, .	122	33	.	53	42	.	1	251	12	135	55	10	212	(in. 1 l.) 4	467
Sept. 7, .	117	79	.	139	26	.	5	366	2	75	32	.	109	.	475
Oct. 4, .	72	34	.	70	15	.	.	191	1	7	8	23	39	1	231
Dec. 1, .	.	.	.	2	6	.	.	8	9	8	17	.	34	.	42
	336	172	.	340	109	.	6	963	28	266	128	155	577	6	1546
Station III.															
June 12, .	44	48	.	45	20	.	1	158	8	19	29	32	88	3	249
Aug. 1, .	196	72	.	42	19	.	5	334	45	64	96	24	229	5	568
Sept. 10, .	50	33	.	18	3	.	.	104	24	25	60	7	116	(in. 1 t.) 2	222
Oct. 8, .	7	40	.	15	20	.	7	89	46	39	32	1	118	1	208
Nov. 8, .	1	11	.	13	14	.	2	41	15	3	17	.	35	4	80
Nov. 30, .	.	1	.	1	1	.	2	5	15	.	19	.	34	.	39
	298	205	.	134	77	.	17	731	153	150	253	64	620	15	1366
Station IV.															
June 12, .	63	11	.	23	2	.	4	103	3	10	18	9	40	3	146
Aug. 2, .	350	31	.	96	3	.	15	495	4	66	15	26	111	1	607
Sept. 8, .	279	52	.	92	2	.	11	436	6	33	14	34	87	2	525
Oct. 8, .	159	.	.	26	.	.	.	185	1	.	2	3	6	4	195
Nov. 30, .	13	6	.	10	14	.	2	45	27	.	22	.	49	11	105
Dec. 21, .	18	.	.	.	1	.	.	19	2	.	2	.	4	.	23
	882	100	.	247	22	.	32	1283	43	109	73	72	297	21	1601
Station V.															
June 15, .	5	7	7	.	10	.	1	30	2	21	1	5	29	.	59
Aug. 3, .	7	.	.	.	24	.	.	31	1	146	53	3	203	1	235
Sept. 7, .	23	7	6	10	40	.	1	87	3	164	28	10	205	3	295
Oct 3, .	3	2	.	14	5	.	.	24	2	72	2	3	79	.	103
Dec. 6, .	.	.	1	9	9	.	2	21	11	55	7	.	73	.	94
	38	16	14	33	88	.	4	193	19	458	91	21	589	4	786
Station VI.															
June 15, .	11	6	.	5	.	.	.	22	2	3	4	27	36	1	59
Aug. 3, .	19	9	.	6	.	.	.	34	2	5	15	8	30	4	68
Sept. 7, .	33	34	.	11	9	.	.	87	1	32	41	12	86	(in. 2 t.) 7	180
Oct. 3, .	41	12	.	5	.	.	2	60	1	2	1	4	8	(in. 1 t.) 4	72
Dec. 6, .	3	1	.	7	2	.	.	13	8	1	6	.	15	1	29
Total, .	107	62	.	34	11	.	2	216	14	43	67	51	175	17	408

TABLE A.—SHOWING SUMMARY OF FISH TAKEN BY THE 'GARLAND' ON THE EAST COAST IN 1888—*continued.*

Station and Date.	Flat-Fish.								Round-Fish.					Other Fish.	Total.
	Plaice.	Lemon Sole.	Witch Sole.	Common Dabs.	Long Roughs.	Flounder.	Skate.	Total.	Cod.	Haddock.	Whiting.	Gurnard.	Total.		
FIRTH OF FORTH—*continued.*															
Station VII.															
June 15, .	13	16	.	14	13	.	.	56	.	1	2	36	39	2	97
Aug. 2, .	27	7	.	81	24	.	1	140	1	170	22	.	193	(in. 1 t.) 2	335
Sept. 6, .	61	14	.	153	18	.	3	249	.	112	13	15	140	(in. 2 t.) 2	391
Oct. 2, .	8	3	1	22	35	.	6	75	2	227	56	4	289	3	367
Nov. 7, .	.	.	.	5	3	.	2	10	10	33	16	.	59	(t) 1	70
Dec. 5, .	.	.	1	.	3	.	1	5	11	8	25	.	44	1	50
	109	40	2	275	96	.	13	535	24	551	134	55	764	11	1310
Station VIII.															
June 19, .	6	11	7	7	12	.	2	45	4	116	29	40	189	7	241
Aug. 2, .	16	.	9	5	22	.	.	52	3	71	169	46	289	2	343
Sept. 6, .	5	.	6	14	25	.	2	52	2	89	62	16	169	2	223
Oct. 2, .	2	.	5	2	14	.	2	25	7	40	10	1	58	1	84
Nov. 1, .	2	4	2	36	26	.	1	71	.	54	8	8	70	(in 1 l. 1 t.) 5	146
Dec. 5, .	.	.	.	8	8	.	2	18	3	103	13	.	119	.	137
	31	15	29	72	107	.	9	263	19	473	291	111	894	17	1174
Station IX.															
Sept. 6, .	1	.	1	.	14	.	1	17	1	7	67	29	104	1	122
Oct. 2, .	.	.	9	.	14	.	9	32	8	29	6	.	43	1	76
Nov. 1, .	.	.	2	13	.	.	.	15	.	15	3	13	31	1	47
Dec. 5, .	.	.	.	3	14	.	.	17	8	25	42	.	75	1	93
	1	.	12	16	42	.	10	81	17	76	118	42	253	4	338
ST ANDREWS BAY—															
Station I.															
July 12, .	49	.	.	26	1	.	1	77	.	55	43	6	104	1	182
Aug. 16, .	44	.	.	86	2	.	1	133	.	3	2	17	22	(t.) 1	156
Sept. 18, .	115	.	.	267	17	.	4	403	.	2	1	39	42	1	446
Oct. 17, .	76	.	.	17	.	.	1	94	.	.	.	2	2	.	96
Dec. 19, .	.	.	.	9	1	.	1	11	.	.	.	1	1	.	12
	284	.	.	405	21	.	8	718	.	60	46	65	171	3	892
Station II.															
July 12, .	189	1	.	94	2	2	4	292	.	111	23	38	172	2	466
Aug. 16, .	185	1	.	213	2	.	4	405	.	4	1	35	40	1	446
Sept. 18, .	42	.	.	89	4	.	4	139	.	.	2	1	3	1	143
Oct. 17, .	89	1	.	35	2	.	2	129	.	1	1	13	15	(in. 2 t.) 3	147
Dec. 19, .	1	.	.	13	1	.	1	16	.	.	2	.	2	.	18
	506	3	.	444	11	2	15	981	.	116	29	87	232	7	1220
Station III.															
July 13, .	52	.	.	63	1	.	1	117	.	386	4	38	428	(in. 1 t.) 2	547
Aug. 17, .	103	.	.	183	1	.	4	291	.	150	1	85	236	2	529
Sept. 18, .	160	.	.	297	1	.	.	458	.	.	3	34	37	(t.) 1	496
Oct. 17, .	236	.	.	53	1	.	3	293	.	.	.	3	3	(t.) 2	298
Dec. 19, .	3	.	.	16	5	.	1	25	5	33	23	.	61	.	86
	554	.	.	612	9	.	9	1184	5	569	31	160	765	7	1956
Station IV.															
July 13, .	304	.	.	141	.	.	8	453	.	47	9	39	95		550
Aug. 17, .	191	.	.	222	.	.	4	417	.	12	1	77	90	(in. 1 t.) 5	512
Sept. 18, .	219	.	.	72	.	.	4	295	.	.	1	13	14	1	310
Oct. 16, .	233	2	.	14	.	.	.	249	.	.	4	3	7	3	259
Dec. 18, .	13	.	.	2	.	.	1	16	.	.	5	.	5	1	22
Total .	960	2	.	451	.	.	17	1430	.	59	20	132	211	12	1653

TABLE A.—Showing Summary of Fish taken by the 'Garland' on the East Coast in 1888—*continued.*

Station and Date.	Flat-Fish.								Round-Fish.					Other Fish.	Total.
	Plaice.	Lemon Sole.	Witch Sole.	Common Dabs.	Long Roughs.	Flounder.	Skate.	Total.	Cod.	Haddock.	Whiting.	Gurnard.	Total.		
St Andrews Bay—*continued.*															
Station V.															
July 13, .	19	.	.	11	4	.	.	34	.	53	99	23	175	.	209
Aug. 17, .	103	3	.	55	7	.	2	170	.	11	2	25	38	.	208
Sept. 17, .	115	4	.	278	5	.	.	402	.	31	14	14	59	.	461
Oct. 16, .	11	.	.	112	6	.	.	129	2	61	13	8	84	.	213
Dec. 18, .	.	.	.	7	2	.	.	9	1	2	2	1	6	.	15
	248	7	.	463	24	.	2	744	3	158	130	71	362	.	1106
Montrose—															
Station I.															
July 30, .	9	.	.	20	.	.	1	30	.	.	.	2	2	2	34
Station II.															
July 30, .	26	.	.	32	1	.	2	61	.	51	5	43	99	.	160
	35	.	.	52	1	.	3	91	.	51	5	45	101	2	194
Aberdeen Bay—															
Station I.															
July 18, .	39	.	.	56	.	.	.	95	.	.	4	54	58	1	154
Station II.															
July 18, .	12	.	.	20	7	.	1	40	.	2	4	36	42		82
Station III.															
July 18, .	11	.	.	9	.	.	.	20	.	1	6	48	55		75
Station IV.															
July 18, .	7	.	.	6	.	.	.	13	.	1	4	21	26	1	40
Station V.															
July 18, .	7	1	.	19	2	.	.	29	.	.	.	30	30	1	60
Station VI.															
July 18,	7	.	.	6	1	.	1	15	.	.	.	7	7	.	22
	83	1	.	116	10	.	2	212	.	4	18	196	218	3	433
Cruden Bay—															
July 19, .	18	.	.	31	.	.	3	52	2	19	2	59	82	.	134
Moray Firth—															
Station I.															
May 29, .	13	6	71	7	61	.	1	159	1	9	5	23	38	3	200

TABLE A.—SHOWING SUMMARY OF FISH TAKEN BY THE 'GARLAND' ON THE EAST COAST IN 1888—*continued.*

Station and Date.	Flat-Fish.								Round-Fish.					Other Fish.	Total.
	Plaice.	Lemon Sole.	Witch Sole.	Common Dabs.	Long Roughs.	Flounder.	Skate.	Total.	Cod.	Haddock.	Whiting.	Gurnard.	Total.		
MORAY FIRTH—*continued.*															
Station II.															
May 29, .	13	5	100	27	69	.	4	218	1	37	2	17	97	.	315
Station III.															
May 26, .	20	5	.	.	.	.	1	26	2	.	.	.	2	1	29
Station IV.															
May 25, .	25	.	.	18	.	.	3	46	.	.	.	59	59	.	105
Station V.															
May 25, .	12	12	1	142	2	.	.	169	1	62	43	123	229	.	398
Station VI.															
May 25 .	5	2	.	7	.	.	1	15	2	35	45	13	95	1	111
Total, .	88	30	172	204	132	.	10	633	7	143	135	235	520	5	1158

TABLE B.—ANALYSIS OF THE 'GARLAND'S' STATISTICS RELATING TO THE RELATIVE ABUNDANCE OF FISH.

A. Showing the Average Per 'Shot' of each kind of Fish taken.

Station.	Flat-Fish.								Round-Fish.					Other Fish.	Total.
	Plaice.	Lemon Sole.	Witch Sole.	Common Dabs.	Long Roughs.	Flounder.	Skate.	Total.	Cod.	Haddock.	Whiting.	Gurnard.	Total.		
I. *Firth of Forth*, 1888.															
Closed Area.															
I.	33·7	39·7	–	13·1	19·4	–	2·8	108·8	32·5	13·5	33·2	15·2	94·7	2	205·5
II.	67·2	34·4	–	68	21·8	–	1·2	192·6	5·6	53·2	25·6	31	115·4	1·2	309·2
III.	49·6	34·1	–	22·3	12·8	–	2·6	121·8	25·5	25	42·1	10·6	103·3	2·5	227·6
IV.	147	16·6	–	41·1	3·6	–	5·3	213·8	7·1	18·1	12·1	20	49·5	3·5	266·8
V.	7·6	3·2	2·8	6·6	17·6	–	0·8	38·6	3·8	91·6	18·2	4·2	117·8	0·8	157·2
VI.	21·4	12·4	–	6·8	2·2	–	0·4	43·2	2·8	8·6	13·4	10·2	35	3·4	81·6
VII.	18·1	6·6	0·3	45·8	16	–	2·1	89·1	4·0	91·8	22·3	9·1	127·3	1·8	218·3
Average per shot of 40 shots.	50·1	21·8	0·4	28·8	13·4	–	2·3	117·0	12.7	41·8	24·4	13·1	92·1	2·2	211·4
Unclosed Area.															
VIII.	5·1	2·5	4·8	12	17·8	–	1·5	43·8	3·1	78·8	48·5	18·5	149	2·8	195·6
IX.	0·2	–	3·0	4	10·5	–	2·5	20·2	4·2	19	29·5	10·5	63·2	1	84·5
Average per shot of 10 shots.	3·2	1·5	4·1	8·8	14·9	–	1·9	34·4	3·6	54·9	40·9	15·3	114·7	2·1	151·2
II. *St Andrews Bay*, 1888.															
Closed Area.															
I.	56·8	–	–	81	4·2	–	1·6	143·6	–	12	9·2	13	34·2	0·6	178·4
II.	101·2	0·6	–	88·8	2·2	0·4	3	196·2	–	23·2	5·8	17·4	46·4	1·4	244
III.	110·8	–	–	122·4	1·8	–	1·8	236·8	1	113·8	6·2	32	153	1·4	391·2
IV.	192	0·4	–	90·2	–	–	3·4	286	–	11·8	4	26·4	42·2	2·4	330·6
Average per shot of 20 shots.	115·2	0·2	–	95·6	2	0·1	2·4	215·6	0·2	40·2	6·3	22·2	68·9	1·4	286
Unclosed Area. V. Average of 5 shots.	49·6	1·4	–	92·6	4·8	–	0·4	148·8	0·6	31·6	26	14·2	72·4	–	22
III. *Montrose*, 30*th July*.															
Average at 2 Stations.	17·5	–	–	26	0·5	–	1·5	45·5	–	25·5	2·5	22·5	50·5	1	97
IV. *Aberdeen Bay*, 18*th July*.															
Average at 6 Stations.	13·8	–	–	19·3	1·6	–	0·3	35·3	–	0·6	3	32·6	36·3	0·5	72·1
V. *Cruden Bay*, 19*th July*.															
One Station.	18	–	–	31	–	–	0·3	52	0·2	19		59	82	–	134
VI. *Moray Firth*, 25*th*, 26*th*, *and* 29*th May*.															
Average at 6 Stations.	14·6	5	28·6	33·5	22	–	1·6	105·5	1·1	23·8	22·5	39·1	86·6	0·8	193

B. Showing the Monthly Average per 'Shot' of each kind of Fish Taken in 1888.

Date.	Flat-Fish.								Round-Fish.					Other Fish.	Total.
	Plaice.	Lemon Sole.	Witch Sole.	Common Dabs.	Long Roughs.	Flounder.	S[illegible]a	Total.	Cod.	Haddock.	Whiting.	Gurnard.	Total.		
I. *Firth of Forth.*															
Closed Area.															
June	33·5	25·7	1·0	26·7	11·5	–	1·0	99·5	7·5	16·5	11·4	43·2	78·8	1·7	180·1
August	111·2	30·0	–	45·7	21·7	–	3·5	212·2	11·0	88·1	39·1	12·2	150·5	2·5	365·4
Sept.	91·8	43·4	0·8	61·0	14·1	–	3·0	214·2	14·4	65·5	39·1	12·2	131·4	2·8	348·5
Oct.	44·8	19·1	0·1	23·0	13·8	–	2·7	103·7	15·7	51·1	27·7	7·1	101·7	2·5	208·0
Nov.	0·3	5	–	6·3	8·6	–	2	22·3	10	12	12·6	–	34·6	1·6	58·6
Dec.	2·2	1·4	0.2	5·4	7·4	–	1·8	18·7	12·7	11·1	14·7	–	38·5	2·1	59·4
Unclosed Area.															
June	6·0	11·0	7·0	7·0	12·0	–	2·0	45·0	4·0	116·0	29·0	40·0	189·0	7·0	241·0
August	16·0	–	9·0	5·0	22·0	–	–	52·0	3·0	71·0	169·0	46·0	289·0	2·0	343·0
Sept.	3·0	–	3·5	7·0	19·5	–	1·5	34·5	1·5	48·0	64·5	22·5	136·5	1·5	172·5
Oct.	1·0	–	7·0	1·0	14·0	–	5·5	28·5	7·5	34·5	8·0	0·5	50·5	1·0	80·0
Nov.	1·0	2·0	2·0	24·5	13·0	–	·5	43·0	–	34·5	5·5	10·5	50·5	3·0	96·5
Dec.	–	–	–	5·5	11·0	–	1·0	17·5	5·5	64·0	27·5	–	97·0	0·5	115·0
II. *St Andrews Bay.*															
Closed Area.															
July	14	0·2	–	81·0	1·0	0·5	3·5	234·7	–	149·7	19·7	30·2	199·7	1·7	436·2
August	130·7	0·2	–	176·0	1·2	–	3·2	311·5		42·2	1·2	53·5	97·0	2·2	410·7
Sept.	134·0	–	–	181·2	5·5	–	3·0	323·7	–	0·5	1·7	21·7	24·0	1·0	348·7
Oct.	158·5	0·7	–	29·7	0·7	–	1·5	191·2	–	0·2	1·2	5·2	6·7	2·0	200·0
Dec.	4·2	–	–	10·0	1·7	–	1·0	17·0	1·2	8·2	7·5	0·2	17·2	0·2	34·5
Unclosed Area.															
July	19	–	–	11	4		–	34	-	53	99	23	175	-	209
August	103	3	–	55	7	–	2	170	–	11	2	25	38	–	208
Sept.	115.	4	–	278	5	–	–	402	–	31	14	14	59	–	361
Oct.	11	–	–	112	6	–	-	129	2	61	13	8	84	–	213
Dec.	–	–	–	7	2	–	–	9	1	2	2	1	6	–	15

LIST OF COMMON AND SCIENTIFIC NAMES (DAY) OF FISH MENTIONED IN THE RETURNS.

Angler,	*Lophius piscatorius.*
Bib,	*Gadus luscus.*
Brassie,	*Gadus luscus.*
Brill,	*Rhombus lævis.*
Butter-fish,	*Centronotus gunnellus.*
Cat-fish,	*Anarrhichas lupus.*
Coal-fish,	*Gadus virens.*
Cobbler,	*Cottus scorpius.*
Cod,	*Gadus morrhua.*
Conger,	*Conger vulgaris.*
Dab, common,	*Pleuronectes limanda.*
,, lemon,	,, *microcephalus.*
,, long rough,	*Hippoglossoides limandoides.*
Dragonet,	*Callionymus lyra.*
Eel, greater sand,	*Ammodytes lanceolatus.*
Father-lasher,	*Cottus scorpius.*
Fishing-frog,	*Lophius piscatorius.*
Flounder,	*Pleuronectes flesus.*
,, long,	*Pleuronectes cynoglossa.*
Fluke, sail,	*Arnoglossus megastoma.*
,, sand,	,, ,,
,, white,	*Pleuronectes flesus.*
Gurnard, common,	*Trigla gurnardus.*
,, red,	,, *cuculus.*
Haddock,	*Gadus æglefinus.*
Halibut,	*Hippoglossus vulgaris.*
Hake,	*Merluccius vulgaris.*
Herring,	*Clupea harengus.*
John Dory,	*Zeus faber.*
Ling,	*Molva vulgaris.*
Lump-sucker,	*Cyclopterus lumpus.*
Lythe,	*Gadus pollachius.*
Mackerel,	*Scomber scomber.*
Monk,	*Lophius piscatorius.*
Plaice,	*Pleuronectes platessa.*
Pogge,	*Agonus cataphractus.*
Ray, sandy,	*Raia circularis.*
,, shagreen,	,, *fullonica.*
,, starry,	,, *radiata.*
,, thornback,	,, *clavata.*
,, spotted,	,, *maculata.*
Saithe,	*Gadus virens.*
Sand-eel greater,	*Ammodytes lanceolatus.*
Skate, flapper,	*Raia macrorhynchus.*
,, white,	,, *alba.*
,, gray,	,, *batis.*
Sole,	*Solea vulgaris.*
,, black,	,, ,,
,, witch,	*Pleuronectes cynoglossu*
Sprat,	*Clupea sprattus.*
Turbot,	*Rhombus maximus.*
Whiting,	*Gadus merlangus.*
Weever, greater,	*Trachinus draco.*
Wolf-fish,	*Anarrhichas lupus.*

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast.

E. before the figures indicating temperature means east end of station, and W. west end.

Station, Date, and Time when Trawl let down.	Temperature. Air.	Temperature. Water.		Surface Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Dry Bulb.	Surface.	Bottom.		H. M.		No.	Inches	No.	Inches	No.	Inches		
I. Firth of Forth, 11th June 1888, 2.45 p.m.	48·6	47·8	46·2		2 5	Thornback ray,	1	26	...	...	...	...	Good	N.S.W. breeze.
						Plaice,	24	9	21	14	29	12	"	Cloudy sky.
						Common dabs,	4	9	20	6	...	...	"	Some rain.
						Lemon dabs,	26	12	40	8	...	...	"	
						Long rough dabs,	7	10	9	8	...	...	"	
						Common white fluke,	1	9½	...	...	...	...	"	
						Haddocks,	3	13	18	9	...	...	"	
						Codlings,	6	16	15	13	13	9½	"	
						Whiting,	4	12	6	9	...	...	"	
						Gurnard,	12	13	60	8	...	...	"	
						Catfish,	1	21	...	...	...	...	"	
II. Firth of Forth. 12th June 1888. 1.15 p.m.	54·8	48·0	46·8		2 3	Plaice,	15	13	10	9	...	...	"	Light breeze.
						Common dabs,	10	8	66	6	...	...	"	S.S.E. dull.
						Lemon dabs,	13	12	13	9	...	...	"	Cloudy sky.
						Long rough dabs,	8	9	12	6	...	...	"	Easterly swell.
						Haddock,	41	10	...	...	...	...	"	
						Codling,	4	10	...	...	...	...	"	
						Whiting,	16	10	...	...	...	...	"	
						Gurnards,	122	9	...	...	...	...	"	
						Dragonet,	1	5	...	...	...	...	"	

TABLE C.—Record of Observations made on board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Surface Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
III.	53·0	48·9	46·2		H. M. 2 15	White skate, . .	1	24	...	...	...	...	Good	Southerly breeze.
Firth of Forth,						Plaice, . . .	31	13	13	10	...	...	"	Cloudy.
12th June 1888,						Common dabs, .	12	9	33	6	...	...	"	Some rain.
4.30 p.m.						Lemon dabs, . .	21	12	27	9	...	...	"	
						Long rough dabs, .	6	9	14	7	...	...	"	
						Common dabs, .	1	14	...	...	...	...	"	
						Haddocks, . .	19	9	...	...	...	...	"	
						Codlings, . .	4	17	4	9	...	...	"	
						Whitings, . .	12	13	17	10	...	...	"	
						Gurnard, . .	32	9	...	...	...	...	"	
						Dragonet, . .	1	5	...	...	...	...	"	
						Catfish, . .	1	36	...	...	...	...	"	
						Crayfish . .	24	...	...	...	...	...	"	
IV.	52·8	50·0	52·0		2 0	White skate, . .	2	21	1	18	1	15	"	S.W. breeze.
Firth of Forth,						Plaice, . . .	40	13	23	10	...	...	"	Cloudy sky.
12th June 1888,						Common dabs, .	9	9	14	6	...	...	"	Some rain.
7.47 p.m.						Lemon dabs, . .	7	11	4	8	...	...	"	
						Long rough dabs, .	2	10	...	...	...	...	"	
						Haddocks, . .	10	11	...	...	...	...	"	
						Codlings, . .	3	10	...	...	...	...	"	
						Whitings, . .	18	10	...	...	...	...	"	
						Herring (young), .	3	$3\frac{1}{4}$	...	...	...	...	"	
						Gurnard, . .	2	14	7	$7\frac{1}{2}$	...	...	"	
						Crayfish, . .	1	...	...	...	...	...	"	

TABLE C.—Record of Observations made on board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Surface Fauna Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
V. Firth of Forth, 15th June 1888, 12.20 p.m.	59·0	48·5	45·0		H. M. 2 10	Skate,	1	7	...	...	...	...	Good	Calm.
						Plaice,	3	14	2	10	...	...	„	Easterly swell.
						Lemon dabs,	4	11	3	8	...	...	„	Cloudy sky.
						Long rough dabs,	4	9½	6	7	...	...	„	Some showers.
						Witch soles,	7	15	...	...	...	...	„	
						Haddock,	1	14	20	10	...	...	„	
						Codling,	1	16	1	10	...	...	„	
						Whiting,	1	12	...	...	...	...	„	
						Gurnard,	5	10	...	...	...	...	„	
						Crayfish,	5	...	...	...	...	...	„	
VI. Firth of Forth, 15th June 1888, 10.35 a.m.	55·0	48·0	46·0		1 0	Plaice,	1	24	10	15	...	...	„	Westerly breeze.
						Common dab,	2	7	3	6	...	...	„	Cloudy; with some rain.
						Lemon dabs,	5	12	1	7	...	...	„	Easterly swell.
						Haddocks,	3	11	...	...	...	...	„	
						Codling,	2	14	...	...	...	...	„	
						Whiting,	3	9	1	6	...	...	„	
						Gurnard,	1	15	26	8	...	...	„	
						Angler,	1	15	...	...	...	...	„	
VII. Firth of Forth, 15th June 1888, 3.45 p.m.	52·0	51·4	46·4		2 20	Plaice,	1	17	12	12	...	...	„	Light northerly breeze.
						Common dabs,	14	8	...	...	...	...	„	Easterly swell.
						Lemon dabs,	13	12	3	7	...	...	„	Cloudy sky.
						Long rough dabs,	2	13	11	7	...	...	„	

TABLE C.—Record of Observations made on Board the 'Garland on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Water. Surface.	Water. Bottom.	Surface Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
					H. M.									
VII.—*continued.* Firth of Forth, 15th June 1888, 3.45 p.m.	52·0	51·4	46·4		2 20	Haddock,	1	7	...	...	...	...	Good	Light northerly breeze.
						Whitings,	2	6½	...	...	...	...	”	Easterly swell.
						Gurnards,	36	8	...	...	...	...	”	Cloudy sky.
						Angler,	1	40	...	...	...	...	”	
						Catfish,	1	34	...	...	...	...	”	
VIII. Firth of Forth, 19th June 1888, 7.50 a.m.	51·2	50·2	45·5		2 45	Gray skate,	2	16	...	...	...	...	”	Fresh easterly breeze with bright clear sky.
						Plaice,	6	12	...	...	...	...	”	Strong easterly sea rolling up Firth.
						Common dabs,	2	8	5	6	...	...	”	
						Lemon soles,	5	12	6	8	...	...	”	
						Long rough dabs,	12	8	...	...	...	...	”	
						Witch soles,	7	13	...	...	...	...	”	
						White fluke,	1	7	...	...	...	...	”	
						Haddocks,	114	9	2	7	...	...	”	
						Codling,	3	18	1	7	...	...	”	
						Brassie,	1	12	...	...	...	...	”	
						Whiting,	8	13	21	10	...	...	”	
						Gurnards,	6	12	34	9	...	...	”	
						Angler,	1	25	1	15	...	...	”	
						Catfish,	1	33	...	...	...	...	”	
						Saithe,	2	12	...	...	...	...	”	
						Crayfish,	5	...	...	...	.	...	”	

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Surface Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
I. FIRTH OF FORTH, 1st August 1888, 2.25 p.m.	55·0	54·8	51·0		H. M. 2 5	Gray skate,	1	20	1	18	1	7	Good	Easterly breeze and fine smooth sea.
						Plaice,	1	24	36	14	21	9½	"	
						Common dabs,	8	9	28	7½	6	5½	"	
						Lemon dabs,	44	11½	5	13	9	8	"	
						Long rough dabs,	8	10	24	8	8	6½	"	
						Haddocks,	12	11	18	10	1	7½	"	
						Codlings,	2	18	7	13	3	8	"	
						Whitings,	5	14	10	12	3	9	"	
						Gurnards,	2	13	7	9	6	4½	"	
						Angler,	1	18	...	...	...	...	"	
						A quantity of clams, crayfish, starfish, and cuttlefish.								
II. FIRTH OF FORTH. 1st August 1888, 5.20 p.m.	54·0	54·8	51·6		2 0	Thornback ray	1	14	...	...	...	...	"	Fine E.S.E. breeze and clear smooth sea.
						Plaice,	65	13	57	9	...	...	"	
						Common dabs,	15	10	36	6½	2	6	"	
						Lemon dabs,	24	11	9	8	...	...	"	
						Long rough dabs,	15	10	26	7½	1	7	"	
						Haddocks,	79	10	47	8½	9	7½	"	
						Cod,	1	30	1	36	...	...	"	
						Codling,	9	11½	1	8	...	...	"	
						Whitings,	8	13	44	12	3	6	"	
						Ling,	1	33	...	...	...	...	"	
						Gurnard,	4	13	4	7½	2	5½	"	
						Angler,	1	29	1	17	1	10	"	
						Several crayfish and starfish.								

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Surface Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
III.					H. M.									
Firth of Forth,	56·2	55·7	53·0		2 20	Gray skate,	1	15	1	12	...	...	Good	Light easterly breeze
1st August 1888,						Thornback ray,	2	20	1	29	...	...	,,	and fine smooth
11.10 a.m.						Plaice,	184	12	12	8	...	...	,,	sea.
						Common dabs,	3	13	22	9	17	6½	,,	Fine clear weather.
						Lemon dabs,	60	10	12	7½	...	...	,,	
						Long rough dabs,	15	6½	3	6	1	5	,,	
						Turbot,	1	21½	...	...	...	...	,,	
						Haddock,	1	16	27	12	36	9½	,,	
						Cod,	1	29	...	...	...	...	,,	
						Codlings,	6	17	19	12	19	8½	,,	
						Whiting,	15	16	50	10	31	8½	,,	
						Gurnard	4	14½	18	8	2	6	,,	
						Angler,	2	22		26	1	20	,,	
						Large quantites of clams, crayfish, star fish, and cuttle-fish.								
IV.														
Firth of Forth,	60·7	55·9	55·0		2 40	Thornback ray,	4	20	3	18	8	16	,,	Light easterly breeze
2nd August 1888,						Plaice,	245	14	101	10	4	7	,,	and fine.
9.35 a.m.						Common dab,	29	9	62	6½	5	6	,,	Hazy round horizon.
						Lemon dabs,	28	12	3	8	...	...	,,	Sea smooth.
						Long rough dabs,	3	10½	...	...	...	...	,,	
						White fluke,	1	10	...	...	...	...	,,	

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Surface Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	nches		
IV.—*continued.*					H. M.									
Firth of Forth. 2nd August 1888. 9.35 a.m.	60·7	55·9	55·0		2 40	Haddocks, . .	52	12	14	9	...	...	Good	Light easterly breeze and fine.
						Codlings, . .	4	13½	...	...	...	...	„	Hazy round horizon.
						Whiting, . .	11	12	4	6½	...	...	„	Sea smooth.
						Gurnard, . .	16	13	8	8½	2	6½	„	Net cheffed a good deal with clams.
						A large quantity of clams, and a few cuttlefish.								
V. Firth of Forth, 3rd August 1888, 10.25 a.m.	59·2	53·2	50·2		2 0	Plaice, . . .	7	13½	...	...	...	...	„	Fresh westerly breeze and fine smooth sea.
						Long rough dabs, .	15	8½	6	6½	3	5½	„	
						Haddocks, . .	107	11½	30	9	9	7½	„	
						Cod, . . .	1	32½	...	...	...	...	„	
						Whiting, . .	6	14½	34	11½	13	10½	„	
						Gurnard, . .	2	9	1	7½	...	...	„	
						Conger, . . .	1	33	...	...	...	...	„	
						Small quantity of crayfish.								
VI. Firth of Forth, 3rd August 1888, 9.35 a.m.	57·4	54·5	51·1		0 30	Plaice, . . .	3	21½	15	15	1	9½	„	Fresh westerly breeze and cloudy sky.
						Common dabs, .	6	7½	...	...	...	...	„	
						Lemon dabs, . .	6	13	3	9½	...	...	„	
						Haddocks, . .	5	11½	...	...	...	...	„	
						Codling, . . .	1	18	1	14	...	...	„	
						Whiting, . .	5	14½	10	10	...	...	„	
						Gurnard, . .	5	11	3	9	...	...	„	
						Angler, . . .	1	15½	1	28	1	39	„	
						Catfish, . . .	1	25½	...	...	...	...	„	

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Surface Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
VII. Firth of Forth, 2nd August 1888 1.20 p.m.	57·0	54·6	50·8		H. M. 1 55	Gray skate,	1	15	...	...	...	...	Good	Light easterly breeze and hazy smooth sea.
						Plaice,	22	10	2	9	3	8½	,,	
						Common dabs,	28	7½	51	6½	2	5½	,,	
						Lemon dabs,	6	11	1	9½	..	...	,,	
						Long rough dabs,	5	9	19	7	...	...	,,	
						Turbot,	1	14½	...	...	...	...	,,	
						Haddocks,	59	11	67	9½	44	7	,,	
						Codling,	1	18½	...	...	...	...	,,	
						Whiting,	15	10	5	6	2	8	,,	
						Cat-fish,	1	38	...	...	...	...	,,	
VIII. Firth of Forth, 3rd August 1888, 1.20 p.m.	61·0	54·4	51·0		2 0	Plaice	16	13½	...	...	...	...	,,	Light westerly airs and hazy smooth sea.
						Common dabs,	5	7	...	...	...	...	,,	
						Long rough dabs,	6	11	15	7	1	5½	,,	
						Witch soles,	7	17	2	9	...	...	,,	
						Haddocks,	45	10½	23	7½	3	6	,,	
						Cod,	1	35	1	39	...	...	,,	
						Codling,	1	6½	...	...	...	...	,,	
						Whitings,	84	11	85	10	...	...	,,	
						Gurnard,	11	11½	32	8	3	5½	,,	
						Angler,	1	22	1	24	...	...	,,	
						A quantity of cray-fish.								

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Sur	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and oung Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Size of Fish. Inches	Size of Fish. No.	Size of Fish. Inches	Size of Fish. No.	Size of Fish. Inches	Condition of Fish.	Wind, Weather, and other Observations.
I. FIRTH OF FORTH, 10th September 1888, 12.35 p.m.	E. 56·0	53·3	51·5 15½ fathoms	Surface net:—Great numbers of small Crustacea (*Megalops*-stage and a little more advanced); a good many Calanidæ (*Dias*); a few Medusids and 1 or 2 Perches. Bottom net:—A good many Schizopods (*Nyctiphanes*), 1 *Pandalus annulicornis*, a few *Tomopteris*, *Sagittæ*, *Cumæ*, Calanidæ (*Temora*, &c.), but organisms very much less numerous than in surface net.	H. M. 2 0	hornback ray,	1	15	...	...	...	...	Immature average quality.	At commencement—East-end wind W.N.W.; force 1; sea smooth, with a swell from eastward; transparency disk (9⅜ inch diam.) just visible at 3 fathoms; weather hazy. At finish—West-end wind; weather and sea similar, but water less transparent; disk just visible at 1¾ fathoms.
						Plaice,	66	13	13	9½	1	7½		
	W. 55·½	54·0	52·0 15 fathoms			Common dabs,	3	9	1	7½	...	...		
						Lemon dabs,	49	12	32	8½	4	7½		
						Long rough dabs,	1	10	...	...	...	...		
						Haddocks,	9	9½	9	11	...	...		
						Cod,	1	28	13	15	8	12		
						,,	16	9½	27	7½	...	...		
						Whitings,	41	13½	35	10½	10	9½		
						Common gurnards,	3	15	5	11	...	...		
						Monk or angler,	2	17	1	20	1	28		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
II. Firth of Forth, 7th September 1888, 12.40 p.m.	E. 56·5 W. 57·5	51·9 52·0	51·0 12 faths. 51·9 13 faths.	Surface net:—Larval Decapod Crustaceans in great abundance; few Calanidæ. Bottom net:—Organisms similar to those from Station V., but very few in number.	H. M. 2 10	Starry ray,	1	9½	...	...	..	...	Fish of good average quality, but mostly immature.	At commencement—wind N.N.E., force 3; sea moderate, about 3½ hours flood; transparency, white disk (9⅜ inches diam.) just visible at 2½ fathoms; weather cloudy, showery. At finish—Wind N.N.E., force 2; sea tolerably smooth, about high water; weather cloudy, but fine; transparency, disk, just visible at 2½ fathoms.
						Thornback ray,	1	18	1	15	1	16		
						,, ,,	1	14	...	...	...	...		
						Plaice,	49	13	62	9	6	7		
						Common dabs,	5	8½	124	6½	5	5½		
						,, ,,	5	4½	...	...	...	...		
						Lemon dabs,	66	14	13	7	...	...		
						Long rough dabs,	10	11	13	9½	3	6½		
						Haddocks,	43	12	17	11	15	8		
						Cod,	2	11	...	...	...	...		
						Whitings,	11	14	18	10	3	9		
III. Firth of Forth. 10th September 1888, 3.25 p.m.	E. 54·5 W. 53·5	52·5 52·1	51·4 15 faths. 51·9 11 faths.	Surface net:—Very young Decapod Crustaceans very abundant, fishes appear to be feeding on them—a few Medusids and Calanidæ, but little else. Bottom net:—A few *Sagittæ Tomopteris* Medusids and Calanidæ, but not nearly so numerous as in surface net.	2 35	Plaice,	23	13	23	10	4	8½	All more or less immature, of average quality.	At commencement—Wind W.N.W., force 1; sea smooth, transparency, disk (9⅜ inch. diam.) just visible at 2 fathoms; weather hazy. At finish—Wind and sea as at commencement; transparency, disk just visible at 1½ fathoms; weather a little cloudy but fine; tide about high water.
						Common dabs,	3	11	12	8	3	5½		
						Lemon ,,	21	13	9	9½	3	7½		
						Long rough dabs,	2	11½	1	9	...	...		
						Haddocks,	22	11	8	9½	...	...		
						Cod,	1	16	9	14	5	21		
						,,	9	9	...	...	...	...		
						Whitings,	2	14½	21	12½	33	9½		
						,,	2	8½	2	6½	...	...		
						Common gurnards,	2	13½	2	11	2	9		
						,, ,,	1	5	...	...	...	...		
						Monk or angler,	1	37	1	18	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
IV. Firth of Forth, 8th September 1888, 1.10 p.m.	E. 5·3 W. 54·5	54·0 55·0	53·0 7 faths. 5·3 7 faths.	Surface net :—Abundance of Decapod Crustacea—*Megalopa*—stage (probably the young of either the shore or swimming crab), a good many Medusids, a few Calanidæ, and two young lump-suckers (*Cyclopterus*). Bottom net :—A few *Sagittæ*, *Tomopteris*, Medusids, and Calanidæ. Bottom organisms not numerous.	2 5	Thornback ray, .	1	17	4	16	4	14	Fish of fair average quality but immature.	At commencement—Wind S.E., light, force about 1; sea smooth; transparency, disk ($9\frac{3}{8}$ inch, diam.) just visible at 2 fathoms, weather clear and fine; tide about 3 hours flood. At finish—Wind, sea, transparency, weather; similar to commencement.
						,, ,,	1	12	1	6	...	...		
						Plaice, . .	103	14	151	10	25	7		
						Common dabs, .	13	9	72	8	6	6		
						,, ,, .	1	4½	...	...	...	...		
						Lemon ,, .	44	12	8	9	...	...		
						Long rough dabs, .	1	10	1	8	...	...		
						Haddocks, . .	26	12	7	10	...	...		
						Cod, . . .	6	13½	...	...	...	...		
						Whitings, . .	3	12	8	11	3	...		
						Common gurnard, .	11	15	12	11	7	9		
						,, ,,	4	6½	...	...	...	...		
						Monk or angler, .	1	18	1	14	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
V. Firth of Forth, 7th September 1888, 7.15 a.m.	W. 53·0 E. 52·5	57·2 51·8	51·0 26 faths. 50·0 21 faths.	Surface net :—Larval Decapod Crustaceans in abundance, a good many Calanidæ, a few young fish. Tadpole ascidians, *Sagittæ*, and Ctenophora. Bottom net :—A number of *Sagittæ*, a few Amphipods, Calanidæ and Ctenophores ;—Organisms not very plentiful.	H. M. 2 15	Gray skate,	1	7	...	...	...	...	All, with few exceptions, more or less immature—of average quality.	At commencement—Wind W.S.W., force 6; sea moderate, tide, 4 hours ebb; weather cloudy; with occasional sunshine, but squally and unsettled; transparency of water-disk (9⅜ diam.) just visible at 4 fathoms. At finish—Weather cloudy, showery; wind moderating; wind N.; force 3; sea tolerably smooth; transparency of water-disk just visible at 5 fathoms.
						Plaice,	23	15	...	...	...	...		
						Common dabs,	3	9	7	7½	...	...		
						Lemon ,,	7	12	...	...	...	...		
						Long rough dabs,	21	8½	16	6½	3	5½		
						Witch soles,	5	16	1	18	...	...		
						Haddocks	150	12	14	8½	...	...		
						Cod,	3	13	...	...	...	...		
						Whitings,	16	14	12	10	...	...		
						Common gurnards,	4	13	4	8½	2	6½		
						Monk or angler,	1	36	1	19	...	...		
						Dragonet,	1	7	...	...	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Water. Surface.	Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
VI. Firth of Forth, 7th September 1888, 10.20 a.m.	E. 55·5 W. 54·75	51·1 51·3	51·3 14 faths. 51·2 15 faths.	Surface net:—Larval Decapod Crustaceans, very numerous, a good many Calanidæ, a few young fish, Tadpole Ascidians, *Sagittæ*, and Ctenophora. Bottom net:—A considerable number of Calanidæ (*Temora* mostly), a good many *Sagittæ*, Ctenophora, some Larval Decapods and young Caridæ and *Caligus*; also small Annelids (*Tomopteris*, &c.), young fish, a few Amphipods but no fish eggs.	H. M. 1 10	Plaice,	2	20½	17	15	14	13		At commencement —Wind N.N.E., force about 3; sea moderate, 1 hour flood; weather cloudy, unsettled; transparency of water, white disk (9⅜ in. diam.) just visible at 3 fathoms. At finish—Wind N.N.E., force 6; weather squally with showers; transparency of water, disk just visible at 3 fathoms.
						Common dabs,	5	8	2	7	4	5		
						Lemon ,,	19	13	13	9	2	8		
						Long rough dabs,	2	11	1	13	6	9		
						Turbot,	1	25	1	16	...	...		
						Haddocks,	12	11	20	9½	...	...		
						Cod,	1	14	...	...	...	...		
						Whitings,	1	15½	19	12½	15	10		
						,,	6	9	...	...	...	...		
						Common gurnards,	1	11½	10	9½	1	5½		
						Monk or angler,	1	33	1	23	1	18		
						,, ,, ,,	2	15	...	...	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
VII. Firth of Forth, 6th September 1888, 1.45 p.m.	E. 51·0 W. 55·0	53·3 53·2	51·8 14½ fths. 51·9 12 faths.	Surface net :—A number of Ctenophoræ and Larval Decapods, a few Isopods (*Idotea*), small Gasteropods, and one or two embryo mussels (*Mytilis*). Bottom net :—*Sagittæ* very abundant, Amphipods and Larval Decapod Crustaceans numerous, a good many Ctenophoræ, a few *Bolina*, young fish, small Annelids, and Calanidæ.	H. M. 2 15	Gray skate,	1	14	1	12½	1	10	All more or less immature and of average quality.	At commencement—Wind W.S.W., force about 7; sea moderate, 1 hour to high water weather cloudy, squally with cold showers; transparency of water disk (9⅜ in. diam.) just visible at 2½ fathoms. At finish—Wind as above, force 6; sea getting rough; weather cloudy, with occasional sunshine; transparency of water, disk just visible at 2 fathoms.
						Plaice,	43	14½	18	9	...	...		
						Common dabs,	9	11	101	7½	42	6½		
						,, ,,	1	4¼	...	...	...	...		
						Lemon ,,	12	11	2	9	...	...		
						Long rough dabs,	6	12	12	7	...	...		
						Turbot,	2	15½	...	...	...	...		
						Haddocks,	60	12	24	10½	22	9		
						,,	6	8	...	...	...	...		
						Whitings,	12	12	1	9	...	...		
						Common gurnards	7	13	7	8½	1	5½		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
VIII. Firth of Forth, 6th September 1888, 11 a.m.	E. 54·0 W. 57·0	52·9 53·1	49·8 21 faths. 52·0 20 faths.	Surface net: — Larval Decapods plentiful, a few *Calanus*, a few young fish and a good many small Ctenophoræ. Bottom net:—*Sagittæ*, very plentiful, a number of Amphipods, a few young fish, Larval Decapods, small Annelides, *Caligus* and *Calanus*.	H. M. 1 45	Gray skate, . .	2	16	...	...	...	...	All more or less immature, but of average quality.	At commencement—Wind W.S.W.; force about 6; weather dull, showery; sea moderate, about $2\frac{1}{2}$ hours flood; transparency of water-disk ($9\frac{3}{8}$ inches diam.), just visible at 5 fathoms. At finish—Wind W.S.W., force about 5; sea moderate; transparency of water, disk just visible at 3 fathoms.
						Plaice, . . .	4	13	1	11	...	...		
						Common dabs, .	13	$7\frac{1}{2}$	1	$5\frac{1}{2}$	...	...		
						Long rough dabs, .	20	8	5	6	...	...		
						Witch soles, . .	1	15	5	18	...	...		
						Sand fluke, . .	1	$12\frac{1}{2}$	...	...	...	...		
						Haddocks, . .	2	16	59	11	28	$7\frac{1}{2}$		
						Cod, . . .	1	$12\frac{1}{2}$	1	9	...	...		
						Whitings, . .	12	13	48	$10\frac{1}{2}$	2	7		
						Common gurnards, .	2	12	9	$8\frac{1}{2}$	5	7		
						Monk or angler, .	1	22	...	...	...	...		

TABLE C.—Record of Observations made on board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
IX. FIRTH OF FORTH, 6th September 1888, 7.25 a.m.	W. 53·5 E. 55·5	53·2 53·8	50·2 26 faths. 50·0 29 faths.	Surface net—A good many larval Decapods, a few Calanidæ (*Calanus*, *Temora*, *Dias*), a few *Sagittæ*, tadpole Ascidians, and a few *Pleurobrachiæ*. Bottom net—*Sagittæ* in great abundance, a good many Amphipods (*Calanus finmarchicus*), a number of young fish (2 species), a few small annelids (*Tomopteris*), young Gasteropods, and young starfishes (*Asterias*).	H. M. 2 5	Gray skate,	1	17	...	...	...	...	More or less immature, quality fair.	At commencement—Wind S.W., force about 3; weather clear; sea moderate, water very transparent, disk (9⅜ inches diam.), just visible at 7½ fathoms. At finish—Sky becoming over-cast; Wind W., force 3; sea moderate; transparency as above. The N.W. end of station is about 5 miles S.E. by S. of May Island; the S.E. end about 10¼ miles S.E. ½ S. of May Island.
						Plaice,	1	19	...	...	...	...		
						Long rough dabs,	5	9	9	6	...	...		
						Witch soles,	1	15½	...	...	...	...		
						Haddocks,	6	11	1	9	...	...		
						Cod,	1	16	...	...	...	...		
						Whiting,	6	13	14	11	32	9½		
						"	15	7½	...	...	...	...		
						Common gurnards,	1	14	20	12	8	9½		
						Monk or angler fish,	1	17½	...	...	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
I. Firth of Forth, 6th October 1888, 1 p.m.	44·0	50·5	50·8 19 faths.	Surface net—A number of Medusidæ and very young Decapod Crustaceans, but apparently little else. Bottom net—A good number of young fish (sand-eels?). A number of Schizopods (*Mysis*, *Nyctiphanes*), Cumæ (*Leucon*), *Sagittæ*, and a good deal of muddy-like stuff, probably broken up Medusidæ.	H. M. 1 45	Thornback ray,	2	20	2	15	...	...	Fish of scarcely average condition.	At beginning—Wind N., force 8; weather, moderately clear; sea a little rough, transparency of water-disk (24 inch diam.) just visible at 2 fathoms. At finish—Wind, weather, &c., as above. State of tide, about high water at finish.
	W. 46·0	50·2	49·5 12 faths.			Plaice,	10	14	11	12	3	9		
						Common dabs,	8	8½	1	7	...	...		
						Lemon "	5	15	33	11	5	9		
						Long rough dabs,	3	11	5	9	14	8		
						Haddock,	7	12½	2	11	1	10		
						"	1	8	...	...	...	...		
						Cod,	3	40	1	30	1	28		
						"	3	20	18	15½	15	12		
						"	16	9	...	...	...	...		
						Whiting,	31	14½	47	12	14	9½		
						"	1	7	...	...	...	...		
						Common gurnards,	5	15	5	9	2	7		
						Monk or angler,	1	46	1	20	1	26		
						" "	1	15	1	10	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued*.

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Size of Fish. Inches	Size of Fish. No.	Size of Fish. Inches	Size of Fish. No.	Size of Fish. Inches	Condition of Fish.	Wind, Weather, and other Observations.
II. Firth of Forth, 4th October 1888, 12.25 p.m.	E. 35·0 W. 42·0	50·9 50·9	50·0 12 faths. 51·0 16 faths.	Surface net—A considerable number of small Decapod Crustaceans, a good many young fish (*Motella mustela*), Medusidæ, *Cyclopterus lumpus* (young), a few *Temora longicornis*, *Sagittæ*. Bottom net—A good many *Sagittæ*, Medusidæ, and muddy stuff.	H. M. 1 35	Plaice,	14	14	51	10½	7	8	Fish small and mostly immature.	At beginning—Wind N., force 9; sea rough; weather overcast, with showers of rain mixed with hail; transparency-disk (24 inch diam.) just visible at 3 fathoms; state of tide, 5 hours flood. At finish—Wind N. by W., force 6; sea moderate; weather moderately clear, fair; transparency, similar to first observation.
						Common dabs,	5	11½	1	9	55	7		
						,, ,,	9	5½	...	...	...	...		
						Lemon ,,	17	13	15	10½	2	8		
						Long rough dabs,	10	10	5	7	...	...		
						Haddock,	7	11½	...	...	...	...		
						Cod,	1	23½	...	...	...	...		
						Whitings,	4	11½	3	9	1	7		
						Common gurnards,	3	15	1	10½	9	9		
						,, ,,	10	5½	...	...	...	...		
						Monk or angler,	1	14	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No	Inches	No.	Inches		
III. FIRTH OF FORTH, 8th October 1888, 10.50 a.m.	E. 51·3 W. 52·0	48·8 49·2	48·9 13 faths. 49·3	Surface net—Contained very little, only a number of very young Decapod Crustacea, some *Pleurobrachiæ*, Calanidæ, and Isopods. Bottom net—Contained a good number of young fish (sand-eels, *Gobius minutus*, and others), the meshes of the trawl-net (the lower and middle part) had a great many of these young fish attached to them—they could also be seen floating in the water after the trawl-net had been hauled on board—a few *Nyctiphanes*, *Sagittæ*, *Tomopteris*, a considerable number of Medusidæ (*Pleurobrachia*, *Bolina*, &c.), a few Amphipods, Calanidæ, &c.	H. M. 2 0	Gray skate, . .	1	14	...	...	...	...	Rather under average quality.	At beginning—Wind N.W., force 3; weather hazy; sea moderate; transparency, white disk (24 inches diam.) just visible at 1½ fathoms; state of tide, about 1 hour flood. At finish—Wind W. by N., force 2; weather hazy; sea smooth; transparency-disk, just visible at 1½ fathoms. *Pecten opercularis* plentiful at this station.
						Starry ray, . .	1	10	...	...	...	...		
						Thornback ray, .	2	17	1	16	2	14		
						Plaice, . . .	3	13	3	11	1	10		
						Common dabs, .	4	10	4	9	7	7		
						Lemon dabs, . .	20	12	14	10	4	9		
						" " . .	2	8	...	...	...	...		
						Long rough dabs, .	1	14	1	11½	5	9½		
						" " .	12	7	1	6	...	...		
						Haddock, . .	36	12	2	14	1	9		
						Cod, . . .	1	19	14	17	8	14		
						" . . .	19	10	3	9	1	8½		
						Whiting, . .	1	15½	1	14	18	11		
						" . . .	12	9½	...	...	...	...		
						Herring, . .	1	5½	...	...	...	...		
						Common gurnards,	1	14	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Surface Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
IV. FIRTH OF FORTH, 8th October 1888, 1.40 p.m.	E. 51·5 W. 52·0	46·2 49·0	47·5 7 faths. 49·0 8½ faths.	Surface net—A few Isopods, *Eurydice pulchra*, a few very young Decapods, a large quantity of extraneous matter, such as sea-weed, engine ashes, &c. Bottom net — A great many Medusidæ, a few fish, *Nyctiphanes*, *Sagittæ*, but very little of anything else than Medusidæ.	H. M. 2 25	Plaice, . . .	49	16	45	14½	24	11½	Good	At beginning — Wind W., force 1; weather hazy; sea smooth; transparency, white disk (24 inches diam.) just visible at 1½ fathoms; state of tide 4 hours flood. At finish—Wind E. by N., force 1; weather a little hazy; sea smooth; transparency-disk, just visible at 2 fathoms. *Pecten opercularis* common at this station.
						,, . . .	31	10	10	9	...	...	,,	
						Common dabs, .	5	11	5	9	13	7	,,	
						,, ,, . .	3	6	...	...	...	...	,,	
						Cod, . . .	1	12	...	...	...	...	,,	
						Whiting, . .	1	13	1	7	...	...	,,	
						Herring, . .	1	6½	...	...	...	...	,,	
						Sprats, . . .	2	3½	...	...	...	...	,,	
						Common gurnards,	1	13½	1	9½	1	8	,,	
						Monk or angler, .	1	12	...	...	...	...	,,	

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
V. Firth of Forth, 3rd October 1888, 1.30 p.m.	W. 52·8	51·8	51·6 32 faths.	Surface net—Very young Decapods plentiful, a number of young fish (*Motella mustela*), 1 *Cyclopterus lumpus* (young), and some Medusidæ. Bottom net—A few Schizopods (*Erythrops* and *Mysis*), *Cuma*, *Crangon*, and Amphipods; also a few Calanidæ and *Sagittæ*.	H. M. 2 0	Plaice,	2	14	1	13	...	...		At beginning—Wind N.E., force 3; sea moderate; weather, clear, fine; transparency, white disk ($9\frac{3}{8}$ inch. diam.) just visible at $2\frac{1}{2}$ fathoms. At finish—Wind N.E. by N., force 3; sea moderate, but with a swell coming from N.E.; weather somewhat cloudy, but fine; transparency, disk just visible at about 3 fathoms.
	E. 51·5	51·4	51·5 32 faths.			Common dabs,	12	$8\frac{1}{2}$	2	$6\frac{1}{2}$	...	...		
						Lemon dabs,	1	16	1	11	...	...		
						Long rough dabs,	5	$9\frac{1}{2}$	...	...	...	...		
						Haddock,	62	12	1	15	1	$9\frac{1}{2}$		
						,,	8	8	...	..	...	...		
						Cod,	1	25	1	10	...	...		
						Whiting,	2	$11\frac{1}{2}$	...	...	...	...		
						Common gurnards,	1	$13\frac{1}{2}$	1	$10\frac{1}{2}$	1	$7\frac{1}{2}$		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued*.

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
VI. Firth of Forth, 3rd October 1888, 4.30 p.m.	W. 51·75 E. 50·5	51·2 51·2	51·1 17 faths. 51·5 14 faths.	Surface net—A good number of very young Brachyura (*Portunus*?) and Macrura (*Nephrops*). A few Medusidæ and one young fish (*Motella mustela*). Bottom net—A good many *Sagittæ*, a few *Tomopteris*, *Calanus*, Medusidæ, one *Leptomysis*, and a quantity of fine shelly sand.	H. M. 1 0	Starry ray,	1	12½	...	...	...	...	Fish of very good quality.	At beginning—Wind N.E. by N., force 3; sea moderate; weather, clear, fine; transparency white disk (9⅜ inches diam.) just visible at 3½ fathoms; tide 3½ ebb. At finish—Wind, weather, sea, as at previous observation; transparency also similar; tide 4½ hours ebb.
						Thornback ray,	1	29	...	...	...	...		
						Plaice,	37	16	4	13	...	...		
						Common dabs	5	8	...	...	...	...		
						Lemon ,,	7	12½	3	11	2	9½		
						Turbot,	1	20	...	...	...	...		
						Brill,	1*	24	1	18	1	16½		
						Haddock,	1	12½	1	9	...	...		
						Cod,	1	17½	...	...	...	...		
						Whiting,	1	12	...	...	...	...		
						Common gurnards,	3	10	1	9	...	...		

* This brill is as long as the longest mentioned in Day's *British Fishes*.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
VII. FIRTH OF FORTH, 2nd October 1888, 1·15 p.m.	W. 46·0 E. 43·0	50·9 51·1	51·5 19 faths. 51·7 24 faths.	Surface net—Young Decapod Crustacea numerous, a good number of Medusidæ, several young fish, and Calanidæ. Bottom net—A great many young fish, mostly sand eels (?), one or two flat fishes, a good many *Pleurobrachiæ*, a few Amphipods, *Calanus*, *Sagittæ*, *Tomopteris*, &c.	H. M. 1 45	Thornback ray,	1	18	2	17	1	14		At beginning—Wind W.S.W., force 4; weather overcast, with rain; sea moderate; transparency of water, white disk (9⅜ inch diam.) just visible at 1½ fathoms; tide 1 hour ebb. At finish — Wind S.W. by S., force 2; weather overcast, fair; sea smooth; transparency of water, disk just visible at 2 fathoms.
						,, ,,	1	13½	1	12½	...	...		
						Plaice,	1	25	1	24	1	16		
						,,	1	14	2	13	2	12		
						Common dabs,	3	10½	18	7½	1	4½		
						Lemon ,,	1	12½	1	11	1	8½		
						Long rough dabs,	15	10½	8	9	12	6½		
						Witch soles,	1	17	...	...	...	...		
						Haddocks,	81	12½	102	10½	44	8		
						Cod,	1	29½	1	18	...	...		
						Whitings	9	13½	40	11	7	8		
						Lythe,	1	31	...	...	...	...		
						Common gurnards,	3	13	1	9	...	...		
						Monk or angler,	1	17	1	15	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
VIII. Firth of Forth, 2nd October 1888, 3.40 p.m.	W. 43·0 E. 45·75	50·1 51·0	51·6 24 faths. 51·5 26 faths.	Surface net—A good many young Decapod Crustacea, and young Gadidæ (*Motella mustela*), young sand-eels, some Medusidæ, *Anomalocera*, and other Calanidæ. Bottom net—A great many young fishes mostly sand-eels; these young fishes were adhering in great numbers to the meshes of the trawl net, and were floating dead in the water in considerable abundance after the net had been hauled on board, a few Schizopods (*Erythrops* (new to Forth), and *Mysis ornata*).	H. M. 1 50	Starry ray, . .	1	3½	...	...	...	...		At beginning—Wind S., force 2; weather overcast, fair; sea smooth; transparency disk (9⅜ inch diam.) just visible at 2 fathoms; tide 3½ hours ebb. At finish — Wind S.E., force 2; weather overcast, fair; sea smooth; transparency disk just visible at 4 fathoms.
						Thornback skate, .	1		...	...	...	...		
						Plaice, . . .	1	14½	1	12	...	...		
						Common dabs, .	2	7½	...	...	...	...		
						Long rough dabs, .	8	8	6	6½	...	...		
						Witch soles, . .	2	19	2	17	1	16		
						Haddocks, . .	1	16	12	12	26	9		
						" . .	1	8	...	...	...	...		
						Cod, . . .	3	40	1	35	1	30		
						" . . .	1	24	1	22	...	...		
						Whiting, . .	1	14	6	11	3	9		
						Common gurnards,	1	8	...	...	...	...		
						Monk or angler, .	1	21	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
IX. FIRTH OF FORTH, 2nd October 1888, 6 p.m.	E. 47·0	51·0	51·3 26 faths.	Surface net—A considerable number of young Decapod Crustacea (Brachyura, Macrura), a number of *Pleurobrachiæ*, several young fishes (sand-eels, *Motella mustela*, flat-fish, &c.) from half to an inch or an inch and a half long, also a few Calanidæ. Bottom net—A good many young fishes (sand-eels mostly, one or two flat fishes), a good number of *Pleurobrachiæ*, a few Amphipods, *Calanus*, *Sagittæ*, *Tomopteris*, and other Annelids.	H. M. 2 10	Gray skate,	1	21	1	20	1	14		At beginning—Wind S.E. by S., force 3; weather overcast, fair; sea moderate; transparency, disk ($9\frac{3}{8}$ inch diam.) just visible at $3\frac{1}{2}$ fathoms; tide about low water. At finish — Wind S.E., changeable, force 6; weather, overcast, with heavy rain; too dark to take transparency of water.
	W 45·0	51·1	51·5 26 faths.			,, ,,	1	16	1	8	...	...		
						Starry ray,	2	$7\frac{1}{2}$	1	$5\frac{1}{2}$	...	...		
						Thornback skate,	1	23	...	...	...	...		
						Long rough dabs,	6	$8\frac{1}{2}$	8	7	...	...		
						Witch soles,	2	18	3	17	1	16		
						,, ,,	2	14	1	9	...	...		
						Haddocks,	5	$11\frac{1}{2}$	23	10	1	8		
						Cod,	2	33	1	36	1	24		
						,,	1	18	1	$12\frac{1}{2}$	1	11		
						,,	1	8	...	...	...	...		
						Whiting,	3	14	2	11	1	9		
						Monk or angler,	1	18	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
I. FIRTH OF FORTH, 8th November 1888, 1.30 p.m.	E. 41·5 W. 42·0	47·2 47·0	47·5 10 faths. 47·0 11 faths.	Surface net—*Nil.* Bottom net — A considerable number of *Pleurobrachiæ*, a number of Schizopods (*Nyctiphanes, Erythrops, Mysis, Macropsis, Gastrosaccus, Mysidopsis*), a few Amphipods, some young fishes (*Gobius, Callionymus*, gurnard, sand-eel (?), flat-fish, herring), a good many *Sagittæ*.	H. M. 1 55	Thornback ray, .	2	15	...	...	...	...	Of average quality.	At beginning—Wind E.S.E., force 9; weather cloudy; sea rough; transparency of water, disk (24 inch diam.) just visible at 1½ fathoms; state of tide, about 2 hours flood. At finish of trawl—Wind, weather, and sea as above; also transparency of water.
						Common dabs, .	1	8½	...	...	...	...		
						Lemon dabs, . .	1	16	2	12½	1	10½		
						Long rough dabs, .	1	12	2	9½	3	8		
						,, ,, .	3	7½	...	..	...	...		
						Cod, . . .	1	37	1	20	1	11		
						,, . . .	2	10	...	...	...	...		
						Whiting, . .	2	13	1	11	2	10½		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
III. FIRTH OF FORTH, 8th November 1888, 10.45 a.m.	E. 42·0 W. 41·4	47·3 47·0	47·6 12 faths. 47·1 8 faths.	Surface net—An Amphipod, a *Caligus*, and one or two *Calanus*, but nothing else. Bottom net had got entangled about the trawl head, and contained nothing.	H. M. 1 50	Gray skate,	1	25	...	...	...	...	Of average quality.	At beginning—Weather cloudy; wind E.S.E., force 8; sea rough; transparency of water, disk (24 inch diam.) just visible at 1½ fathoms; state of tide, 5½ hours ebb. At finish of trawl—Weather, wind, and sea as above; force of wind 10; transparency of water, disk just visible at 1 fathom.
						Thornback ray,	1	14	...	...	...	...		
						Plaice,	1	13	...	...	...	...		
						Common dabs,	1	9½	1	8	8	7½		
						,, ,,	2	7	1	5	...	...		
						Lemon ,,	7	13	4	11	...	...		
						Long rough dabs,	5	10	7	7½	2	6½		
						Haddock,	1	18	1	11½	1	10½		
						Cod,	1	34	1	28½	1	21		
						,,	2	15	3	9½	7	8½		
						Coal-fish,	1	12½	...	...	...	...		
						Whiting,		13½	4	12½	3	11		
						,,		8	1	5½	...	...		
						Monk or angler,	1	21½	1	18	...	...		
						Catfish,	1	21½	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
VII. FIRTH OF FORTH, 7th November 1888, 11.50 a.m.	E. 40·8 W. 44·0	48·3 48·0	48·5 15 faths. 48·0 10 faths.	Surface net — Very little of anything: viz., 3 *Idotea marina*, 1 *Caligus*, 1 or 2 *Temora longicornis*, a few *Sagittæ*, 1 very young fish (a sand-eel ?). Bottom net — Numerous *Sagittæ*, *Nyctiphanes*, a few *Mysis*, *Erythrops goesii*, some Amphipods, numerous young fishes (*Gobius*, *Syngnathus acus*, flat-fish, *Ammodytes lanceolatus*).	H. M. 1 40	Gray skate, . .	1	7½	...	...	...	...	Quality good.	At beginning—Wind E.S.E., force 9; weather overcast; sea rough; state of tide about 1½ hour flood; transparency of water, disk (24 inch. diam.) just visible at 2 fathoms. At finish—Wind, weather, and sea as above; transparency, disk just visible at 1½ fathoms.
						Thorny ray, . .	1	19½	...	...	...	...		
						Common dabs, .	1	9	2	8	1	7		
						„ „ .	1	6	...	...	...	...		
						Long rough dabs, .	2	8	1	7	...	...		
						Turbot, . . .	1	16	...	...	...	...		
						Haddocks, . .	13	13	13	12	6	11		
						„ . .	1	9	...	...	...	...		
						Cod, . . .	3	33	2	29½	1	27		
						„ . . .	3	23½	1	10	...	...		
						Whiting, . .	4	15	4	12	5	11		
						„ . .	2	9½	1	4	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
VIII. Firth of Forth, 1st November 1888, 12.30 p.m.	S. 46·0 N. 47·0	47·8 49·9	49·2 $10\frac{1}{2}$ faths. 49·8 23 faths.	Surface net—A few *Sagittæ*, Calanidæ (*Calanus*), very young Decapod Crustacea (very few surface organisms). Bottom net—An abundance of *Sagittæ*, a few Copepoda (Calanidæ), a few very immature starfishes.	H. M. 1 45	Thornback ray,	1	17	...	...	...	...	Quality inferior—condition immature.	At beginning—Wind N.E. by N., force 4; weather, overcast, with cold showers of rain; sea moderate; transparency of water, disk (24 inches diam.) just visible at 5 fathoms; state of tide, high water. At finish of trawl—Wind N.E. by N., force 6; weather as above; sea rough; transparency of water, same as above.
						Plaice,	1	$16\frac{1}{2}$	1	15	...	...		
						Common dabs,	1	9	14	$7\frac{1}{2}$	17	7		
						" "	3	$6\frac{1}{2}$	1	5	...	...		
						Lemon "	3	$12\frac{1}{2}$	1	10	...	...		
						Long rough dabs,	19	$7\frac{1}{2}$	7	6	...	...		
						Witch soles,	1	$17\frac{1}{2}$	1	$16\frac{1}{2}$	...	...		
						Turbot,	1	21	...	...	...	...		
						Haddock,	21	12	1	14	15	$10\frac{1}{2}$		
						"	17	9	...	...	...	...		
						Whiting,	3	$13\frac{1}{2}$	4	12	1	8		
						Ling,	1	$25\frac{1}{2}$	...	...	...	...		
						Common gurnards,	1	$15\frac{1}{2}$	5	10	1	9		
						" "	1	$5\frac{1}{2}$	...	...	...	...		
						Monk or angler,	1	18	2	17	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued*.

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.		H. M.		No.	Inches	No.	Inches	No	Inches		
IX. Firth of Forth, 1st November 1888, 3.10 p.m.	E. 46·6	49·8	50·0 31 faths.	Surface net—A few organisms similar to those captured in surface net at Station VIII., viz., *Sagittæ*, *Calanus*, young Decapod Crustacea. Bottom net—A considerable number of *Sagittæ*, a few Calanidæ, but little else.	1 20	Common dabs, .	2	10	3	8	5	7	Quality inferior—condition immature.	At beginning—Wind N.E. by N., force 6; weather, overcast, with cold rain showers; sea rough; transparency of water, disk (24 inches diam.) just visible at $5\frac{1}{2}$ fathoms; state of tide, $2\frac{3}{4}$ hours ebb. At finish — Wind N.E. by N., force 8; sea rough; weather and transparency of water similar to the above; weather very stormy.
	W. 47·0	50·0	49·9 31 faths.			" " . .	3	$6\frac{1}{2}$	...	...	...	...		
						Witch soles, . .	1	17	1	15	...	...		
						Haddock, . .	5	11	8	$9\frac{1}{2}$	2	$8\frac{1}{2}$		
						Whiting, . .	1	12	1	10	1	8		
						Common gurnard, .	1	14	5	10	7	9		
						Monk or angler, .	1	20	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
I. FIRTH OF FORTH, 1st December 1888, 7.55 a.m.	E. 39·0 W. 41·0	44·5 44·8	45·0 17 faths. 45·0 14 faths.	Surface net—Only a few Medusidæ. Bottom net—A good deal of mud and broken shells, and a number of *Pandalus*, *Crangon*, *Erythrops*, Amphipods, *Calanus*, and *Sagittæ*.	H. M. 1 58	Starry ray, . .	1	12	1	11	1	5	Of fair average quality.	At beginning—Wind W.S.W., force 2; weather hazy; sea smooth, with an easterly swell; barometer 29·67; transparency of water, disk (24 inches diam.) just visible at $1\frac{3}{4}$ fathoms; state of tide about 1 hour flood. At finish — Wind, weather, and sea similar to above; transparency $2\frac{1}{2}$ fathoms; barometer, 29·67.
						Thornback ray, .	1	17	2	14	...	...		
						Common dabs, .	2	$9\frac{1}{2}$	2	8	2	7		
						" " . .	2	$5\frac{1}{2}$	1	$4\frac{1}{2}$	...	...		
						Lemon dabs, . .	1	13	1	12	...	...		
						Long rough dabs, .	4	10	4	$8\frac{1}{2}$	5	$7\frac{1}{2}$		
						" " . .	3	6	1	5	...	...		
						Haddock, . .	1	17	1	12	2	11		
						" . . .	2	10	...	...	...	...		
						Cod, . . .	1	39	1	$37\frac{1}{2}$	1	$31\frac{1}{2}$		
						" . . .	1	26	1	$23\frac{1}{2}$	1	$19\frac{1}{2}$		
						" . . .	1	$18\frac{1}{2}$	1	11	...	...		
						Whiting, . .	1	15	2	12	2	11		
						" . . .	2	9	...	...	...	...		
						Ling, . . .	1	26	..	...	...	...		
						Monk or angler, .	1	$12\frac{1}{2}$	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
II. FIRTH OF FORTH, 1st December 1888, 11.15 a.m.	E. 44·0	44·3	44·5 12 faths.	Surface net — A few Medusids, and one *Parathemisto.* Bottom net—A considerable number of *Sagittæ* and Schizopods (*Nyctiphanes*, *Mysis ornatus*, and *Lamornæ*), a few Cumacea, *Erythrops*, *Crangon*, *Calanus*, and *Temora.*	H. M. 1 45	Common dabs,	2	7	...	...	...	..	Quality good.	At beginning—Wind W.S.W., force 2; weather hazy; sea smooth, with easterly swell; barometer 29·66; transparency $1\frac{1}{4}$ fathoms; state of tide, about 4 hours flood. At finish—Wind, weather, and sea similar to above; transparency $2\frac{1}{4}$ fathoms; barometer 29·63.
	W. 45·0	44·8	45·3 12 faths.			Long rough dabs,	6	7	...	...	...	...	,,	
						Haddock,	3	18	1	20	3	$12\frac{1}{2}$	,,	
						,,	1	9	...	...	...	...	,,	
						Cod,	1	38	1	30	1	21	,,	
						,,	1	20	1	18		15	,,	
						,,	3	11	...	...	...	...	,,	
						Whiting	2	16	5	13	5	$10\frac{1}{2}$	,,	
						,,	4	9	1	$6\frac{1}{2}$	...	...	,,	

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
III. Firth of Forth, 30th November 1888, 3.30 p.m.	W. 43·0 E. 44·0	45·0 45·3	45·5 $8\frac{1}{2}$ faths. 45·9 9 faths.	Surface net—Only a few Medusidæ, *Sagittæ*, and *Nyctiphanes*. Bottom net—A considerable number of *Sagittæ*, some *Erythrops*, a few *Crangon allmanni* and *nanus*, a few *Macropsis*, *Mysis ornata*, *Nyctiphanes*, and *Calanus*.	H. M. 1 50	Starry ray,	1	$8\frac{1}{2}$	1	$4\frac{1}{2}$	...	...	Fairly good quality.	At beginning—Wind E., force 2; weather dull; sea moderately smooth, with easterly swell; barometer 29·51; transparency of water, disk (24 inch. diam.) just visible at $1\frac{3}{4}$ fathoms; state of tide, nearly 4 hours ebb. At finish—Wind, weather, and sea similar to above; barometer 29·52.
						Common dabs.	1	$6\frac{1}{2}$	...	...	...	...		
						Lemon ,,	1	$9\frac{1}{2}$	...	...	...	...		
						Long rough ,,	1	10	...	...	...	...		
						Cod.	1	$41\frac{1}{2}$	1	36	1	27		
						,,	1	21	1	$16\frac{1}{2}$	1	15		
						,,	1	14	1	12	7	10		
						Whiting.	1	19	1	$13\frac{1}{2}$	9	11		
						,,	4	$8\frac{1}{2}$	4	$7\frac{1}{2}$	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
IV. FIRTH OF FORTH, 30th November 1888, 11.25 a.m.	W. 43·0	45·1	45·3	Surface net — Only a few Medusidæ and 1 *Idotea marina.* Bottom net — A mass of *Sagittæ*, some *Nyctiphanes*, a few *Erythrops*, and *Caligus* and *Calanus*, 1 *Leptomysis gracilis.*	H. M. 2 5	Starry ray, . .	1	12	1	11	...	...	Of average quality.	At beginning—Wind E. by S., force 2; weather dull; sea moderately smooth, but with an easterly swell; barometer 29·51; transparency of water, disk (24 inch, diam.) just visible at 1 fathom; state of tide, about 5 hours flood. At finish—Wind, weather, and sea similar to above; barometer 29·51.
			8 faths.			Plaice, . . .	5	15	5	14	2	13		
	E. 43·4	45·8	45·9			,, . . .	1	11	...	...	...	..		
						Common dabs, .	2	8	7	7	1	5		
						Lemon ,, .	4	12	2	9	...	...		
						Long rough dabs, .	1	12½	1	11	6	9		
						,, ,, .	3	8	1	7	2	6½		
						Cod, . . .	1	23	1	22	4	18½		
						,, . . .	1	26	1	16	7	11½		
						,, . . .	6	10	5	9	1	5		
						Whiting, . .	5	11	8	9	6	7		
						,, . .	3	4⅓	...	...	...	...		
						Herring, . .	1	7½	4	7	2	5¾		
						Sprats, . . .	2	3¾	...	...	...	...		
						Monk or angler, .	2	13	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
V. FIRTH OF FORTH, 6th December 1888, 8.15 a.m.	W. 49·0	46·0	46·1 28 faths.	Surface net — A few *Sagittæ*, *Bolina*, and *Beroe*, but very few. Bottom net—*Sagittæ* numerous, a good many *Crangon allmanni*, *Mysis ornata*, *Nyctiphanes*, a few *Mysis spiritus*, 1 *Mysidopsis didelphys*, a few *Calanus*, *Parathemisto*, and other Amphipods, 1 or 2 young fishes (*Gobius minutus*).	H. M. 1 25	Thornback ray,	1	14	1	13	...	...	Quality good.	At beginning—Wind W.N.W., force 2; weather cloudy, but fine; sea smooth; barometer 30·07; transparency of water, 3 fathoms; state of tide, about 4 hours ebb. At finish—Wind W., force 2; weather a little hazy, but fine; sea smooth; barometer 30·09; transparency, 3 fathoms.
	E. 49·0	46·1	46·3 28 faths.			Common dabs,	2	10	3	8	4	7	,,	
						Long roughs,	1	9½	3	8	5	7	,,	
						Witch,	1	17	...	...	...	...	,,	
						Haddocks,	2	10	41	12	11	11	,,	
						,,	1	10	...	...	...	...	,,	
						Cod,	1	40	4	36	1	16	,,	
						,,	1	13	2	11	1	10	,,	
						,,	1	9	...	...	...	...	,,	
						Whiting,	2	13	2	10	3	9	,,	

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
VI. Firth of Forth, 6th December 1888, 12.45 p.m.	E. 48·5 W. 50·0	46·0 46·0	46·2 14 faths. 46·0 13 faths.	Surface net—Almost *nil*, only a few Medusidæ. Bottom net—Many *Sagittæ*, Schizopods (*Nyctiphanes*, *Erythrops gœsii*, *Mysis ornatus*, and *M. spiritus*, *Leptomysis gracilis*, and *L. lingrura* (young), *Calanus*, a few *Parathemisto* and *Tomopteris* and very young Decapod Crustacean.	H. M. 0 45	Plaice, . . .	1	16	1	14	1	13	Quality good.	At beginning—Wind W., force 2; weather a little hazy, but fine; sea smooth; barometer 30·09: transparency of water, 2½ fathoms; state of tide, fully 2 hours flood. At finish—Wind, weather, sea, barometer, and transparency as above.
						Common dab. .	2	10	4	9	1	8	,,	
						Lemon ,, .	1	13	...	...	...	...	,,	
						Long rough, . .	1	7		6½	...	...	,,	
						Brill, . . .	1	20½	...	...	...	...	,,	
						Haddock. . .	1	18	...	...	...	...	,,	
						Cod. . . .	1	46	1	41	1	19	,,	
						,, . . .	2	17	2	13½	1	10	,,	
						Whiting, . .	1	10	3	8	1	9	,,	
						,, . .	1	6	...	...	...	...	,,	

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
VII. Firth of Forth, 5th December 1888, 4.20 p.m.	E. 51·5 W. 52·0	45·8 45·8	45·7 26 faths. 46·1 21 faths.	Surface net—A good many *Sagittæ*, a few *Nyctiphanes* and *Calanus*, and one or two *Idotea*. Bottom net—A considerable number of *Sagittæ* and Schizopoda (including many *Nyctiphanes*, some *Mysis ornatus*, a few *Erythrops goesii*), a good many Amphipods (*Ampelisca*, *Halirages*, &c.), *Calanus finmarchum* (the only species of Calanidæ observed in tow nettings for some time past), and one or two young *Gobius minutus*.	H. M. 1 55	Thornback ray,	1	11½	...	...	...	...	Quality good.	At beginning—Wind S.W., force 5; weather, rainy; sea moderate; barometer 29·88; transparency of water, disk just visible at 2 fathoms; state of tide, about 1 hour ebb. At finish—Wind S.W., force 3; weather dull, but fair; sea moderate; barometer 29·89; too dark for transparency.
						Long rough dabs,	2	8	1	6½	...	...	,,	
						Witch soles,	1	19	...	...	...	...	,,	
						Haddock,	1	20	1	13	1	12	,,	
						,,	2	11	2	10	1	9	,,	
						Cod,	2	38	1	34	1	32	,,	
						,,	1	31	3	30	1	28	,,	
						,,	1	22	1	12	...	..	,,	
						Whiting,	7	14	1	11	14	8	,,	
						,,	3	6	...	...	...	...	,,	
						Monk or angler,	1	10½	...	...	...	...	,,	

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
VIII. FIRTH OF FORTH, 5th December 1888, 2.15 p.m.	E. 51·1 W. 52·0	46·0 45·8	46·8 28 faths. 45·9 $26\frac{1}{2}$ faths.	Surface net—A few *Sagittæ* and *Bolina*. Bottom net—A good many *Nyctiphanes*, a few *Mysis ornatus* and *Erythrops*, a number of Amphipods, a good many Medusidæ, *Sagittæ*, and Calanidæ, a few *Gobius minutus*, and *Crangon allmanni*.	H. M. 1 45	Gray skate,	1	16	1	11	...	...	Of good quality.	At beginning—Wind S., force 2; weather cloudy; sea moderate; barometer 29·90; transparency of water, disk just visible at $3\frac{1}{4}$ fathoms; state of tide, about 3 hours flood. At finish — Wind S.W., force 5; weather rainy; sea moderate; barometer 29·89; transparency of water, disk just visible at 2 fathoms.
						Common dabs,	1	9	2	8	2	7		
						,, ,,	2	6	1	5	...	...		
						Long rough dabs,	6	$8\frac{1}{2}$	1	$7\frac{1}{2}$	1	6		
						Haddock,	2	18	48	12	30	10		
						,,	22	9	1	5	...	...		
						Cod,	1	41	1	12	1	8		
						Whiting,	1	15	2	12	9	$8\frac{1}{2}$		
						,,	1	6	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
IX. FIRTH OF FORTH, 5th December 1888, 12.5 p.m.	E. 51·8 W. 52·8	46·0 46·1	47·0 29 faths. 46·8 28 faths.	Surface net — A few *Parathemisto oblivia*, 1 *Caligus*, a few *Sagittæ*, and *Bolina*. Bottom net — Numerous *Nyctiphanes*, a number of *Mysis ornata*, a few *Crangon allmanni*, and *nanus*, a number of Amphipods, including a few *Parathemisto*, a good many Medusidæ, principally *Beroe*, a good many *Sagittæ*, and Calanidæ, and a few young *Gobius minutus*.	H. M. 1 45	Common dabs,	2	8	1	7	...	...	Of average quality.	At beginning—Wind S.E., force 3; weather cloudy; sea moderate; barometer 29·91; transparency of water, disk (24 inches diam.) just visible at 3 fathoms; state of tide, about 1 hour flood. At finish — Wind S. by W., force 2; weather cloudy; sea moderate; barometer 29·91; transparency, disk just visible at 3 fathoms.
						Long roughs,	5	8	8	6	1	5		
						Haddock,	8	13	15	10½	2	9		
						Cod,	1	33	1	26	1	14		
						,,	3	10½	2	8½	...	...		
						Whiting,	8	13	4	12	1	11		
						,,	16	9	10	8	3	7		
						Monk or angler,	1	18	...	...	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued*.

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Water. Surface.	Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
1. Firth of Forth, 20th December 1888, 11.45 a.m.	E. 43·6 W. 46·3	45·0 45·0	45·8 13 faths. 45·5 14 faths.	Surface net—A few Medusids and Amphipods (*Parathemisto, Hyperia, Metopor*), 1 *Idotea marina.* Bottom net—A good many *Nyctiphanes, Sagittæ,* and *Calanus,* and a good many Medusidæ.		Gray skate,	1	10½	...	...	...	...	Quality scarcely up to the average.	At beginning—Wind E., force 3; weather hazy; sea smooth; barometer 29·52; transarency of water, disk just visible at 2½ fathoms; state of tide, about 2 hours flood. At finish—Wind, weather, and sea as above; barometer 29·48; transparency 2 fathoms. The trawl net came up filled with clams and mud, so that it was with great difficulty got on board.
						Thornback ray,	1	13	1	8	...	...		
						Common dabs,	1	8½	2	6½	...	...		
						Lemon dabs,	12	13	2	14	6	9		
						Long rough dabs,	4	10	6	9	10	7		
						,,	10	6	1	3	...	...		
						Haddock,	5	13	1	12	2	10		
						Cod,	1	36	1	27	1	21		
						,,	4	17	7	12	23	10		
						,,	8	9	2	8	...	...		
						Whiting,	2	14	1	12	5	11		
						,,	3	10	2	8	1	5		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Water. Surface.	Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
IV. FIRTH OF FORTH, 21st December 1888, 1.53 p.m.	E. 45·0 W. 46·0	43·9 43·0	43·8 5 faths. 43·1 6 faths.	Surface net — 1 or 2 *Sagittæ*, a few Medusidæ (*Beroe*). 1 *Idotea marina.* Bottom net — A number of *Sagittæ*, a few *Mysis*.	H. M. 1 22	Plaice,	8	14	5	12½	3	11	Fish in fairly good condition.	At beginning—Wind S.E. by S., force 8; weather cloudy; sea rough; barometer 29·11; transparency of water, disk just visible at $1\frac{3}{4}$ fathoms; state of tide. At finish—Wind S.E., force 8; weather cloudy (like rain); sea rough; barometer 29·10.; transparency of water about $1\frac{3}{4}$ fathoms; light variable airs; with strong N.E. swell, rolling up Bay; atmosphere fine and clear.
						,,	2	10	...	...	...	...		
						Long rough dabs,	1	8	...	...	...	...		
						Cod,	1	19½	1	11½	...	...		
						Whiting.	1	7	1	5	...	...		
I. ST ANDREWS BAY, 12th July 1888.	63·9	52·1	52·0		1 55	Thornback ray,	1	18	...	...	...	...	Inferior.	
						Plaice,	11	12	38	8	...	...		
						Common dabs,	7	11	19	7	...	...		
						Long rough dabs,	1	9	...	...	...	...		
						Haddocks,	2	21	53	11	...	...		
						Whitings,	4	14	39	12	...	...		
						Common gurnards,	6	8	...	...	...	...		
						Small angler,	1	...	...	...	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air.	Temperature. Water.		Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
II. St Andrews Bay, 12th July 1888, 1.25 p.m.	60·0	53·9	51·1		H. M. 1 55	Gray skate, . .	1	12	...	...	...	...	Inferior	Light variable airs; strong N.E. swell, rolling up Bay; atmosphere fine and clear.
						Thornback ray, .	3	15	...	...	...	...	,,	
						Plaice, . . .	39	14	36	9	114	6	,,	
						Common dabs, .	15	9	79	8	...	...	,,	
						Lemon dabs, . .	1	9	...	...	...	...	,,	
						Long rough, . .	2	9	...	...	...	...	,,	
						White flounders, .	2	9	...	...	...	...	,,	
						Haddocks, . .	1	21	110	11	...	...	,,	
						Whiting, . .	3	13	20	9½	...	...	,,	
						Common gurnards,	8	9	30	7	...	...	,,	
						Angler, . . .	2	...	...	...	...	...	,,	
III. St Andrews Bay, 13th July 1888, 10.15 a.m.	54·5	52·0	51·3		1 45	Thornback ray, .	1	13	...	...	...	...	Very good	Light westerly breeze; and cloudy sky, some rain; N.E. swell.
						Plaice, . . .	17	12½	35	8	...	...		
						Common dabs, .	11	9½	52	7½	...	...	,,	
						Long rough dabs, .	1	11	...	...	...	...	,,	
						White fluke, .	1	5½	...	...	...	...	,,	
						Turbot, . . .	1	15	...	...	...	...	,,	
						Haddocks, . .	386	10	...	...	...	...	,,	
						Whiting, . .	2	13	2	10	...	...	,,	
						Common gurnards,	22	13	16	8½	...	...	,,	
IV. St Andrews Bay, 13th July 1888, 0.45 p.m.	62·0	53·5	51·5		2 10	Thornback ray, .	3	15	3	19½	2	10½	,,	Light westerly breeze; N.E. swell; cloudy sky, some rain.
						Plaice, . . .	58	13½	246	10	...	...	,,	
						Common dabs, .	21	10	120	8½	...	...	,,	
						Haddocks, . .	47	11	...	...	...	...	,,	
						Whiting, . .	9	10½	...	...	...	...	,,	
						Common gurnards,	14	13	25	9½	...	...	,,	
						Angler, . . .	2	...	...	...	..	...	,,	

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulbs.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
V. St Andrews Bay, 13th July 1888, 5.15 p.m.	59·5	51·4	48·9		H. M. 1 45	Plaice, . . .	8	12	11	$8\frac{1}{2}$	...	...	Very good	Light variable airs, and cloudy sky; N.E. swell.
						Common dabs, .	11	$8\frac{1}{2}$	...	...	...	...	,,	
						Long rough dabs, .	4	9	...	...	...	...	,,	
						Haddocks, . .	53	10	...	...	...	...	,,	
						Whiting, . .	9	$12\frac{1}{2}$	90	$7\frac{1}{2}$	...	...	,,	
						Common gurnards,	13	12	10	9	...	...	,,	
I. St Andrews Bay, 16th August 1888, 3 p.m.	E. 53·0	52·8	52·4 11 faths.	Surface net — A great many Medusidæ and larval Crustaceans (Decapods), and also a few fish eggs, but no young fish.	1 50	Thornback ray, .	1	17	...	...	...	...	All more or less immature, and of inferior quality.	Weather fine and clear; wind E.N.E., with a force about 4; sea moderate; transparency of water, white disk ($9\frac{2}{3}$ inches diam.) visible at about $3\frac{1}{2}$ fathoms; tide, about low water at beginning of trawl.
	W. 54·0	54·0	53·8 8 faths.			Plaice, . . .	6	$13\frac{1}{2}$	25	$9\frac{1}{2}$	13	$7\frac{1}{2}$		
						Common dabs, .	1	$14\frac{1}{2}$	14	$8\frac{1}{2}$	15	$7\frac{1}{2}$		
						,, ,,	53	$6\frac{1}{2}$	3	6	1	5		
						Long rough dabs, .	2	$9\frac{1}{2}$	...	...	...	...		
						Haddocks, . .	1	11	1	10	1	9		
						Whiting, . .	2	9	...	...	...	...		
						Turbot, . . .	1	$15\frac{1}{2}$	...	...	...	...		
						Common gurnards,	1	$14\frac{1}{2}$	10	$11\frac{1}{2}$	2	8		
						,, ,,	3	$6\frac{1}{2}$	1	5	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Surface Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
II. St Andrews Bay, 16th August 1888, 5.15 p.m.	E. 53·75 W. 53·5	53·2 54·0	52·0 10 faths. 53·9 6½ faths.	Surface Fauna similar to Station I.	H. M. 2 0	Thornback ray,	1	19	1	16	2	15	All more or less immature, and of inferior quality.	Weather a little cloudy but fine—Wind E.N.E. with a force of about 4; sea moderate; tide about 2 hours flood at beginning of trawl; white disk (9⅜ inches diam.) visible at about 3½ fathoms.
						Plaice,	42	12	137	9	4	6		
						,,	2	5½	...	...	...	...		
						Common dabs,	12	9	194	7½	4	6		
						,, ,,	3	5	...	...	...	...		
						Lemon ,,	1	9	...	...	...	...		
						Long rough dabs,	2	11	...	...	...	...		
						Haddock,	1	15	3	11½	...	...		
						Whiting,	1	11½	...	...	...	...		
						Common gurnard,	16	12½	9	10½	7	9½		
						,, ,,	3	5	...	...	...	...		
						Monk,	1	15	...	...	...	...		
III. St Andrews Bay, 17th August 1888, 3.10 p.m.	E. 52·25 W. 52·5	53·9 54·0	53·0 11½ faths 53·8 6½ faths.	The tow nets, both surface and attached to trawl head, contained only a few Medusidæ and larval Decapods. No fish eggs or young fish were observed.	1 40	Thornback ray,	1	15	1	21	1	18	All except gurnards, more or less immature, and inferior in quality.	Weather fine, but a little cloudy and cold—Wind E. by N., force 4; sea moderate; tide, low water at finish of trawl; transparency similar to that of Stations IV. and V.
						,, ,,	1	12	...	...	...	...		
						Plaice,	15	13	88	10½	...	...		
						Common dabs,	22	9	161	7	...	...		
						Long rough dabs,	1	10	...	...	...	...		
						Haddock,	128	11	22	8½	...	...		
						Whiting,	1	9½	...	...	...	...		
						Common gurnard,	63	14	20	8	2	7½		
						Monk,	1	17	1	9	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Surface Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
IV. St Andrews Bay, 17th August 1888, 1.0 p.m.	E. 57·25	53·4	53·0 12 faths.	Organisms taken by surface tow-net as well as by tow net fixed to trawl head, were as far as could be made out small Medusidæ and larval Decapods, both being abundant.	H. M. 1 45	Thornback ray,	2	17	2	18	...	...	All except the gurnards more or less immature, and inferior in quality.	Weather fine, a little cloudy—Wind N.E., force about 5; sea moderate; tide about 2½ hours ebb at beginning of trawl; transparency of water similar to Station V.
	W. 52·5	54·0	53·9 6 faths.			Plaice,	38	14	150	9½	1	7		
						,,	2	6½	...	...	...	...		
						Common dabs,	28	9	193	7	1	5½		
						White fluke,	1	7½	...	...	...	...		
						Turbot,	1	15	...	...	...	...		
						Haddock,	10	11	2	9	...	...		
						Whiting,	1	13	...	...	...	...		
						Common gurnards,	66	13	11	9	...	...		
						Monk,	1	15	1	16	1	18		
V. St Andrews Bay, 17th August 1888, 10.40 a.m.	S. 51·0	53·3	52·4 14½ faths	Surface net—A great many Medusidæ, but little else. Bottom net—A number of small Medusidæ, very young Lump-suckers (*Cyclopterus lumpus*), and a few Calanidæ.	1 50	Gray skate,	1	14	...	...	...	...	All the fish more or less immature, and inferior in quality.	Weather fine, a little cloudy—Wind N.E., force about 5; sea moderate; tide about high water at beginning of trawl; white disk (9⅜ inch. diam.) just visible at about 3½ fathoms.
	N. 51·0	53·2	52·8 13 faths.			Starry ray,	1	6	...	...	...	...		
						Plaice,	1	14	31	12	69	9		
						,,	1	8	1	7	...	...		
						Common dabs,	5	10	30	7½	12	7		
						,, ,,	8	5½	...	...	...	...		
						Lemon ,,	1	9	1	8	1	7		
						Long rough dabs,	5	10	2	8	...	...		
						Haddock,	11	10½	...	...	...	...		
						Whiting,	1	11	1	10	...	...		
						Common gurnards,	17	13	6	9	1	7		
						,, ,,	1	5	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
I. St Andrews Bay, 18th September 1888, 1.35 p.m.	E. 59·0	54·4	52·0 17 faths.	Surface net—Young (larval) Decapods plentiful, and fish appear to be feeding on them, 1 *Gasterosteus aculeatus*, var., 1 very young *Cyclopterus lumpus*, a number of *Pleurobrachia*, 1 *Sagitta* and a few Amphipods. Bottom net—A few Calanidæ (*Calanus*, *Temora*), a few *Caligus*, 1 sea spider (*Pallene*), a few *Sagittæ* and *Pleurobrachia* and other small Medusidæ, but organisms comparatively few in number.	H. M. 2 10	Thornback ray, .	1	21	1	17	2	14	Fish more or less immature.	At commencement—Wind light, south, variable; weather clear, fine; sea smooth; transparency of water, (disk $8\frac{3}{8}$ inch. diam.) just visible at 5 fathoms. At finish—Wind S. by E., light; weather and sea as above; transparency of water, disk just visible at 5 fathoms; tide fully 2 hours ebb at finish.
	W. 58·5	54·8	52·2 $9\frac{1}{2}$ faths.			Plaice, . . .	1	26	8	15	39	12		
						,, . . .	67	8	...	...	...	...		
						Common dabs, .	12	$13\frac{1}{2}$	20	$10\frac{1}{2}$	221	7		
						,, ,, .	14	5	...	...	...	...		
						Long rough dabs, .	9	10	8	$8\frac{1}{2}$	...	...		
						Haddock, . .	2	$9\frac{1}{2}$	...	...	...	...		
						Whiting, . .	1	$9\frac{1}{2}$	...	...	...	...		
						Common gurnards,	13	14	16	9	6	7		
						,, ,,	4	6	...	...	...	...		
						Monk or angler, .	1	15	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
II. St Andrews Bay, 18th September 1888, 11.30 a.m.	E. 59·0 W. 58·5	54·0 53·8	52·3 15½ fathoms. 52·2 10¼ fathoms.	Surface net—A good many very young Decapod Crustacean, 1 very young gurnard, 1 or 2 very young *Syngnathus acus*, and a few *Sagittæ* and Calanidæ. Bottom net—A number of calanidæ (*Calanus*, *Pseudocalanus*, *Temora*), a few *Sagittæ*, *Pleurobrachia*, *Geryonopsis*, Amphipods and very young Decapods. No fish eggs.	H. M. 1 45	Thornback ray, .	1	18	1	14	2	13	Fish mostly immature.	At beginning—Wind E. light, variable; sea smooth; weather clear, fine; transparency of water, disk (9⅜ inch. diam.) just visible at 5 fathoms. At finish—Wind, weather, and sea as above; transparency also the same; tide, high water at finish.
						Plaice, . . .	1	17	3	14½	12	12		
						"	21	8½	5	7	...	...		
						Common dabs, .	24	9	31	8	27	6½		
						" " .	5	5½	2	4	...	...		
						Long rough dabs, .	1	12½	3	10	...	...		
						Whiting, . .	1	10	1	7	...	...		
						Common gurnards,	1	12	...	...	...	...		
						Dragonet, . .	1	8	...	...	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued*.

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
III. St Andrews Bay, 18th September 1888, 6.55 a.m.	W. 51·0	53·0	52·4 9 faths.	Surface net — A number of very young Decapods, Crustacea, and Medusidæ, a few Calanidæ (*Calanus*, *Temora*, &c.) and *Sagittæ*; organisms comparatively few. Bottom net—A good many Calanidæ (*Temora* mostly), one or two Cumacea (*Pseudocuma*), a few very young fish (Gadidæ ?), very young Decapods (*Brachyura* and *Anomura*), a few *Tomopteris* and *Sagittæ*; no fish eggs.	H. M. 1 40	Plaice, . . .	18	$12\frac{1}{2}$	85	10	57	7	Fish nearly all immature.	At beginning—Wind W. by N., light; weather, clear, fine; sea smooth; transparency disk ($9\frac{3}{8}$ inch diam.) just visible at 4 fathoms; tide, about low water. At finish — Wind, weather, and sea as above; transparency, disk just visible at $4\frac{1}{2}$ fathoms; bottom, sandy, clean.
	E. 55·0	53·0	52·2 $12\frac{1}{2}$ faths			Common dabs, .	28	10	256	7	8	6		
						" " .	3	$5\frac{1}{2}$	2	4	...	...		
						Long rough dabs, .	1	$10\frac{1}{2}$	...	...	...	...		
						Turbot, . . .	1	$13\frac{1}{2}$	...	...	...	...		
						Whiting, . .	1	15	2	9	...	...		
						Common gurnards,	21	$15\frac{1}{2}$	8	10	3	$8\frac{1}{2}$		
						" "	2	5	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and young fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
IV. St Andrews Bay, 18th September 1888, 9.20 a.m.	E. 56·0	54·0	52·5 9½ faths.	Surface net—Several *Eurydice pulchra*, a number of very young Decapod Crustacea, several young *Syngnathus acus*, and some Calanidæ. Bottom net—A good many Medusidæ (*Pleurobrachia*), a few very young fish (Gadidæ?), *Sagitta*, and Calanidæ.	H. M. 1 40	Thornback ray,	2	22	2	20	...	...	Fish rather immature.	At beginning—Wind W. by N., light, variable; weather, fine, clear; sea smooth; transparency of water, disk (9⅜ inch diam.) just visible at 3 fathoms; tide about two hours flood. At finish — Wind, weather, and sea similar to above; transparency of water, disk just visible at 5 fathoms.
	W. 59·0	54·6	52·9 5½ faths.			Plaice,	15	14	26	11½	88	9½		
						,,	77	8	13	6	...	...		
						Common dabs,	23	11	46	8	3	5½		
						Sand flukes,	1	15½	...	...	...	...		
						Whiting,	1	7½	...	...	...	...		
						Common gurnards,	2	15	4	14	2	11½		
						,, ,,	5	9½	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
V. ST ANDREWS BAY, 17th September 1888, 4.15 p.m.	S. 59·0 N. 57·0	54·0 53·9	52·1 13 faths. 52·2 13½ faths	Surface net — A good many very young Decapods, belonging to two distinct species, a young *Syngnathus acus*, a few young Gadidæ, a number of *Sagittæ* and Medusidæ, and a few Calanidæ (*Temora*, &c.) Bottom net—Very few organisms; principally *Sagittæ* and Medusidæ.	H. M. 1 45	Plaice,	24	14	57	10½	30	9	All immature.	At beginning — The wind was west, force about 4; sea moderate; weather, fine, clear; temperature of air was rather higher than it has been observed for some time; transparency of water, white disk (9⅜ inch diam.) just visible at 5 fathoms. At finish—Wind, west, force 3; weather, fine; sea smooth; transparency of water, disk just visible at 5 fathoms; bottom, sandy, clean.
						,,	4	7½	...	...	...	...		
						Common dabs,	11	5	243	6½	24	9		
						Lemon dabs,	1	14	1	10	2	9		
						Long rough dabs,	2	12	1	10½	2	9		
						Haddocks,	5	11½	20	10	6	8		
						Whiting,	5	11	7	9½	2	7		
						Common gurnards,	5	14	7	11	2	7		

Table C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued*.

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
I. St Andrews Bay, 17th October 1888, 12.20 p.m.	W. 50·0 E. 57·0	49·0 49·0	48·3 11 faths. 49·5 12 faths.	Surface net — A few Medusidæ, Calanidæ and very young Decapod Crustacean, 1 very young fish. Bottom net — Some Medusidæ, *Caligi*, Calanidæ (*Calanus*, *Temora*), a few Amphipods, *Sagittæ*, 1 or 2 young fish (sand-eels or herrings ?).	H. M. 1 50	Thornback ray,	1	7	...	...	...	...		At beginning—Wind S.E. by E., force 2; weather hazy; sea smooth; tide, 5 hours flood; transparency of water, disk (24 inch diam.) just visible at 4½ fathoms. At finish — Wind south, force 2; weather as above; sea smooth; transparency of water, disk just visible at 4 fathoms.
						Plaice,	1	15	13	14	20	12		
						,,	30	11	11	9	1	8		
						Common dabs,	5	11½	6	10	6	9		
						Common gurnards,	1	15½	1	12	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
II. St Andrews Bay, 17th October 1888, 7.15 a.m.	W. 44·6	48·7	49·2 7½ faths.	Surface net — A number of very young Decapod Crustacea and Calanidæ (*Temora*, *Calanus*), a few *Pleurobrachia* and *Tomopteris*. Bottom net — A good number of Calanidæ, *Sagitta*, *Caligus*, a few Medusidæ (*Pleurobrachia* and *Bolina*), a small *Solis*, 2 *Ophiura albida*, and a few *Tomopteris*; organisms not very abundant in tow nets.	H. M. 2 15	Thornback ray,	1	13	1	7	...	...		At beginning—Wind N.W. by N., force 2; weather cloudy; sea smooth; tide, low water; transparency of water, disk (24 inch diam.) just visible at 4 fathoms. At finish—Wind E. force 1; weather, cloudy but fine; sea smooth; transparency of water, disk just visible at 5 fathoms.
	E. 49·5	49·0	49·8 12 faths.			Plaice,	12	15	26	14	25	11		
						,,	23	10	3	8	...	...		
						Common dabs,	5	12½	7	11	12	8		
						,, ,,	11	10	...	...	...	...		
						Lemon ,,	1	9	...	...	...	...		
						Long rough ,,	2	10	...	...	...	...		
						Turbot,	1	15	1	16	...	...		
						Haddock,	1	15½	...	...	...	...		
						Whiting,	1	8½	...	...	...	...		
						Gommon gurnards,	8	13½	4	12	1	9½		
						Monk or angler,	1	9	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
III. St Andrews Bay, 17th October 1888, 10 a.m.	E. 50·0	48·5	49·5 13 faths.	Surface net — A few *Eurydice pulchra*, 1 *Idotea marina*, a few very small Decapods, Calanidæ, and Medusidæ, 1 young fish (sand-eel or herring ?), 1 or 2 Amphipods. Bottom net — A considerable number of Medusidæ, a few young fishes (sand-eels or herrings ?), a few *Sagittæ* and *Caligi*, 1 *Ophiura albida*.	H. M. 1 50	Thornback ray, .	2	14½	1	7½	...	...	Fish rather immature, quality scarcely average.	At beginning—Wind S.E., force 2; weather cloudy, but fine; sea smooth; tide, about 2¾ hours flood; transparency of water, disk (24 inch diam.) just visible at 5 fathoms. At finish — Wind, weather, sea, and transparency of water as above.
	W. 50·0	48·4	49·0			Plaice, . . .	17	14½	59	13½	61	11		
						,, . . .	83	9½	16	8½	...	...		
						Common dabs, .	12	11	1	13	13	10		
						,, ,, .	7	9	13	8	3	6		
						,, ,, .	4	5	...	...	...	...		
						Long rough ,, .	1	10	...	...	...	...		
						Turbot, . . .	1	16	1	14½	...	...		
						Common gurnards,	1	15	1	13½	1	12		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued*.

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
IV. St Andrews Bay, 16th October 1888, 4.50 p.m.	E. 51·0 W. 51·8	48·6 48·8	49·0 12 faths. 49·0 7 faths.	Surface net — A good many Medusidæ, a few *Eurydice pulchra*, but not much else. Bottom net — A good many Medusidæ, a number of young fish (sand-eels or young herring?), some *Sagittæ*, but little else.	H. M. 1 10	Plaice,	49	13	141	$10\frac{1}{2}$	37	9	Fish immature and quality scarcely average.	At beginning—Wind W. by N. ½ N., force 3; sea moderate; weather overcast, hazy; transparency of water, disk (24 inch.) diam. just visible at 4 fathoms; tide 4¼ hours ebb. At finish — Wind and sea as above; weather dull, inclining to rain, too dark to take transparency.
						,,	6	7	...	...	...	...		
						Common dabs,	1	12	5	$10\frac{1}{2}$	7	$8\frac{1}{2}$		
						,, ,,	1	6	...	...	...	...		
						Lemon ,,	1	13	1	12	...	...		
						Whiting,	2	14	2	10	...	...		
						Sprats,	2	$3\frac{3}{4}$	...	...	...	...		
						Common gurnards,	2	13	1	$11\frac{1}{2}$	...	...		
						Monk or angler,	1	11	...	...	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
V. St Andrews Bay, 16th October 1888, 3 p.m.	S. 51·8	48·8	49·8 14 faths.	Surface net—A good number of Medusidæ (*Pleurobrachia*) and one or two *Eurydice pulchra*, but apparently nothing else. Bottom net—A considerable number of Medusidæ and a good many young fishes (sand-eels or herring?), one Amphipod (*Anonyx Edwardsii*), but there appeared to be nothing else.	H. M. 1 15	Plaice, . . .	4	13½	7	11½	...	...	Fish of fairly good quality, but immature.	At beginning—Wind W.N.W., force 4; sea moderate; weather overcast; tide 2½ hours ebb; transparency of water, disk (24 inch diam.) just visible at 4 fathoms. At finish — Wind W.N.W., force 3; sea moderate; weather overcast, dull; tide about 3¾ hours ebb; transparency disk just visible at 3½ fathoms.
	N. 51	49·0	49½ 14 faths.			Common dabs, .	12	9½	44	8	42	7		
						" " .	10	6	3	5½	1	4½		
						Long rough dabs, .	2	11	2	9	2	8		
						Haddock, . .	1	20½	1	19	2	18		
						" . .	22	13	27	11½	8	10		
						Cod, . . .	1	13	1	11½	...	...		
						Whiting, . .	9	11½	1	12½	1	14		
						" . . .	2	9½	...	...	...	...		
						Common gurnards,	1	15	1	13	3	12		
						" "	3	9	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued*.

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.		H. M.		No.	Inches	No.	Inches	No.	Inches		
I. ST ANDREWS BAY, 19th December 1888, 11.10 a.m.	W. 45·5	45·0	46·0 7½ faths.	Surface net—A number of Medusidæ and *Parathemisto*, a few *Sagittæ* and *Calanus*. Bottom net — A considerable number of *Sagittæ*, a few Medusidæ, *Calanus*, and *Parathemisto*, *Caligi*, *Tomopteris*, *Mysis* (*ornatus* and *spiritus*), and *Nyctiphanes*.	1 15	Starry ray,	1	8	...	...	...	...	Good quality.	At beginning—Wind S.S.E., force 5; weather, hazy; sea, moderate; barometer 29·67; transparency of water, disk just visible at 4½ fathoms; state of tide, about two hours flood. At finish — Wind S.E., force 6; weather cloudy; sea moderate; barometer 29·62+; transparency of water about 3 fathoms.
	E. 46·5	45·4	46·6 10½ faths			Common dabs	1	15	2	12½	3	7½		
						,, ,,	1	10	2	6½	...	...		
						Long rough dabs,	1	8½	...	...	...	...		
						Common gurnards,	1	15	...	...	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Size of Fish. Inches	Size of Fish. No.	Size of Fish. Inches	Size of Fish. No.	Size of Fish. Inches	Condition of Fish.	Wind, Weather, and other Observations.
II. St Andrews Bay, 19th December 1888, 8.40 a.m.	E. 44·3 W. 46·0	45·1 44·9	46·0 11 faths. 45·5 7½ faths.	Surface net—*Sagittæ*, numerous, a few Medusidæ, *Parathemisto*, *Calanus*, a few small *Telena fabula* (dead), 1 *Metopa* sp. Bottom net—A number of *Sagittæ* and Medusidæ (not so many as in surface net), a few *Parathemisto*, *Caligi*, *Calanus*, *Tomopteris*, *Mysis ornatus*, and *M. spiritus*.	H. M. 2 3	Starry ray,	1	9	...	...	...	...	Of average quality.	At beginning—Wind S.S.E., force 5; weather hazy; sea moderate; barometer 29·74; transparency of water, disk just visible at 3 fathoms; state of tide, near low water. At finish—Wind S.S.E., force 4; weather hazy; sea smooth; barometer 29·69; transparency, 3¾ fathoms.
						Plaice,	1	14½	...	...	...	...		
						Common dabs,	3	10	1	8	...	...		
						,, ,,	3	5	2	6½	1	4½		
						Long rough dabs,	1	11½	...	...	...	...		
						Whiting,	1	10	1	8½	3	7		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
III. St Andrews Bay, 19th December 1888, 6.30 a.m.	W. 43·5	44·8	45·3 9 faths.	Surface net—A number of *Sagittæ*, Medusidæ (*Sarsi*, &c.), *Parathemisto*, and *Calanus*, a few *Tomopteris*, *Caligi*, 1 young fish (herring or sprat), *Idotea marina*, 1 *Metopa* sp. Bottom net—Sagitta (numerous), medusids (numerous), a number of *Mysis ornatus* and *M. spiritus*, and *Parathemisto*, a few *Calanus*, *Tomopteris*, young fish (herring or sprats); organisms more numerous in bottom than in surface net.	H. M. 1 40	Starry ray, . .	1	11	...	...	...	...	Fish of average quality.	At beginning—Wind S.E., force 4; weather hazy; sea smooth: barometer 29·78; state of tide, about 3½ hours ebb. At finish—Wind S.S.E., force 5; weather hazy; sea moderate; barometer 29·75; transparency of water, disk just visible at 2¾ fathoms.
	E. 44·2	44·9	45·3 11½ faths			Plaice, . . .	1	17	1	15½	1	13½		
						Common dabs, .	1	11	2	9	2	8		
						" " .	2	6½	4	5½	3	5		
						" " .	2	4	...	...	...	..		
						Long rough dabs,	1	13	2	11	1	9½		
						" " .	1	7	...	...	...	...		
						Whiting, . .	3	12	4	10½	10	9		
						" . .	6	8	...	...	..	...		
						Cod, . . .	3	11	2	10½	...	...		
						Haddocks, . .	17	13	13	12	1	10		
						" . .	2	18	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
IV. ST ANDREWS BAY, 18th December 1888, 3.17 p.m.	E. 43·0 W. 42·7	44·9 45·0	45·5 10 faths. 45·9 7 faths.	Surface net—A number of *Sagittæ*, Medusidæ, and *Parathemisto*. Bottom net—A good many *Sagittæ* and Medusids, a number of *Parathemisto*, a few *Mysis ornata*, 1 *Pseudocuma cercaria*, 1 *Diastylis*. No fish-eggs or young fish.	H. M. 1 48	Starry ray, . .	1	12	...	...	...	...	Of average quality.	At beginning—Wind W. by N., force 2; weather hazy; sea smooth; barometer 30·04; state of tide, about 1 hour ebb; transparency of water, disk just visible at $2\frac{1}{2}$ fathoms. At finish—Wind, weather, sea as above; barometer 30.
						Plaice, . . .	10	$14\frac{1}{2}$	3	13	...	...		
						Common dabs, .	2	$4\frac{1}{2}$	...	...	...	...		
						Whiting, . .	1	10	2	$8\frac{1}{2}$	1	$5\frac{1}{2}$		
						,, . .	1	$3\frac{1}{2}$	...	...	..	...		
						Red gurnard, . .	1	$10\frac{1}{2}$	...	...	...	...		

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
V. St Andrews Bay, 18th December 1888, 1.15 p.m.	S. 43·0	45·8	46·1 13 faths.	Surface net—A number of *Sagittæ*, Medusidæ, *Calanus finmarchicus*, *Tomopteris*, and a few *Parathemisto oblivia* and *Caligi*. Bottom net—Similar to those taken in surface net, but rather more numerous. Comparatively few organisms were taken either in surface or bottom nets.	H. M. 1 35	Common dabs .	3	8	2	6	2	7		At beginning—Weather hazy; wind W. by N., force 3; sea smooth; barometer 30·09; transparency of water, disk just visible at 4½ fathoms; state of tide, about 5 hours flood. At finish — Wind W. by N., force 2; weather and sea as above; barometer 30·05; transparency of water, 2½ fathoms.
	N. 43·5	45·0	46·6 13 faths.			Long rough dabs, .	1	10	1	8	...	...		
						Haddock, . .	1	11	1	8½	...	...		
						Cod, . . .	1	14½	...	...	...	...		
						Whiting, . .		10	1	9	...	...		
						Common gurnards,	1	9	...	...	...	...		

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No	Inches		
I. Montrose, 30th July 1888, 1.40 p.m.	52·9	52·0	52·0		H. M. 1 10	Thornback ray,	1	17½	...	...	...	...	Good.	Moderate gale; N.E. with strong sea; ship rolling and shipping water; dull heavy sky.
						Plaice,	3	11	3	8½	3	7½	„	
						Common dabs,	16	8	4	5	...	...	„	
						Soles,	1	12½	...	...	...	...	„	
						Gurnard,	1	10	1	6½	...	...	„	
						Angler,	1	5½	...	...	...	...	„	
II. Montrose, 30th July 1888, 11.40 a.m.	51·9	52·3	52·2		1 5	Thornback ray,	1	20	1	15	...	...	„	Strong N.E. breeze and sea; ship rolling; dull cloudy sky.
						Plaice,	2	18	8	16	16	13	„	
						Common dabs,	13	8	17	6½	2	5½	„	
						Long roughs,	1	9	...	...	...	...	„	
						Haddocks,	20	12	31	10	...	...	„	
						Whitings,	5	12	...	...	...	...	„	
						Common gurnards,	10	12	28	9½	5	7	„	
I. Aberdeen Bay, 18th July 1888, 9.30 a.m.	58·0	51·5	51·0		1 45	Plaice,	31	13	8	9	...	...	„	Fresh breeze, with strong E.N.E. sea; trawl jumping over bottom; ship rolling heavily.
						Common dabs,	8	10½	48	7	...	...	„	
						Whiting,	1	14	3	10½	...	...	„	
						Common gurnards,	24	10	30	7½	...	...	„	
						Angler,	1	...	...	...	...	...	„	

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Water. Surface.	Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
II. Aberdeen Bay, 18th July 1888, 11.25 a.m.	55·0	51·8	50·9		1 10	Thornback ray, .	1	9	...	...	...	...	Inferior.	Fresh breeze, and strong E.N.E. sea; ship rolling; trawl jumping over bottom; sky clearing up.
						Plaice, . . .	9	12	3	10½	...	...	,,	
						Common dabs, .	20	8	...	...	...	...	,,	
						Long rough dabs, .	1	12	6	8	...	...	,,	
						Haddocks, . .	1	15	1	9	...	...	,,	
						Whitings, . .	2	9½	2	7½	...	...	,,	
						Common gurnards,	9	11	27	8½	...	...	,,	
III. Aberdeen Bay, 18th July 1888, 0.55 p.m.	55·5	52·0	51·0		1 25	Plaice, . . .	8	13	3	9	...	...	Good.	Fresh breeze N.E.; strong E.N.E. sea; ship rolling; trawl jumping over bottom; sky fine and clear.
						Common dabs, .	9	7	...	...	...	...	,,	
						Haddocks, . .	1	10½	...	...	...	...	,,	
						Whiting, . .	6	9	...	...	...	...	,,	
						Common gurnards,	13	10	35	8½	...	...	,,	
IV. Aberdeen Bay, 18th July 1888, 2.55 p.m.	58·0	52·4	51·2		1 15	Plaice, . . .	3	13	4	10	...	..	,,	Light breeze N.E.; strong E.N.E. sea; ship rolling; trawl jumping over bottom; sky clear.
						Common dabs .	6	8	...	...	...	...	,,	
						Sand fluke, , .	1	17	...	...	...	...	,,	
						Haddocks, . .	1	11	...	...	...	...	,,	
						Whiting, . .	4	7½	...	...	...	...	,,	
						Common gurnards,	1	14	20	9	...	...	,,	

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' ON THE EAST COAST—*continued.*

Station, Date, and Time when Trawl let down.	Temperature.			Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish.						Condition of Fish.	Wind, Weather, and other Observations.
	Air.	Water.												
	Dry Bulb.	Surface.	Bottom.				No.	Inches	No.	Inches	No.	Inches		
V. ABERDEEN BAY, 17th July 1888, 2.45 p.m.	53·5	57·0	50·8	.	H. M. 2 15	Plaice,	3	12	4	9	...	...	Inferior.	Blowing fresh from E.N.E. with high sea; trawl jumping over bottom; ship rolling and shipping a lot of water.
						Common dabs,	1	9	18	7	...	...	,,	
						Lemon soles,	1	12	...	...	...	...	,,	
						Long rough dabs,	2	8	...	...	...	...	,,	
						Gurnard,	9	9	21	8	...	...	,,	
						Angler,	1	...	...	...	...	...	,,	
VI. ABERDEEN BAY, 18th July 1888, 4.55 p.m.	59·0	52·6	51·1		1 40	Gray skate,	1	18	...	...	...	...	Good.	Light northerly breeze N.; clear sky; strong E.N.E. sea; ship rolling; trawl jumping over bottom.
						Plaice,	6	14	1	6½	...	...	,,	
						Common dabs,	6	7½	...	...	...	...	,,	
						Long rough dabs,	1	9½	...	...	...	...	,,	
						Common gurnards,	7	9	...	...	...	...	,,	
CRUDEN BAY, 19th July 1888, 3.30 p.m.	63·0	53·0	51·2		2 20	Sandy ray,	1	14	2	8	...	...	,,	Weather fine and clear; light variable airs; easterly swell; ship rolling.
						Plaice,	12	14½	4	14	2	10½	,,	
						Common dabs,	20	8	11	7½	...	...	,,	
						Haddocks,	13	13	6	10	...	...	,,	
						Codling,	1	10	1	12	...	...	,,	
						Whiting,	2	12	...	...	...	...	,,	
						Common gurnards,	1	14	30	9½	28	8½	,,	

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Size of Fish. Inches	Size of Fish. No.	Size of Fish. Inches	Size of Fish. No.	Size of Fish. Inches	Condition of Fish.	Wind, Weather, and other Observations.
I. Moray Firth, 29th May 1888, 11.45 a.m.	50·9	49·5	44·0		H. M. 2 0	Grey skate,	1	9	...	...	...	...	Good.	Strong breeze and cloudy, with S.E. sea coming away.
						Plaice,	6	14	7	10	...	...	,,	
						Common dabs,	7	9	...	...	...	...	,,	
						Lemon dabs,	1	14	5	8	...	...	,,	
						Long rough dabs,	61	9	...	...	...	...	,,	
						Witch soles,	12	18	29	14	30	10	,,	
						Haddocks,	2	16	7	9	...	...	,,	
						Small codling,	1	8	...	...	...	...	,,	
						Whiting,	5	10	...	...	...	...	,,	
						Common gurnards,	23	9	...	...	...	...	,,	
						Angler,	3	...	...	...	...	...	,,	
II. Moray Firth, 29th May 1888, 2.15 p.m.	43·5	48·5	45·4		2 15	Plaice,	7	11	6	10	...	...	,,	Blowing strong from S.E.; squally with rain; strong sea; shipping a lot of water.
						Common dabs,	7	8	10	6	10	5	,,	
						Lemon dabs,	5	8	...	...	...	...	,,	
						Long rough dabs,	39	9	30	8	...	...	,,	
						Witch soles,	68	17	16	12	16	10	,,	
						Haddocks,	37	12	...	...	...	...	,,	
						Cod,	1	32	...	...	...	...	,,	
						Whiting,	22	13	10	10	10	8	,,	
						Hake,	1	16	3	11	...	...	,,	
						Common gurnards,	5	14	12	9	...	...	,,	
						Large quantity common star fish,								

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued.*

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Size of Fish. Inches	Size of Fish. No.	Size of Fish. Inches	Size of Fish. No.	Size of Fish. Inches	Condition of Fish.	Wind, Weather, and other Observations.
III. Cromarty Firth, 26th May 1888, 10.40 a.m.	50·0	49·3	49·2		H. M. 1 50	Thornback ray,	1	25	...	...	...	...	Inferior.	Light N.E. breeze; smooth sea and cloudy sky.
						Plaice,	5	18½	15	11	...	..	,,	
						Lemon dabs,	5	10½	...	...	...	...	,,	
						White flounder,	1	9	...	...	...	...	,,	
						Cod,	2	27½	...	...	...	...	,,	
IV. Dornoch Firth, 25th May 1888, 10.20 a.m.	51·9	49·5	49·3		2 25	Thornback ray,	3	19	...	...	...	...	Good.	N.E. by N.; fresh breeze and cloudy; sea moderate.
						Plaice,	3	20	4	8	18	6	,,	
						Common dabs,	6	9	12	7	...	...	,,	
						Common gurnards,	3	11	56	8	...	...	,,	
V. Dornoch Firth, 25th May 1888, 2 p.m.	51·0	48·8	44·1		2 15	Plaice,	4	19	8	13	...	...	,,	N.E. strong breeze; rough sea; wind and sea increasing; cloudy overcast sky.
						Common dabs,	7	11	135	8	...	...	,,	
						Lemon dabs,	2	13	10	9	...	...	,,	
						Long rough dabs,	2	9	...	...	...	...	,,	
						Witch soles,	1	19	...	...	...	...	,,	
						Haddocks,	1	16½	61	11	...	...	,,	
						Small cod,	1	7½	...	...	...	...	,,	
						Whitings,	7	13	36	10	...	...	,,	
						Common gurnards,	2	16	121	11	...	...	,,	

TABLE C.—Record of Observations made on Board the 'Garland' on the East Coast—*continued*.

Station, Date, and Time when Trawl let down.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Pelagic Fauna, Spawn, and young Fish.	Time Trawl down.	Description of Take.	Size of Fish. No.	Inches	No.	Inches	No.	Inches	Condition of Fish.	Wind, Weather, and other Observations.
V. Inverness Firth, 21st May 1888, 8.50 a.m.	53·2	51·7	46·5		H. M. 1 50	Plaice, . . .	18	9½	76	7½	...	...	Inferior.	N.E. fine; sea smooth.
						Common dabs, .	1	8	...	...	...	...	,,	
						,, ,, .	4	6	...	...	...	...	,,	
VI Dornoch Firth, 25th May 1888, 8.15 a.m.	50·0	49·3	49·0		1 30	Thornback ray, .	1	18	...	...	...	...	Good.	N.E. by N.; fresh breeze and cloudy; sea moderate.
						Plaice, . . .	2	24	3	16	...	...	,,	
						Common dabs, .	3	8	4	5	...	...	,,	
						Lemon dabs, . .	2	16½	...	...	...	...	,,	
						Haddocks, . .	5	15	16	12	14	9½	,,	
						Small cod, . .	2	7½	...	...	...	...	,,	
						Whiting, . .	10	13	35	9	...	...	,,	
						Common gurnards,	4	16	9	9	...	...	,,	
						1 angler fish, . .	...	...	...	...	...	...	,,	

TABLE D.—ANSTRUTHER DISTRICT—BUCKHAVEN HADDOCK AND COD LINE FISHING—YEARS 1887–88.

MONTHS.	1887.								1888.							
	Number of Days Boats were out per Month.	Total Number of Shots per Month.	Haddocks and Whitings.		Number of Cod.	Average Number of Fish per Shot.			Number of Days Boats were out per Month.	Total Number of Shots per Month.	Haddocks and Whitings.		Number of Cod.	Average Number of Fish per Shot.		
						Haddocks and Whitings.		Cod.						Haddocks and Whitings.		Cod.
			100's of Large.	100's of Small.		Large.	Small.				100's of Large.	100's of Small.		Large.	Small.	
January, . .	17	148	40¾	58	348	35·2	50·1	2·28	24	243	64¼	455	153	33·8	239·6	0·62
February, . .	18	144	23½	39½	143	20·8	35·1	0·99	21	202	–	276½	93	–	175·2	0·46
March, . . .	24	373	73¼	74	152	25·1	25·3	0·40	20	240	33⅛	283	167	17·6	150·9	0·69
April, . . .	25	835	598½	87	172	91·7	13·3	0·20	22	596	181	895	168	38·8	192·2	0·28
May, . . .	26	790	393	98½	85	63·6	15·9	0·10	25	566	87½	1257	106	19·7	284·2	0·18
June, . . .	26	569	433	984	124	97·4	221·3	0·21	26	382	165	1166	99	55·2	390·7	0·25
July, . . .	26	497	157½	1595	130	40·5	410·7	0·26	24	339	194	1014	71	73·2	382·8	0·20
August, . .	26	391	69½	1332	113	22·7	436·0	0·29	26	321	219	820	60	87·3	326·9	0·18
September, . .	25	547	88½	1814½	81	20·7	424·6	0·14	25	504	325	1148	91	82·5	291·5	0·18
October, . .	26	977	131	2685	199	17·1	351·7	0·20	25	983	764	1984	292	99·4	258·3	0·29
November, . .	22	605	56¼	987	157	11·9	208·8	0·26	16	458	261	279	352	72·9	77·9	0·76
December, . .	23	394	35½	480	200	11·5	155·9	0·50	25	714	422½	325½	852	75·7	58·3	1·19
Totals for Year,	284	6270	2100¼	10234½	1904	42·8	208·9	0·23	279	5548	2716⅜	9903	2504	62·6	228·4	0·45

Note.—'Large' fish are Haddocks only; 'Small' includes Whitings and (principally) Small Haddocks. One hundred fish is 32 warp or 128 fish. The total number of shots per month is ascertained by adding together the number of boats out each day.

TABLE E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats.

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock.	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of White Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of Shell Fish.	Total Value.
		cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s.	100s	cwt.	£
	Leith District.																								
1888 Jan.	I. By net and line boats,	8748	7985	–	–	1577	139	–	26	13,346	1065	2	6	–	404	18	129	1016	90	1184	2704	–	261	57	10,787
	II. By steam beam trawl boats, . .	–	–	–	–	678	27	–	29	3,457	817	48	1	176	458	6	61	1124	–	–	–	–	–	–	2,963
	Total, .	8748	7985	–	–	2255	166	–	55	16,803	1882	50	7	176	862	24	190	2140	90	1184	2704	–	261	57	13,750
Feb.	I. By net and line boats,	8138	640	–	–	1376	91	–	21	13,528	1541	9	15½	–	442	31	151	1095	60	1730	2144	–	287	42	8,556
	II. By steam beam trawl boats, . .	–	–	–	–	516	32	–	16	2,315	799	29	2	152	241	5	40	865	–	–	–	–	–	–	2,009
	Total, .	8138	640	–	–	1892	123	–	37	15,843	2340	38	17½	152	683	36	191	1960	60	1730	2144	–	287	42	10,565
March.	I. By net and line boats,	4171	–	–	–	1236	47	–	36	5,831	579	21	11	1	277	5	135	962	54	1972	2550	–	64	93	6,157
	II. By steam beam trawl boats, . .	–	–	–	–	1137	32	–	12	1,823	426	34	1	85	284	4	87	414	–	–	–	–	–	–	2,326
	Total, .	4171	–	–	–	2373	79	–	48	7,654	1005	55	12	86	561	9	222	1376	54	1972	2550	–	64	93	8,483
April.	I. By net and line boats,	195	–	–	–	3420	182	–	361	7,040	602	31	82	–	246	5	278	1240	50	1806	1985	–	153	116	7,152
	II. By steam beam trawl boats, . .	–	–	–	–	1336	25	–	28	681	361	27	–	63	121	2	44	211	–	–	–	–	–	–	1,377
	Total, .	195	–	–	–	4756	207	–	389	7,721	963	58	82	63	367	7	322	1422	50	1806	1985	–	153	116	8,529

TABLE E.—SHOWING FISH LANDED BY NET AND LINE BOATS AND BY STEAM BEAM TRAWL BOATS—*continued.*

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock.	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other Kinds of White Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of Shell Fish.	Total Value.
		cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s.	100s	cwt.	£
1888	**Leith District**—*continued.*																								
May.	I. By net and line boats,	298	--	–	–	9101	278	–	426	5455	406	18	196	–	249	3	288	240	–	1596	1330	3½	2311	167	9,793
	II. By steam beam trawl boats,	–	–	–	–	1061	88	-	37	2227	120	85	4	270	614	–	39	451	–	–	–	–	–	–	2,593
	Total,	298	–	–	–	10,162	366	–	463	7682	526	103	200	270	863	3	327	691	–	1596	1330	3½	2311	167	12,386
June.	I. By net and line boats,	527	–	–	–	4706	722	–	804	6349	465	97	328	–	250	17	370	1162	–	998	578	13¼	1830	108	7,210
	II. By steam beam trawl boats,	–	–	–	–	783	35	–	23	3909	200	85	1	702	915	20	40	1076	–	–	–	–	–	–	3,212
	Total,	527	–	–	–	5489	757	–	827	10,258	665	182	329	702	1165	37	410	2238	–	998	578	13¼	1830	108	10,422
July.	I. By net and line boats,	1950	–	–	–	328	20	–	28	1460	329	7	5	–	263	–	80	96	–	512	580	4½	1102	244	2,623
	II. By steam beam trawl boats,	–	–	–	–	827	35	–	14	9269	169	94	1	598	1854	–	96	1555	–	–	–	–	–	–	6,698
	Total,	1950	–	–	–	1155	55	–	42	10,729	498	101	6	598	2117	-	176	1651	–	512	580	4½	1102	244	9,321
August.	I. By net and line boats,	11,171	–	–	1	220	4	–	2	1654	126	1	–	–	309	7	21	111	–	434	545	3	450	366	4,316
	II. By steam beam trawl boats,	–	–	–	–	691	28	–	15	4833	394	145	–	483	611	7	141	1253	–	–	–	–	–	–	4,232
	Total,	11,171	–	–	1	911	32	–	17	6487	520	146	–	483	520	14	162	1364	–	434	545	3	450	366	8,548

TABLE E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats—*continued.*

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock.	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of White Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of Shell Fish.	Total Value.
		cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s.	100s	cwt.	£
1888	**Leith District**—*continued.*																								
Sept.	I. By net and line boats,	42	–	–	–	278	12	–	6	6,185	202	6	–	–	455	2	60	414	–	10,730	750	4	289	272	4,713
	II. By steam beam trawl boats,	–	–	–	–	859	27	–	16	13,716	433	75	–	578	725	16	47	1577	–	–	–	–	–	–	7,509
	Total,	42	–	–	–	1137	39	–	22	19,901	635	81	–	578	1180	18	107	1991	–	10,730	750	4	289	272	12,222
Oct.	I. By net and line boats,	31	–	–	–	1046	29	–	4	4,432	306	3	–	–	591½	6	25	870	92	2279	2144	4	580	240	3,973
	II. By steam beam trawl boats,	–	–	–	–	972	32	–	13	6,289	281	72	–	275	718	22	118	1408	–	–	–	–	–	–	4,499
	Total,	31	–	–	–	2018	61	–	17	10,721	587	75	–	275	1309½	28	143	2278	92	2279	2144	4	580	240	8,472
Nov.	I. By net and line boats,	196	–	–	–	830	1	–	–	1,526	168	–	–	–	142	–	8	43	40	1350	1594	–	165	126	2,729
	II. By steam beam trawl boats,	–	–	–	–	566	8	–	2	931	144	29½	–	47	138	1	18	252	–	–	–	–	–	–	1,568
	Total,	196	–	–	–	1396	9	–	2	2,457	312	29½	–	47	280	1	26	295	40	1350	1594	–	165	126	4,297

TABLE E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats—*continued.*

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock.	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of White Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of Shell Fish.	Total Value.
		cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s.	100s	cwt.	£
	Leith District—*continued.*																								
1888 Dec.	I. By net and line boats,	3239	–	–	–	2095	120	–	42	11,347	307	4	–	–	186	41	70	1308	48	1,155	2,106	1½	783	77	9,430
	II. By steam beam trawl boats, . .	–	–	–	–	910	26	–	11	1,656	166	118½	1	188	402	4	113	767	–	–	–	–	–	–	2,437
	Total, .	3239	–	–	–	3005	146	–	53	13,003	473	122½	1	188	588	45	183	2075	48	1,155	2,106	1½	783	77	11,867
Whole year.	I. By net and line boats,	38,706	8625	–	1	26,213	1645	–	1756	78,153	6,096	199	643½	1	3,814½	135	1615	8557	434	25,746	19,010	33·75	8275	1908	77,439
	II. By steam beam trawl boats, . .	–	–	–	–	10,336	395	–	216	51,106	4,310	842	11	3617	7,081	87	844	10,953	–	–	–	–	–	–	41,423
	Total, .	38,706	8625	–	1	36,549	2040	–	1972	129,259	10,406	1041	654½	3618	10,895½	222	2459	19,510	434	25,746	19,010	33·75	8275	1908	118,862

TABLE E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats—*continued.*

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock.	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of White Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of Shell Fish.	Total Value.
	***Anstruther District.**	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s.	100s.	cwt.	£
1888 January	By net and line boats,	26,017	400	5½	–	3,753	11	–	465	2,647	179	1	3	–	1278	10	40	3	–	2,073	-	·80	–	80	10,429
February	,, ,,	41,328	400	11	–	3,657	271	–	14	2,799	120	–	34	–	867	8	200	–	–	1,992	–	·50	–	20	8,102
March	,, ,,	9,104	200	3½	–	2,231	187	–	7	2,518	54	–	44½	–	251	7	187	–	–	1,930	144	–	–	150	5,360
April	,, ,,	160	–	3½	–	3,800	415	–	161	3,963	68	5	59	–	396	2	430	–	–	2,890	540	2·59	320·5	100	4,470
May	,, ,,	302		–	–	11,229	1369	5	1093	3,711	139	36	280	–	325	5	975	105	–	1,437	125	8·65	2753·5	139	7,404
June	,, ,,	265		–	–	9,148	1012	5	1232	3,512	529	96	289	–	160	7	986	17	–	1,524	–	4·30	2283·5	90	6,657
July	,, ,,	1,941		–	–	252	3	–	–	2,588	412	–	1	1	134	20	–	37	–	1,341	–	1·47	1024·75	93	2,218
August	,, ,,	9,375	–	3½	–	836	–	–	–	3,066	316	–	–	–	216	4	–	578	–	942	–	2·5	243·5	60	4,178
September	,, ,,	345	–	9	–	152	–	–	–	3,046	323	–	–	–	153	9	–	36	–	11,630	40	12·63	83·0	95	2,629
October	,, ,,	–	–	17¾	–	519	–	–	–	4,581	469	–	–	–	251	7	–	–	–	2,721	385	7·67	13·5	80	2,704
November	,, ,,	–	280	–	–	274	–	–	–	1,070	78	–	–	–	285	3	–	–	–	1,759	185	·50	·25	55	1,176
December	,, ,,	2,381	1120	1	–	2,945	67	–	3	2,780	244	–	–	–	41	60	–	–	–	2,919	385	–	1·10	77	4,056
Whole year	,, ,,	91,218	2400	54¾	–	38,796	3335	10	2975	36,281	2931	138	710½	1	4357	142	2867	776	–	33,158	1764	41·61	6723·6	1039	59,383

* No trawled fish were landed in this district.

TABLE E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats—*continued.*

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock.	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of White Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of Shell Fish.	Total Value.
		cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s.	100s.	cwt.	£
	Montrose District—																								
1888 Jan.	I. By net and line boats,	177	20	–	–	721	40	–	26	11,715	577	3½	4	–	243	13	28	2451	–	12,076	–	–	–	98	6548
	II. By steam beam trawl boats,	–	–	–	–	44	9	–	6	868	29	25¼	–	61	256	–	20	110	–	–	–	–	–	–	707
	Total,	177	20	–	–	765	49	–	32	12,583	606	28¾	4	61	499	13	48	2561	–	12,076	–	–	–	98	7255
Feb.	I. By net and line boats,	303	570	–	–	399	23	–	5	14,560	199	3½	3	–	608	2	16	1523	–	9026	–	·30	–	150	6938
	II. By steam beam trawl boats,	–	–	–	–	66	11	–	6	335	19	29½	–	58	206	–	10	187	–	–	–	–	–	–	489
	Total,	303	570	–	–	465	34	–	11	14,895	218	33	3	58	814	2	26	1710	–	9026	–	·30	–	150	7427
March.	I. By net and line boats,	–	130	–	–	308	26	–	–	7642	201	–	–	–	306	2	9	1195	–	7516	–	1·49	10·0	203	4397
	II. By steam beam trawl boats,	–	–	–	–	316	4	–	4	940	31	4½	–	17	261	–	11	64	–	–	–	–	–	–	764
	Total,	–	130	–	–	624	30	–	4	8582	232	4½	–	17	567	2	20	1259	–	7516	–	1·49	10·0	203	5143
April.	I. By net and line boats,	3	–	–	–	842	30	–	20	7492	582	2	4	–	215	–	32	997	–	7731	–	8·17	555·0	105	4913
	II. By steam beam trawl boats,	–	–	–	–	196	8	–	4	495	42	9	–	45	191	–	13	52	–	–	–	–	–	–	488
	Total,	3	–	–	–	1038	38	–	24	7987	624	11	4	45	406	–	45	1049	–	7731	–	8·17	555·0	105	5401

TABLE E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats—*continued.*

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock.	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of White Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of Shell Fish.	Total Value.
	Montrose District— *continued.*	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s.	100s	cwt.	£
1888. May.	I. By net and line boats,	81	–	–	–	1935	111	–	177	11,069	1071	3½	46	–	594	–	104	1269	–	8160	–	10·92	1406·0	107	6539
	II. By steam beam trawl boats,	–	–	–	–	80	7	–	6	678	28	32½	–	83	262	–	14	385	–	–	–	–	–	–	623
	Total,	81	–	–	–	2015	118	–	183	11,747	1099	36	46	83	856	–	118	1654	–	8160	–	10·92	1406·0	107	7162
June.	I. By net and line boats,	75	–	–	–	2943	187	–	313	11,276	1347	2	45	–	225	15	258	1116	–	9317	–	7·20	1329·0	118	6634
	II. By steam beam trawl boats,	–	–	–	–	158	7	–	–	1554	62	21	½	99	247	–	14	146	–	–	–	–	–	–	897
	Total,	75	–	–	–	3101	194	–	313	12,830	1409	23	45½	99	472	15	272	1262	–	9317	–	7·20	1329·0	118	7531
July.	I. By net and line boats,	16,839	–	–	–	555	31	–	63	7074	1248	4	1½	–	159	5	49	850	–	4444	–	5·35	530·0	100	6333
	II. By steam beam trawl boats,	–	–	–	–	200	5	–	8	2004	38	14	–	88	323	–	13	128	–	–	–	–	–	–	1051
	Total,	16,839	–	–	–	755	36	–	71	9078	1286	18	1½	88	482	5	62	978	–	4444	–	5·35	530·0	100	7384
August.	I. By net and line boats,	61,898½	–	–	3	159	5	–	29	3805	551	1	1½	–	236	11	28	318	–	3659	–	2·65	177	72	14,819
	II. By steam beam trawl boats,	–	–	–	–	110	13	–	6	1380	44	40	½	104	441	–	14	160	–	–	–	–	–	–	1109
	Total,	61,898½	–	–	3	269	18	–	35	5185	595	41	2	104	677	11	42	478	–	3659	–	2·65	177	72	15,928

TABLE E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats—*continued.*

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of White Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of Shell Fish.	Total Value.
		cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s	100s	cwt.	£
	Montrose District—*continued.*																								
1888. Sept.	I. By net and line boats,	5488½	–	–	3	108	6	–	22	11,149	664	1	–	–	197	16	23	1108	–	12,745	–	3·40	26	52	6851
	II. By steam beam trawl boats,	–	–	–	–	121	21	–	9	1579	99	28	–	163	372	–	16	378	–	–	–	–	–	–	1226
	Total,	5488½	–	–	3	229	27	–	31	12,728	763	29	–	163	569	16	39	1486	–	12,745	–	3·40	26	52	8077
Oct.	I. By net and line boats,	–	–	–	–	517	12	–	17	12,117	1829	4½	–	–	208	1	32	1599	–	6007	–	1·00	5·00	33	6407
	II. By steam beam trawl boats,	–	–	–	–	80	7	–	1	890	75	14	–	108	239	–	13	190	–	–	–	–	–	–	791
	Total,	–	–	–	–	597	19	–	18	13,007	1904	18½	–	108	447	1	45	1789	–	6007	–	1·00	5·00	33	7198
Nov.	I. By net and line boats,	96	42	–	–	370	16	–	18	3552	398	–	–	–	103	21	13	695	–	8416	–	–	–	50	3232
	II. By steam beam trawl boats,	–	–	–	–	68	5	–	6	211	12	9	–	17	83	–	14	102	–	–	–	–	–	–	337
	Total,	96	42	–	–	438	21	–	24	3763	410	9	–	17	186	21	27	797	–	8416	–	–	–	50	3569

TABLE E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats—*continued.*

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock.	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of White Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of Shell Fish.	Total Value.
	Montrose District—*continued.*	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s.	100s.	cwt.	£
1888. Dec.	I. By net and line boats,	891	520	–	–	1057	47	–	157	7210	461	$1\frac{1}{2}$	2	–	157	32	26	1078	–	8570	–	–	–	122	5055
	II. By steam beam trawl boats, . .	–	–	–	–	138	8	–	5	485	25	14	1	23	814	–	11	109	–	–	–	–	–	–	836
	Total, .	891	520	–	–	1195	55	–	162	7695	486	$15\frac{1}{2}$	3	23	971	32	37	1187	–	8570	–	–	–	122	5891
Whole year.	I. By net and line boats,	85,852	1282	–	–	9914	534	–	847	108,661	9128	$26\frac{1}{2}$	107	–	3251	118	618	14,199	–	97,667		40·48	4038·0	1210	78,648
	II. By steam beam trawl boats, . .	–	–	–	–	1577	105	–	61	11,419	504	$240\frac{3}{4}$	2	866	3695	–	163	2011	–	–	–	–	–	–	9318
	Total, .	85,852	1282	–	–	11,491	639	–	908	120,080	9632	$267\frac{1}{4}$	109	866	6946	118	781	16,210	–	97,667	–	40·48	4038·0	1210	87,966

TABLE E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats—*continued.*

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of White Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of Shell Fish.	Total Value.
	*** Stonehaven District—**	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s	100s	cwt.	£
1888. January	By net and line boats,	537	–	–	–	303	9	–	2	2978	165	1	1	–	51	2	3	268	–	–	–	–	–	–	1964
February	,, ,,	409	–	·	–	449	4	–	–	4541	43	–	½	–	61	–	3	347	–	–	–	–	–	70	2484
March	,, ,,	–	–	–	–	68	–	–	–	2321	30	–	–	–	39	–	–	328	–	–	–	–	–	108	1190
April	,, ,,	91	–	–	–	721	42	–	25	1985	48	3	15	–	40	–	40	388	–	–	–	·25	135	105	1514
May	,, ,,	40		–	–	1418	114	1	80	1963	275	6	21	–	24	–	156	223	–	–	–	8·25	412	20	1915
June	,, ,,	70		–	–	1056	72	–	50	1963	581	2	18	–	33	–	67	250	–	–	–	5·50	381	–	1593
July	,, ,,	17,635	–		–	145	–	–	30	835	453	–	–	·	20	–	–	122	–	–	–	1·50	172	–	3478
August	,, ,,	26,600	–	–	–	88	–	–	10	566	279	–	–	–	40	–	–	112	–	–	–	9·25	130	–	6059
September	,, ,,	11,942	–		–	154	–	–	10	1830	198	–	–	–	76	–	–	102	–	–	–	2·00	50	–	3669
October	,, ,,	1	–	–	–	436	–	–	12	3712	533	1	–	–	83	–	–	98	–	–	–	1·25	43	–	1792
November	,, ,,	10	–	–	–	279	7	–	8	839	234	½	½	–	48	14	4	51	–	–	–	–	–	–	880
December	,, ,,	2387	–	–	–	789	18	–	61	1571	160	4	5	–	71	33	30	120	–	–	–	–	–	60	2161
Whole year	,, ,,	59,722	–	–	–	5906	266	1	288	25,104	2999	17½	61	–	586	49	303	2409	–	–	–	28	1323	363	28,699

* No trawled fish were landed in this district.

TABLE E.—SHOWING FISH LANDED BY NET AND LINE BOATS AND BY STEAM BEAM TRAWL BOATS—*continued.*

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk. (Tusk).	Saith (Coalfish).	Haddock.	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of White Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of Shell Fish.	Total Value.
	Aberdeen District.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s	100s	cwt.	£
1888. Jan.	I. By net and line boats,	252	–	–	–	788	117	–	27	5848	988	2	4	–	–	3	156	1308	–	–	–	–	–	–	3491
	II. By steam beam trawl boats, . .	–	–	–	–	405	21	–	10	2941	5	242	–	331	4736	3	110	959	–	–	–	–	–	–	7096
	Total, .	252	–	–	–	1193	138	–	37	8789	993	244	4	331	4736	6	266	2267	–	–	–	–	–	–	10,587
Feb.	I. By net and line boats,	1358	–	–	–	897	150	–	13	10,284	169	20	20	–	–	–	79	320	–	–	–	–	–	–	4976
	II. By steam beam trawl boats, . .	–	–	–	–	502	9	–	4	2132	–	85	–	358	4604	3	53	705	–	–	–	–	–	–	5654
	Total, .	1358	–	–	–	1399	159	–	17	12,416	169	105	20	358	4604	3	132	1025	–	–	–	–	–	–	10,630
March.	I. By net and line boats,	120	–	–	–	503	122	–	26	3962	265	5	48	–	7	–	108	178	–	–	–	–	–	–	2679
	II. By steam beam trawl boats, . .	–	–	–	–	1816	30	–	20	3538	56	62	2	269	3225	–	85	636	–	–	–	–	–	–	8082
	Total, .	120	–	–	–	2319	152	–	46	7500	321	67	50	269	3232	–	193	814	–	–	–	–	–	–	10,761
April.	I. By net and line boats,	162	–	–	–	1817	588	4	194	3231	505	1	191	–	294	–	687	86	–	–	–	·25	–	–	3939
	II. By steam beam trawl boats, . .	–	–	–	–	999	25	–	18	2098	72	78	–	486	1506	–	68	470	–	–	–	–	–	–	4001
	Total, .	162	–	–	–	2816	613	4	212	5379	577	79	191	486	1800	–	755	556	–	–	–	·25	–	–	7940

TABLE E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats—*continued.*

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock.	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of Shell Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of White Fish.	Total Value.
	Aberdeen District—*continued.*	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s	100s	cwt.	£
1888. May.	I. By net and line boats,	656	–	–	–	3772	662	8	638	6379	1779	13	490	–	94	3	931	101	–	–	–	3·00	12·0	–	5640
	II. By steam beam trawl boats,	–	–	–	–	773	32	–	78	3461	157	149	4	1236	2206	4	194	790	–	–	–	–	16·0	–	5463
	Total,	656	–	–	–	4545	694	8	716	9840	1936	162	494	1236	2300	7	1125	891	–	–	–	3·00	28·0	–	11,103
June.	I. By net and line boats.	675	–	–	–	5599	654	5	783	6256	2567	12	820	–	4	6	1168	48	–	–	–	1·5	40·5	–	6059
	II. By steam beam trawl boats,	–	–	–	–	670	38	–	110	3685	166	142	6	537	2040	6	158	1283	–	–	–	–	–	–	4320
	Total,	675	–	–		6269	692	5	893	9941	2733	154	826	537	2044	12	1326	1331	–	–	–	1·5	40·5	–	10,379
July.	I. By net and line boats,	120,548	–	–	–	168	31	–	60	2334	1495	1	10	–	2	–	59	14	–	–	–	–	34·25	–	18,343
	II. By steam beam trawl boats,	–	–	–	–	684	24	–	40	5602	105	147	1	711	1320	7	122	1961	–	–	–	–	–	–	4940
	Total,	120,548	–	–	–	852	55	–	100	7936	1600	148	11	711	1322	7	181	1975	–	–	–	–	34·25	–	23,283
August.	I. By net and line boats,	142,228	–	–	5	4	–	–	–	1057	1434	–	–	–	4	–	–	–	–	–	–	·25	27·25	–	31,030
	II. By steam beam trawl boats,	–	–	–	–	554	16	–	87	6578	37	238	1	729	1723	4	107	2064	–	–	–	–	–	–	7398
	Total,	142,228	–	–	5	558	16	–	87	7635	1471	238	1	729	1727	4	107	2064	–	–	–	·25	27·25	–	38,428

TABLE E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats—*continued.*

Date.	Districts.	Herring.	Sprat.	Sparling	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock.	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of White Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of Shell Fish.	Total Value.
	Aberdeen District—*continued.*	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt	cwt.	100s	cwt.	cwt.	100s	100s.	cwt.	£
1888. Sept.	I. By net and line boats,	22,044	–	–	–	68	26	–	13	2,609	1138	1	–	–	27	9	155	11	–	–	–	·25	30·5	–	7,246
	II. By steam beam trawl boats, . .		–	–	–	528	26	–	127	9,354	27	424	–	957	2106	7	110	2064	–	–	–	–	–	–	9,544
	Total, .	22,044	–	–	–	596	52	–	140	11,963	1165	425	–	957	2133	16	265	2075	–	–	–	·25	30·5	–	16,790
Oct.	I. By net and line boats,	–	–	–	–	288	31	–	11	2,809	1554	3	1	–	34	21	94	202	–	–	–	–	27·00	–	1,629
	II. By steam beam trawl boats, . .	–	–	–	–	518	29	–	45*	8,667	216	476	1	905	1781	5	337	1871	–	–	–	–	–	–	9,850
	Total, .	–	–	–	–	806	60	–	56	11,476	1770	479	2	905	1815	26	431	2073	–	–	–	–	27·00	–	11,479
Nov.	I. By net and line boats,	–	–	–	–	780	25	–	7	2,085	704	–	1	–	–	24	54	128	–	–	–	–	–	–	2,821
	II. By steam beam trawl boats, . .	–	–	–	–	394	18	–	23*	4,550	111	214	–	291	1340	3	172	947	–	–	–	–	–	–	7,514
	Total, .	–	–	–	–	1174	43	–	30	6,635	815	214	1	291	1340	27	226	1075	–	–	–	–	–	–	10,335

* And hake.

TABLE E.—Showing Fish Landed by Net and Line Boats and by Steam Beam Trawl Boats—*continued.*

Date.	District.	Herring.	Sprat.	Sparling.	Mackerel.	Cod.	Ling.	Torsk (Tusk).	Saith (Coalfish).	Haddock.	Whiting.	Turbot.	Halibut.	Sole (Lemon Sole).	Flounder, Plaice, Brill.	Eel.	Skate.	Other kinds of Shell Fish.	Oysters.	Mussels.	Clams.	Lobsters.	Crabs.	Other kinds of White Fish.	Total Value.
	Aberdeen District—*continued*	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	cwt.	100s	cwt.	cwt.	100s	100s.	cwt.	£
1888. Dec.	I. By net and line boats,	213	–	–	–	1210	58	–	34	4264	1063	–	–	–	–	29	81	261	–	–	–	–	–	–	3,055
	II. By steam beam traw boats,	–	–	–	–	318	23	–	33*	5003	60	229	–	367	6319	6	160	729	–	–	–	–	–	–	8,226
	Total,	213	–	–	–	1528	81	–	67	9267	1123	229	–	367	6319	35	241	990	–	–	–	–	–	–	11,281
Whole year.	I. By net and line boats,	288,256	–	–	5	15,894	2464	17	1806	51,168	13,661	58	1585	–	466	95	3572	2,657	–	–		5·25	187·5	–	90,908
	II. By steam beam trawl boats,	–	–	–	–	8,161	291	–	595	57,609	1,012	2486	15	7177	32,906	48	1676	14,479	–	–	–	–	–	–	82,088
	Total,	288,256	–	–	5	24,055	2755	17	2401	108,777	14,673	2544	1600	7177	33,372	143	5248	17,136	–	–	–	5·25	187·5	–	172,996

* And hake.

TABLE F.—SHOWING THE MONTHLY TAKES OF LINE AND NET BOATS FROM INSHORE GROUNDS IN THE LEITH, ANSTRUTHER, MONTROSE, STONEHAVEN, AND ABERDEEN DISTRICTS.

Note.—The figures in smaller type give the average per shot.

LEITH DISTRICT.

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and* Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan. 22	North Berwick,	...	15	269	...	2	...	...	131	17 to 27 ft.	...	...	Medium.	...	Mussels.	Fine; sometimes heavy sea.
		...	0·11	2·05	...	0·01	...	...	...	...	...	...				
Feb. 18	" " .	6	12	138	...	...	...	...	80	...	...	...	Medium.	...	Mussels.	Fine or moderate.
		0·07	0·15	1·72	...	...	...	...	...	...	...	...				
Mar. 14	" " .	...	4	113	...	...	...	...	70	...	...	...	Medium.	...	Mussels.	Fine; often fresh breezes.
		...	0·05	1·61	...	...	...	...	...	...	...	...				
Apr. 18	" " .	...	7	274	...	...	...	...	176	...	...	...	Medium.	...	Mussels.	...
		...	0·04	1·55	...	...	...	...	...	...	...	...				

* Representing the total number per month of trips made by all the boats fishing.

TABLE F.—LEITH DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. May 23	North Berwick,	1	34	420	18	...	...	...	283	...	...	...	Medium.	...	Mussels.	Generally fine.
		...	0·12	1·48	0·06	...	...	...	...	...	...	...				
June 22	" " .	...	4	327	17	...	...	...	260	...	...	...	Medium.	...	Mussels.	Fine; sometimes strong.
		...	0·02	1·25	0·06	...	...	...	...	...	...	...				
July 24	" " .	...	27	428	45	...	...	...	282	...	...	...	Medium.	...	Mussels.	Fine.
		...	0·09	1·51	0·15	...	...	...	...	...	...	...				
Aug. 27	" " .	...	4	528	...	...	...	...	318	...	...	...	Medium.	...	Mussels.	Fine.
		...	0·01	1·39	...	...	...	...	...	...	...	...				
Sept. 25	" " .	...	...	313	39	...	...	...	237	...	...	...	Medium.	...	Mussels.	Fine.
		...	...	1·32	0·16	...	...	...	...	...	...	...				
Oct. 21	" " .	...	11	242	40	...	...	...	195	...	...	...	Medium.	...	...	...
		...	0·05	1·24	0·20	...	...	...	...	...	...	...				
Nov. 13	" " .	...	9	84	11	...	...	...	78	...	...	...	Medium and small.	...	Mussels and Clams.	Weather: Strong.
		...	0·11	1·07	0·14	...	...	...	...	...	...	...				

TABLE F.—LEITH DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Dec. 22	North Berwick,	39	117	144	...	...	...	...	197	...	...	...	Medium.	...	Herrings and Mussels.	Moderate.
		0·19	0·59	0·73	...	...	...	...	...	...	...	...				
Jan. 25	Cockenzie and Port-Seton,	...	376½	300	...	...	...	...	236	23 to 28 ft.	...	...	Mostly medium.	...	Clams.	Generally fine; occasionally stormy.
		...	1·59	1·27	...	...	...	...	...	...	...	...				
Feb. 22	„	...	399	181	...	...	...	...	193	24 to 30 ft.	...	...	Medium.	...	Clams.	Generally fine; sometimes stormy.
		...	2·06	0·93	...	...	...	...	...	...	...	...				
Mar. 24	„	...	401	298	...	...	...	...	228	24 to 30 ft.	...	...	Medium, some small.	...	Clams.	Generally good.
		...	1·75	1·30	...	...	...	...	...	...	...	...				
Apr. 24	„	...	243	309	...	...	...	...	224	24 to 29 ft.	...	...	Mostly small.	...	Clams.	Generally fine.
		...	1·08	1·37	...	...	...	...	...	...	...	...				
May 25	„	...	180	272	...	24	...	...	196	24 to 29 ft.	...	...	½ Medium, ½ small.	...	Clams.	Generally fine.
		...	0·91	1·38	...	0·12	...	...	...	...	...	...				

TABLE F.—LEITH DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. June 25	Cockenzie and Port-Seton,	...	92	283	19	89¼	...	...	210	24 to 29 ft.	...	...	Mostly small.	...	Clams and Worms.	Fine or changeable.
		...	0·43	1·34	0·09	0·42	...	...	...	...	...	...				
July 26	„	...	61	332	113	104	...	...	225	24 to 29 ft.	...	...	Medium.	...	Clams and Worms.	Fine.
		...	0·27	1·47	0·50	0·46	...	...	...	...	...	...				
Aug. 27	„	...	76	194½	23	116	...	...	182	...	...	...	Small.	...	Clams and Worms.	Fine.
		...	0·41	1·06	0·12	0·63	...	...	...	...	...	...				
Sept. 25	„	...	118	295	...	111½	...	...	206	...	...	...	Medium.	...	Clams.	Fine.
		...	0·57	1·43	...	0·54	...	...	...	...	...	...				
Oct. 27	„	...	539	780	78	185	...	...	548	...	...	...	...	...	Clams.	...
		...	0·98	1·42	0·14	0·33	...	...	...	...	...	...				
Nov. 22	„	...	665	291	88	85	...	...	375	...	...	...	Mostly medium; some large.	...	Clams.	Generally stormy.
		...	1·77	0·77	0·23	0·22	...	...	...	...	...	...				
Dec. 25	„	...	634	388	35	32	...	...	364	...	...	...	Large.	...	Clams.	Generally good.
		...	1·74	1·06	0·09	0·08	...	...	...	...	...	...				

TABLE F.—LEITH DISTRICT—*continued*.

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan. 22	Fisherrow, .	172	159	473	52	90	23	15	126	26 to 58	8	40 to 58	Medium ; most small.	...	Clams, Mussels, and Herrings.	Generally fine ; sometimes stormy.
		1·36	1·26	3·75	0·41	0·71	0·18	0·11	...	...	...	...		...		
Feb. 21	,, . .	...	14	65	9	361	...	...	92	...	107	...	Medium and small.	...	Clams, Mussels, and Herrings.	Fine and frosty ; sometimes snowing.
		...	0·15	0·70	00·9	3·92	...	...	...	...	...	...		...		
March 17	,, . .	15	20	102	15	194	1	2	69	...	58	...	Most small ; some medium.	...	Clams, Mussels, and Herrings.	Frosty ; sometimes squalls and snow.
		0·21	0·29	1·48	0·21	2·80	0·01	0·02	...	...	...	...		...		
Apr. 12	,, . .	...	1	49	7	100	...	200 Crabs.	50	...	93	...	Medium.	...	Clams, Mussels, and Herrings.	Generally fine.
		...	0·02	0·98	0·14	2·00	...	...	...	...	...	...		...		
May 24	,, . .	...	13	59	23	130	...	2600 Crabs.	84	...	85	...	Small.	...	Clams, Mussels, and Herrings.	Generally fine ; occasionally stormy.
		...	0·15	0·70	0·27	1·54	...	...	...	...	...	...		...		
June 20	,, . .	...	22	111	30	99	...	1600 Crabs.	77	...	40	...	Small.	...	Mussels, Slugs, and Worms.	Generally fine.
		...	0·28	1·44	0·39	1·28	...	...	...	...	...	...		...		

TABLE F.—Leith District—*continued.*

Month and Number of Days Fishing.	Place where Landed.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
1888.		*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
July 19	Fisherrow, .	...	9	113	24	55	...	750 crabs.	59	...	15	...	Medium and small.	...	Mussels.	Generally fine.
		...	0·15	1·91	0·40	0·93	...	...	...	...	...	...		...		
Aug. 13	,, .	...	3	24	3	28	...	...	14	...	23	...	Medium and small.	...	Mussels.	Generally fine.
		...	0·21	1·71	0·21	2·00	...	...	...	...	...	...		...		
Sept. 15	,, .	...	...	112	14	136	...	...	51	...	14	...	Medium.	...	Mussels.	Fine or light E. Winds.
		...	..	2·23	0·27	2·67	...	...	...	...	...	...		...		
Oct. 19	,, .	9	13	135	19	255	...	...	92	...	42	...	Medium.	...	Mussels.	Fine.
		0·09	0·14	1·46	0·20	2·77	...	...	...	...	...	...		..		
Nov. 17	,, .	12	65	158	12	14	...	...	59	...	28	...	Medium.	...	Mussels and Clams.	Fine.
		0·20	1·10	2·67	0·20	0·23	...	...	...	...	...	...		...		
Dec. 22	,, .	251	...	432	...	20	21	28	109	...	...	...	Medium.	...	Mussels and Clams.	Fine.
		2·30	...	3·96	...	0·18	0·19	0·25	...	...	...	...				

TABLE F.—LEITH DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling. Herring.	Codlings.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Number and Size of Boats Fishing. Inside the Area. No.	Inside the Area. Size.	Outside the Area. No.	Outside the Area. Size.	Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
1888.		*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
Jan. 26	Newhaven,	1085¼	130¼	8½	6¾	5	...	...	819	25 to 30 ft.	17 73	Steam line Large.	Medium.	...	Herrings, Mussels, Clams, and Worms.	...
		1·32	0·15	0·01	...	...	...	...	...	...	...	...				
Feb. 24	,,	104¾	307¼ 7½ Cod	416¼	21	17¼	...	...	293	...	18 119	Steam. Large.	Medium.	...	Herrings, Mussels, Clams, and Worms.	...
		0·35	1·05	1·42	0·07	0·05	...	...	...	...	...	...				
Mar. 26	,,	...	339¾ 29½ Cod	590	32¾	24	...	...	243	...	15 58	Steam. Large.	Medium.	...	Herrings, Mussels, Clams, and Worms.	...
		...	1·51	2·42	1·34	0·09	...	...	...	...	...	...				
Apr. 20	,,	...	318½ 53¼ Cod	373½	33½	28¼	...	¼ Coal	283	...	9 137	Steam line Large.	Medium.	...	Herrings, Mussels, Clams, and Worms.	...
		...	1·31	1·32	0·11	0·10	...	...	...	...	...	...				
May 27	,,	...	86½ 14½ Cod	133½	20¾	18	31½	590 doz. Crabs.	256	...	21 278	Steam. Large.	Medium.	...	Herrings, Mussels, Clams, and Worms.	Generally E.N.E; sometimes strong W.
		...	0·39	0·52	0·08	0·07	0·12	...	...	...	...	...				

TABLE F.—LEITH DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. June 25	Newhaven,	...	16 ¼ Cod	19¾	8	6½	102 Sk. ¼ Tur.	500 doz. Crabs.	188	...	19 236	Steam. Large.	Medium.	...	Herrings, Mussels, Clams, and Worms.	Generally E.N.E. Winds.
		...	0·08	0·10	0·04	0·03	0·54	...	...	...	...	...				
July 26	,,	...	34½ 2½ Cod	39¼	11	62	35 Sk.	332½ doz. Crabs.	188	...	20 45	Steam. Large.	Medium.	...	Herrings, Mussels, Clams, and Worms.	Generally E.N.E. Winds.
		...	0·19	0·20	0·05	0·33	0·18	...	...	...	...	...				
Aug.	,,	...	69 2½ Cod	50¼	9	109¼	...	166 doz. Crabs.	211	...	17 6	Steam. Large.	Medium.	Flounders, with nets.	Herrings, Mussels, Clams, and Worms.	...
		...	0·33	0·23	0·04	0·51	...	...	...	...	...	...				
Sept. 25	,,	...	49 6¾ Cod	71¾	13¾	29¼	...	...	114	...	11 55	Steam. Large.	Medium.	...	Herrings, Mussels, Clams, and Worms.	...
		...	0·48	0·62	0·12	0·25	...	...	..	...	...	...				
Oct. 25	,,	...	48½ 14¼ Cod	126¼	19¼	13¾	...	...	190	...	14 109	Steam. Large.	Medium.	...	...	...
		...	0·33	0·61	0·10	0·07	...	...	...	...	...	...				

TABLE F.—LEITH DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Codlings.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
1888.		*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
Nov. 23	Newhaven, .	97	2½ 42 Cod	42½	11	11½	8	¼ Eel	276	...	5	Large.	...	...	...	Often stormy.
		0·35	0·37	0·15	0·03	0·03	0·02	...	...	...	...	...				
Dec. 26	,, . .	961	156 1868 Cod	42¾	10¾	27¾	160	45½ Eel & Ling, ½ Halbt.	3 124 1091	Steam Large. 25 to 30 ft.	2 85	Steam Large.	...	...	Inkfish, Worms, and Clams.	...

TABLE F.—ANSTRUTHER DISTRICT.

Month and Number of Days Fishing.	Place where Landed.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Crans.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	No.	Size.	No.	Size.				
1888. Jan. 23	Largo, . .	4½	37	250	...	74	...	...	222	Yawls.	...	...	⅓ large; rest small.	...	Mussels and Lug.	Generally fine; sometimes stormy.
		0·02	0·16	1·12	...	0·33	...	...	...	...	...	...				
Feb. 24	,, . .	47	32	132	...	162	...	...	218	Yawls.	...	...	¼ large; small.	...	Mussels and Lug.	Generally fine.
		0·21	0·14	0·60	...	0·74	...	...	...	...	...	...				
Mar. 22	,, . .	...	46	133	...	61	...	...	192	Yawls.	2	45 to 55 ft.	½ large; ½ small.	...	Mussels and Lug.	Fine; several days stormy.
		...	0·23	0·69	...	0·32	...	...	...	...	...	...				
Apr. 25	,, . .	...	30	150	...	103	...	...	220	Yawls.	6	45 to 55 ft.	⅓ large; rest small.	...	Mussels and Lug.	Fine; occasionally stormy.
		...	0·13	0·68	...	0·46	...	...	...	...	...	...				
May 24	,, . .	...	16	165	24	27	...	...	185	Yawls.	13	45 to 55 ft.	Small; a few large.	...	Mussels and Lug.	Fine; occasionally stormy.
		...	0·08	0·89	0·13	0·14	...	...	...	...	...	...				
June 26	,, . .	...	...	244	32	...	...	...	173	Yawls.	7	45 to 55 ft.	Small; a very few large.	...	Mussels and Lug.	Fine; occasionally stormy.
		...	...	1·41	0·18	...	...	...	...	...	...	...				

TABLE F.—Anstruther District—*continued.*

Month and Number of Days Fishing.	Place where Landed.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Crans.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July 26	Largo, . .	...	...	193	14	...	...	...	158	Yawls.	...	...	Small.	..	Mussels and Sand Worms.	Fine; occasionally stormy.
		...	...	1·22	0·08	...	...	...	...	...	...	...				
Aug. 27	,, . .	...	...	170	...	...	...	...	171	Yawls.	...	...	Small.	...	Mussels and Sand Worms.	Fine.
		...	...	1·00	...	...	...	...	...	...	...	...				
Sept. 25	,, . .	...	...	246	20	41	...	...	238	Yawls.	...	...	Small.	...	Mussels and Sand Worms.	Fine.
		...	...	1·03	0·08	0·17	...	...	...	...	...	...				
Oct. 25	,, . .	...	41	411	45	67	...	...	322	Yawls.	...	...	Medium and small.	...	Mussels and Sand Worms.	Fine; sometimes stormy.
		...	0·12	1·27	0·14	0·20	...	...	...	...	...	...				
Nov.	,, . .	...	49	145	17	3	...	...	148	Yawls.	...	...	...	...	...	...
		...	0·33	0·98	0·11	0·02	...	...	...	...	...	...				
Dec. 25	,, . .	131½	82	163	14	...	...	...	404	Yawls.	...	...	Large and small.	...	Mussels.	Fine; sometimes stormy.
		0·32	0·20	0·40	0·03	...	...	...	...	...	...	...				

TABLE F.—ANSTRUTHER DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Sand Eels.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan. 23	Elie and Earlsferry.	...	37	123½	...	4½	...	...	131	Yawls	...	...	Large, medium, and small.	Hook and line.	Mussels and Lug.	Moderate; occasionally stormy.
		...	0·28	0·94	...	0·03	...	...	...	...	...	...				
Feb. 23	" " .	...	60	88	...	80	...	...	138	...	...	...	Medium and small.	...	Mussels and Lug.	Fresh and moderate.
		...	0·43	0·64	...	0·58	...	...	...	...	...	...				
Mar. 20	" " .	...	43	35	...	27	...	...	89	18 to 22 ft.	...	...	Medium and small.	...	Mussels and Lug.	Fresh and moderate.
		...	0·48	0·39	...	0·30	...	...	...	...	...	...				
Apr. 23	" " .	...	61½	91	...	11	...	...	125	16 to 23 ft.	...	...	Principally small; some medium.	...	Mussels and Lug.	Moderate or strong breezes.
		...	0·49	0·72	...	0·08	...	...	...	...	...	...				
May 23	" " .	...	28½	105½	...	8	...	5	106	16 to 23 ft.	...	...	Most small; some medium and large.	Sand Eels by net.	Mussels, Lug, and Sand Eels.	Generally moderate.
		...	0·26	0·99	...	0·07	...	0·04	...	...	...	...				
June 26	" " .	...	10	101	...	73	...	12	101	...	...	...	Medium and small.	Sand Eels by net.	Mussels, Lug, and Sand Eels.	Moderate or light breezes.
		...	0·09	1·00	...	0·72	...	0·11	...	...	...	...				

TABLE F.—ANSTRUTHER DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Sand Eels.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July 26	Elie and Earlsferry,	...	22	98	...	70	...	13	104	...	...	...	Medium and small; some large.	Sand Eels by net.	Mussels, Lug, and Sand Eels.	Generally fine.
		...	0·21	0·94	...	0·66	...	0·12	...	...	...	...				
Aug. 27	" "	...	26	100	61½	...	...	7¾	108	...	...	...	Large, medium and small.	Sand Eels by net.	Mussels, Lug, and Sand Eels.	Moderate or fresh.
		...	0·24	0·92	0·57	...	...	...	...	...	...	...				
Sept. 25	" "	...	38	70	22	...	...	¾	90	...	...	...	Medium and small; some large.	Sand Eels by net.	Mussels, Lug, and Sand Eels.	Generally light; occasionally strong.
		...	0·42	0·77	0·24	...	...	...	...	...	...	...				
Oct. 25	" "	...	49½	100	18	4	...	...	114	...	...	...	Medium and small; some large.	...	Mussels and Lug.	Generally strong and fine.
		...	0·43	0·87	0·15	0·03	...	...	...	...	...	...				
Nov. 12	" "	...	52	39½	...	1½	...	...	51	...	...	...	...	...	...	...
		...	1·02	0·77	...	0·03	...	...	...	...	...	...	...	...	...	...
Dec. 26	" "	20	52	86½	...	2	...	...	128	...	...	...	Large, medium, and small.	...	Lug and Sprats.	Moderate.
		0·15	0·40	0·67	...	0·01	...	...	...	...	...	...				

TABLE F.—ANSTRUTHER DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Crans.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan.	St Monance, .	Statis	tics no	t kept.	...	...	...	...	...	...	...	...	...	...	...	...
		...	...	...	...	...	...	...	...	...	...	...				
Feb.	„ .	Statis	tics no	t kept.	...	...	...	...	...	...	...	...	...	...	...	...
		...	...	...	...	...	...	...	...	...	...	...				
Mar.	„ .	Statis	tics no	t kept.	...	...	...	...	...	...	...	...	...	...	...	...
		...	...	...	...	...	...	...	...	...	...	...				
Apr. 23	„ .	...	614	992½	...	...	...	8	441	Yawls.	47	48 to 53 ft.	Rather more large than small.	...	Mussels, Clams, and Limpets.	Fine; occasionally squally.
		...	1·39	2·25	...	...	...	0·01	...	...	...	...				
May 23	„ .	...	226	647	32½	...	...	...	296	Yawls.	46	52 to 56 ft.	About ½ large, ½ small.	...	Mussels, Herrings, and Sand Eels.	Generally fine.
		...	0·76	2·18	0·11	...	...	...	...	...	...	...				
June 24	„ .	..	146	484	248	...	...	...	287	22 to 28 ft.	42	50 to 56 ft.	¼ large, ¾ small.	...	Herrings and Sand Eels.	Generally fine.
		...	0·50	1·68	0·86	...	...	...	...	...	...	...				

TABLE F.—ANSTRUTHER DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July 26	St Monance,	...	55	256	145	...	...	...	165	...	22	...	½ large, ½ small.	...	Mussels and Sand Eels.	Generally fine.
		...	0·33	1·55	0·87	...	...	...	...	...	...	...				...
Aug. 27	„	245	...	294	155¾	...	...	...	192	...	...	...	¾ small.	...	Mussels.	Fine.
		1·27	...	1·53	0·81	...	...	...	...	...	...	...				
Sept. 23	„	...	...	209	113	...	...	...	143	...	...	...	⅕ large, rest small.	...	Mussels.	Fine.
		...	...	1·46	0·79	...	...	...	...	...	...	...				
Oct. 26	„	...	...	120	597	86	...	...	322	...	...	...	¾ small.	...	Mussels, Limpets, and Ink Fish.	Fine; often fresh.
		...	...	0·37	1·85	0·26	...	...	...	...	...	...				
Nov. 12	„	...	63	170	36	...	...	...	144	...	...	...	...	...	...	...
		...	0·43	1·18	0·25	...	...	...	...	...	...	...				
Dec. 26	„	73	1444	806	122	...	4	5	478	Large boats. Yawls.	...	...	Mostly large.	...	Sprats and Ink Fish.	Moderate or unsettled.
		0·15	3·02	0·68	0·25	...	0·00	0·01	...	...	...	...				

TABLE F.—Anstruther District—*continued.*

Month and Number of Days Fishing.	Place where Landed.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan. 21	Pittenweem, .	291	23	179	26	...	...	...	{ 87 { 121	Large Yawls. }	...	...	Medium and ⅔ small.	...	Mussels, Herrings, and occasionally Sand Eels.	Generally fine; sometimes foggy.
		1·40	0·11	0·86	0·12	...	...	...	...	...	...	...				
Feb. 22	„ .	469	69	234	40	...	...	5½	{ 93 { 111	Large Yawls. }	...	...	Mostly large.	...	Mussels and Clams.	Generally fine, and northerly winds.
		2·30	0·33	1·14	0·19	...	...	0·02	...	...	...	...				
Mar. 17	„ .	38	70	215	42	...	...	...	{ 18 { 84	Large Yawls. }	...	...	...	...	Mussels and Clams.	Generally fine.
		0·37	0·68	2·10	0·41	...	...	...	...	...	...	...	...			
Apr. 19	„ .	...	20	223	37	...	...	1	158	25	8	50	Medium, ⅔ small.	...	Clams and Mussels.	Fine or changeable.
		...	0·12	1·41	0·23	...	...	...	...	...	...	...				
May 20	„ .	...	2	217	32	...	...	...	153	25	3	50	Small.	...	Mussels, Herrings, and occasionally Sand Eels.	Fine
		...	0·01	1·41	0·20	...	...	...	...	...	...	...				
June 20	„ .	7	...	172	25	...	...	...	112	25	...	...	Medium, ⅔ small.	...	Mussels, Herrings, and occasionally Sand Eels.	Fine; easterly winds.
		0·06	...	1·53	0·22	...	...	...	...	...	...	...				

TABLE F.—ANSTRUTHER DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Crans.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July 19	Pittenweem, .	7	...	125	21	...	...	...	81	...	3	...	Medium $\frac{1}{3}$, $\frac{3}{4}$ small.	...	Mussels.	Fine.
		0·08	...	1·54	0·24	...	...	...	...	...	...	...		...		
Aug. 20	" .	378	...	138	34	...	...	...	88	...	20	...	Small.	...	Mussels.	...
		4·29	...	1·56	0·38	...	...	...	...	...	...	...		...		
Sept. 19	" .	...	...	105	35	...	...	...	88	...	...	...	Small.	...	Mussels.	Fine.
		...	...	1·19	0·40	...	...	...	...	...	...	...		...		
Oct. 19	" .	...	9¼	196	48	...	...	...	139	...	5	45	Small.	...	Mussels and Limpets.	Fine.
		...	0·06	1·41	0·34	...	...	...	...	...	...	...		...		
Nov. 5	" .	...	...	35	9	...	...	...	28	...	...	...	...	...	...	...
		...	...	1·25	0·32	...	...	...	...	...	...	...		...	...	
Dec. 18	" .	128	26	147	22	...	...	...	191	Large. Yawls.	...	...	Mostly medium.	...	Mussels.	Fine.
		0·67	0·13	0·77	0·11	...	...	...	...	...	...	...		...		

TABLE F.—Anstruther District—*continued.*

Months and Number of Days Fishing.	Place where Landed.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan. 24 30	Anstruther, .	4675	1241	...	...	...	...	400 coal	1229	Large Yawls.	623	Large.	Nearly all large.	...	Mussels and Herrings.	Generally fine; often strong breezes.
		3·80	1·00	...	...	...	...	0·32	...	...	...	...				
		...	42	85	...	...	...	...	64	...	...	...				
		...	0·65	1·32	...	...	...	...	...	...	...	...				
Feb. 16 21	" . .	5230	785	...	...	...	...	...	672	Large Yawls.	1080	Large.	Mostly large.	...	Mussels and Herrings.	Moderate or fine; generally W. breezes.
		7·78	1·16	...	...	...	...	...	...	...	...	...				
		...	28	170	..	...	...	...	66	...	...	...				
		...	0·42	2·57	...	...	...	...	...	...	...	...				
Mar. 13	" . .	...	20	150	...	...	...	...	49	24 to 26 ft.	529	46 to 58 ft.	⅔ large, rest medium and small.	...	Mussels and Clam.	Moderate; generally E. breezes.
		...	0·40	3·06	...	...	...	...	...	...	...	...				
Apr. 16	" . .	...	11½	39¾	...	2	...	...	37	26	175	46 to 56 ft.	½ large, ½ small.	...	Mussels and Lug.	Fine.
		...	0·31	1·07	...	0·05	...	...	...	...	...	...				
May 13	" . .	...	½	14	...	...	...	...	13	25	231	45 to 57 ft.	Large, and ⅔ small.	...	Mussels and Herrings.	Fine.
		...	0·03	1·07	...	...	...	...	...	...	...	...				
June 3	" . .	...	...	3¼	2¼	...	...	...	3	25	256	46 to 57 ft.	½ large, ½ small.	...	Mussels and Sand Eel.	Fine.
		...	...	1·08	0·75	...	...	...	...	...	...	...				

TABLE F.—ANSTRUTHER DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July	Anstruther, .	1½	...	3¾	...	...	...	...	4	...	33	...	½ large, ½ small.	...	Mussels.	Stormy.
		0·37	...	0·93	...	...	...	...	...	...	...	...				
Aug.	" . .	198	2	10	...	...	...	...	38	...	?	All Herring boats.	⅓ large, ⅔ small.	...	Mussels and Herrings.	Light W. breezes.
		5·21	0·05	0·26	...	...	...	...	...	...	...	...				
Sept.	" . .	...	...	39	¼	...	...	...	21	...	...	...	⅓ medium, ⅔ small.	...	Mussels and Limpets.	Generally light.
		...	...	1·86	0·01	...	...	...	...	...	...	...				
Oct.	" . .	...	28¼	127	3¼	...	...	3 Eels	90	...	...	...	⅓ large, ⅓ medium, ⅓ small.	...	Mussels for Haddock, Ink Fish and Herrings for Cod.	Fresh or fine.
		...	0·31	1·41	0·03	...	...	0·03	...	...	...	...				
Nov.	" . .	...	3	15	½	...	...	...	13	...	...	...	...	...	...	...
		...	0·23	1·15	0·03	...	...	...	...	...	...	...				
Dec. 24	" . .	...	194½	130	...	...	8¼	10½	184	Large boats. Yawls.	59	Large.	Most large.	...	Mussels for Haddock, Ink Fish and Herrings for Cod.	Generally fine.
		...	1·05	0·70	...	...	0·04	0·05	...	...	...	...				
		...	...	32	101½	...	...	...	68	...	...	...				
		...	...	0·47	1·49	...	...	...	...	...	...	...				

TABLE F.—ANSTRUTHER DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan. 16	Crail, . .	87¼	81	154	3	...	...	...	224	...	35	Yawls.	Medium.	...	Mussels and Herrings.	Generally fresh; sometimes light.
		0·39	0·32	0·68	0·01	...	...	...	...	...	...	...				
Feb. 18	" . .	88½	296	285	...	...	...	...	279	...	28	...	Medium.	...	Mussels, Herrings, and Limpets.	Generally strong E. or N. breezes.
		0·31	1·06	1·02	...	...	...	...	...	...	...	...				
Mar. 13	" . .	...	277	247	...	90½	...	...	207	...	...	...	Medium and small.	...	Mussels.	Generally fresh.
		...	1·33	1·19	...	0·43	...	...	...	...	...	...				
Apr. 20	" . .	...	324	110	...	67	1	...	333	...	...	...	Medium, some small.	...	Mussels, Lug, and Limpets.	Strong; occasionally light breezes.
		...	0·97	0·33	...	0·20	...	...	...	...	...	...				
May 20	" . .	...	171	125	...	...	...	91	239	...	...	...	Medium.	...	Mussels, Lug, and Crabs.	Fine; with strong or light wind.
		...	0·71	0·52	...	...	...	0·38	...	...	...	...	Some large.			
June 15	" . .	36½	36½	12	...	...	...	...	70	...	...	...	Medium, some small.	Jig lines for Herrings.	Mussels for Haddock.	Generally light and fine.
		0·52	0·52	0·17	...	...	...	...	...	...	...	...				

TABLE F.—ANSTRUTHER DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbet.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July 22	Crail, . .	7	135	121	...	...	...	24	172	...	...	...	Most medium, some small.	...	Mussels.	Light.
		0·04	0·78	0·70	...	...	...	0·13	...	...	...	...				
Aug. 27	" . .	...	208	155	...	...	...	88	348	...	...	...	Most medium, some large.	...	...	...
		...	0·59	0·44	...	...	...	0·25	...	...	...	...				
Sept. 22	" . .	...	92	87	...	...	...	32	221	...	...	...	Most medium, some small.	...	Mussels, Limpets, Lugs, and Ink Fish.	Generally fine.
		...	0·41	0·39	...	...	...	0·14	...	...	...	...				
Oct. 25	" . .	...	170	127	...	23	...	...	152	...	161	...	Medium and large.	...	Mussels, Ink Fish for Cod.	Generally fine.
		...	1·11	0·83	...	0·15	...	...	...	...	...	...				
Nov. 5	" . .	...	11½	2½	...	...	...	1	12	...	1	...	...	...	...	...
		...	1·00	0·20	...	...	...	0·08	...	...	...	...				
Dec. 22	" . .	...	399	113	...	17½	12	16	142	...	7	...	Most medium, some large and small.	...	Mussels, Herrings, and Slotches.	Generally fine.
		...	2·81	0·79	...	0·12	0·08	0·11	...	...	...	...				

TABLE F.—ANSTRUTHER DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan. 21	St Andrews,	12	20	...	...	1185	...	...	258	25 to 45 ft.	102	...	Large & small, bu tmost medium.	...	Mussels, Lug, and Limpets.	Fine; often fresh.
		0·04	0·07	...	...	4·59	...	...	...	...	...	...				
Feb. 12	„	...	7	...	...	586	...	...	166	25 to 30 ft.	116	30 to 45 ft.	Medium.	...	Mussels and Lug.	Fine; occasionally stormy.
		...	0·04	...	...	3·53	...	...	...	...	...	...				
Mar. 8	„	...	...	...	...	109	...	...	32	25 to 30 ft.	151	40 to 45 ft.	Large and small.	...	Mussels and Lug.	Sometimes fine; generally stormy.
		...	...	...	...	3·40	...	...	...	...	...	...				
Apr. 19	„	...	...	...	...	226	...	...	112	15 to 30 ft.	230	45 to 58 ft.	Large and small.	...	Mussels and Lug.	Fine or moderate.
		...	...	...	...	2·01	...	...	...	...	...	...				
May 25	„	...	...	263	8	298	...	...	263	25 to 30 ft.	214	45 to 58 ft.	Large and small.	...	Mussels, Lug, and Limpets.	Fine or fresh.
		...	...	1·00	0·03	1·01	...	...	...	...	...	...				
June 25	„	...	...	323	...	158	...	...	189	20 to 30 ft.	195	45 to 58 ft.	Large and small.	...	Mussels, Lug, and Limpets.	Occasionally fine; fresh or stormy.
		...	...	1·70	...	0·83	...	...	...	...	...	...				

TABLE F.—Anstruther District—*continued.*

Month and Number of Days Fishing.	Place where Landed.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July 22	St Andrews, .	...	...	383	1	134	...	...	181	...	117	...	Large and small.	...	Mussels, Lug, and Limpets.	Fine or unsettled.
		...	...	2·11	0·00	0·74	...	...	...	...	...	...				
Aug. 27	,, .	...	...	383	6	201	...	...	223	...	67	...	Large and small.	...	Mussels, Lug, and Limpets.	Fine.
		...	...	1·71	0·02	0·90	...	...	...	...	...	...				
Sept. 23	,, .	...	...	324	1	95	...	...	150	...	171	...	Large and small.	...	Mussels and Lug.	Fine.
		...	...	2·16	...	0·63	...	...	...	...	...	...				
Oct. 25	,, .	...	...	387	10	104	...	...	131	...	191	...	Large and small.	...	Mussels.	Fine.
		...	...	2·95	0·07	0·79	...	...	...	...	...	...				
Nov. 11	,, .	...	31	132½	...	287	...	...	131	...	27	...	Large and small.	...	...	...
		...	0·23	1·01	...	2·19	...	...	...	...	...	...				
Dec. 22	,, .	...	248	263	...	...	...	...	204	...	175	...	Large and small.	...	Mussels and 'Paps.'	Generally fine.
		...	1·21	1·23	...	...	...	...	...	...	...	...				

TABLE F.—MONTROSE DISTRICT.

Month and Number of Days Fishing.	Place where Landed.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*No.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan. 11	Broughty Ferry,	...	1	$6\frac{1}{2}$	$1\frac{1}{4}$	...	...	$4\frac{1}{2}$	27	19 to 30 ft.	?	...	$\frac{1}{2}$ large.	...	Mussels and Lug.	Unsettled.
		...	0·03	0·24	0·04	...	...	0·16	...	...	...	...				
Feb. 10	,,	...	...	...	...	280	...	36	71	...	?	...	...	...	Rign and Lug Worms.	Fine.
		...	...	...	...	3·94	...	0·47	...	...	...	...				
Mar. 11	,,	...	...	...	...	174	...	...	55	...	?	...	...	...	Lug.	Unsettled.
		...	...	...	...	3·16	...	...	...	...	...	...				
Apr. 18	,,	...	76	203	36	$240\frac{1}{2}$	...	$30\frac{1}{2}$	138	...	112	...	Mostly small.	...	Lug and Rign Worms.	Fair; sometimes rough.
		...	0·55	1·47	0·60	1·74	...	0·22	...	...	...	...				
May 20	,,	...	24	$117\frac{1}{2}$	13	311	...	$18\frac{3}{4}$	132	...	216	...	Mostly small.	...	Mussels and Worms.	Generally unsettled.
		...	0·18	0·89	0·09	2·35	...	0·14	...	...	...	...				
June 18	,,	...	16	$94\frac{1}{2}$	19	$124\frac{1}{2}$	12	$19\frac{3}{4}$	86	...	207	...	Mostly small.	...	Mussels and Worms.	Moderate but unsteady.
		...	0·18	1·10	0·22	1·44	0·14	0·22	...	...	...	...				

TABLE F.—MONTROSE DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Crans.	*No.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July 18	Broughty Ferry,	...	6	75	$14\frac{1}{2}$	$73\frac{1}{2}$	$3\frac{1}{4}$	$17\frac{1}{4}$	60	...	98	...	Mostly small.	...	Mussels and Lug.	Unsettled.
		...	0·10	1·25	0·24	1·22	0·05	0·28	...	...	...	...				
Aug. 17	,,	...	2	19	2	70	$2\frac{1}{2}$ Skate.	13	49	...	473	...	Mostly small.	...	Mussels and Lug.	Fair, but unsettled.
		...	0·04	0·38	0·04	1·42	0·05	0·26	...	...	...	...				
Sept. 8	,,	...	1	3	$\frac{1}{2}$	22	...	$2\frac{1}{2}$	18	...	258	...	Small.	...	Mussels and Worms.	Fine.
		...	0·05	0·16	0·02	1·22	...	0·13	...	...	...	...				
Oct. 13	,,	...	15	$37\frac{1}{2}$	$13\frac{1}{4}$	36	...	$13\frac{3}{4}$	37	...	96	...	Small.	...	Mussels.	Generally unsteady.
		...	0·40	1·01	0·35	0·97	...	0·37	...	...	...	...				
Nov.	,,	11	108	80	$18\frac{1}{2}$	20	...	22	$\begin{cases}40\\36\end{cases}$	Herring Fishing.	? 42	...	...	...	...	...
		0·27	3·00	2·22	0·51	0·55	...	0·61	...	...	...	...				
Dec. 7	,,	52	175	$46\frac{1}{2}$	10	6	...	$14\frac{1}{2}$	74	...	135	...	$\frac{1}{2}$ large, $\frac{1}{2}$ small.	...	Herring and Mussels.	Unsettled.
		0·70	2·36	0·62	0·13	0·08	...	0·19	...	...	...	...				

TABLE F.—MONTROSE DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*No.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan.	Auchmithie, .	No Fishing within Territorial Waters.						...	...	...	111	...	...	...	...	...
								...	...	...	...	...				
Feb.	" .		"			"		...	...	...	117	...	...	...	...	...
								...	...	...	...	...				
Mar.	" .		"			"		...	...	...	104	...	...	...	...	...
								...	...	...	...	...				
Apr.	" .		"			"		...	...	...	164	...	...	...	...	...
								...	...	...	...	...				
May	" .		"			"		...	...	...	159	...	...	...	...	...
								...	...	...	...	...				
June	" .		"			"		...	...	...	167	...	...	...	...	...
								...	...	...	...	...				

TABLE F.—MONTROSE DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*No.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July	Auchmithie,	No Fis	hing w	ithin T	erritor	ial Wa	ters.	...	...	...	111	...	...	...	...	...
								...	...	...	...	...				
Aug.	"		"			"		...	...	...	106	...	...	...	...	...
								...	...	...	...	...				
Sept.	"		"			"		...	...	...	128	...	...	...	...	...
								...	...	...	...	...				
Oct.	"		"			"		...	...	...	182	...	...	...	...	...
								...	...	...	...	...				
Nov.	"		"			"		...	...	...	31	...	...	...	...	...
								...	...	...	...	...				
Dec. 3	"	...	...	6	...	...	...	13	13	...	127	...	Medium and small.	...	Mussels.	Generally fine.
		...	...	0·46	...	...	...	1·00	...	...	...	...				

TABLE F.—MONTROSE DISTRICT—*continued.*

Month and Number of Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*No.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan. 17	Arbroath, .	6	46	29	...	...	...	38	102	18 to 30 ft.	544	30 to 50 ft.	Medium.	...	Mussels.	Generally fine.
		0·05	0·45	0·28	...	...	...	0·37	...	...	...	...				
Feb. 11	" .	...	4	7	...	...	...	26	66	...	352	...	Medium.	...	Mussels and Herrings.	Generally fine.
		...	0·06	0·10	...	...	...	0·39	...	...	...	...				
Mar. 10	" .	...	...	1	...	...	...	32	40	...	341	...	Medium.	...	Mussels and Herrings.	Generally fine.
		...	...	0·02	...	...	...	0·80	...	...	...	...				
Apr. 16	" .	...	26	20	...	...	...	145	120	...	487	...	½ large ; ½ small.	...	Mussels.	Generally fine.
		...	0·21	0·16	...	...	...	1·20	...	...	...	...				
May 10	" .	...	11	...	...	...	...	8	39	...	306	...	Most medium; some small.	...	Mussels.	Generally fine.
		...	0·28	...	...	...	...	0·20	...	...	...	...				
June 19	" .	...	18	28	...	...	...	29	76	...	570	...	Small.	...	Mussels.	Generally fine.
		...	0·23	0·36	...	...	...	0·38	...	...	...	...				

TABLE F.—MONTROSE DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Area restricted from Trawling.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Crans.	*No.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July 19	Arbroath,	...	15	31	...	...	...	14	74	...	458	...	Small.	...	Mussels.	Generally fine.
		...	0·20	0·41	...	...	...	0·19	...	...	...	...				
Aug. 14	"	...	7	23	...	...	...	4	28	...	...	...	Small.	...	Mussels.	Generally fine.
		...	0.25	0·82	...	...	...	0·14	...	...	...	...				
Sept. 16	"	...	6	30	...	...	...	15	61	...	...	...	Small.	...	Mussels.	Generally fine.
		...	0·10	0·49	...	...	...	0·24	...	...	...	...				
Oct. 21	"	...	70	72	7	...	...	17	76	...	651	...	Small.	...	Mussels.	Generally fine.
		...	0·92	0·95	0·09	...	...	0·22	...	...	...	...				
Nov. 8	"	...	38	19	1	...	...	2	32	...	...	...	Small.	...	Mussels.	Generally fine.
		...	1·18	0·59	0·03	...	...	0·06	...	...	...	...				
Dec. 17	"	...	273	43	1	...	...	69	80	...	504	...	Medium and large.	...	Mussels.	Fine; sometime stormy.
		...	3·41	0·53	0·01	...	...	0·86	...	...	...	...				

TABLE F.—MONTROSE DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Territorial Waters.							Fumber and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan. 21	Montrose and Ferryden,	...	119	266	22½	89	..	89	188	18 to 35 ft.	770	35 to 54 ft.	Medium.	...	Mussels.	...
		...	0·63	1·41	0·12	0·47	...	0·47	...	...	...	...				
Feb. 18	"	...	86	225	3	26	½	61½	134	18 to 35 ft.	541	...	Large.	...	Mussels.	...
		...	0·64	1·67	0·02	0·19	...	0·45	...	...	...	...				
Mar. 12	"	...	99	267	5¼	3½	...	60	125	18 to 35 ft.	308	...	⅔ large.	...	Mussels.	...
		...	0·79	2·13	0·04	0·02	...	0·48	...	...	...	...				
Apr. 17	"	...	67	115	7¼	2¾	1¼	26½	73	18 to 35 ft.	574	...	Small.	...	Mussels.	...
		...	0·91	1·57	0·90	0·03	0·01	0·36	...	...	...	...				
May 14	"	...	85	94½	30	3	1	20¾	57	...	598	...	Small.	...	Mussels.	...
		...	1·49	1·65	0·52	0·05	0·01	0·36	...	...	...	...				
June 14	"	...	43	63	24	7¾	..	22½	46	18 to 35 ft.	600	...	Small.	...	Mussels.	Generally N. Winds
		...	0·93	1·37	0·52	0·16	..	0·48	...	...	...	...				

TABLE F.—MONTROSE DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Territorial Waters.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July 22	Montrose and Ferryden, .	...	88	143	49½	8¾	¼	47	101	18 to 35 ft.	421	...	Small.	...	Mussels.	Generally N. Winds.
		...	0·87	1·41	0·49	0·08	0·00	0·46	...	...	...	...				
Aug. 27	„ .	...	66	162½	35	6¾	...	40½	107	...	194	...	Small.	...	Mussels.	S.W. Winds.
		...	0·62	1·51	0·32	0·06	...	0·37	...	...	...	...				
Sept. 24	„ .	...	42	178	36½	17	...	38	113	...	315	...	Small.	...	Mussels.	Generally S. Winds.
		...	0·37	1·57	0·32	0·15	...	0·33	...	...	...	...				
Oct. 18	„ .	...	56	161	38½	7½	...	43	104	...	724	...	Small.	...	Mussels.	...
		...	0·53	1·54	0·37	0·07	...	0·41	...	...	...	...				
Nov. 10	„ .	...	171	204	26	6½	...	51½	121	...	315	...	...	...	Mussels.	...
		...	1·41	1·68	0·21	0·05	...	0·42	...	...	...	...				
Dec. 18	„ .	...	219	194	40	1	...	74½	144	...	673	...	Small.	...	Mussels.	...
		...	1·52	1·34	0·27	0·00	...	0·51	...	...	...	...				

TABLE F.—MONTROSE DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Territorial Waters.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Crans.	*No.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan. 20	Johnshaven, .	7	516	205	29	...	20	137	197	...	181	...	Mostly large.	...	...	Fine; often squally.
		0·03	2·61	1·04	0·14	...	0·10	0·69	...	...	...	...				
Feb. 23	,, .	...	798	228	...	...	28 Skate.	256	173	...	265	...	Large.	...	...	...
		...	4·61	1·32	...	...	0·16	1·48	...	...	...	...				
Mar. 17	,, .	...	361	34	...	2	...	143	98	...	140	...	Most large.	...	...	Fine.
		...	3·68	0·34	...	0·02	...	1·46	...	...	...	...				
Apr. 20	,, .	...	247	39	...	5	...	119	132	...	39	...	Most small.	...	...	Fine.
		...	1·87	0·29	...	0·03	...	0·90	...	...	...	...				
May 20	,, .	...	40	115	21	...	...	38	141	...	31	...	Small.	...	...	Generally fine.
		...	0·39	1·13	0·20	...	...	0·37	...	...	...	...				
June 21	,, .	4	...	97	34	...	...	21	95	...	21	...	Small.	...	...	Generally fine.
		0·04	...	1·02	0·35	...	...	0·22	...	...	...	...				

TABLE F.—MONTROSE DISTRICT—*continued*.

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Territorial Waters.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*No.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July 23	Johnshaven, .	...	...	124	34	...	...	33	132	...	8	...	Small.	...	...	Generally fine.
		...	...	0·93	0·25	...	...	0·25	...	...	...	...				
Aug. 25	" .	...	...	126	30	1	...	19	107	...	15	...	Small.	...	...	Generally fine.
		...	...	1·17	0·28	...	...	0·17	...	...	...	...				
Sept. 25	" .	...	...	179	28	5	...	51	137	...	191	...	Small.	...	...	Fine.
		...	...	1.30	0·20	0·03	...	0·37	...	...	...	...				
Oct. 20	" .	...	18	171	61	9	...	37	130	...	238	...	Small.	...	Mussels.	Often squally.
		...	0·13	1·31	0·46	0·06	...	0·28	...	...	...	...				
Nov. 9	" .	...	142	72	23	...	...	37	71	...	147	...	...	...	...	...
		..	2·00	1·01	0·32	...	...	0.52	...	...	...	...				
Dec. 17	" .	56	1197	43	1	...	...	74	134	...	151	...	...	...	...	...
		0·41	8·93	0·32	...	...	...	0·55	...	...	...	...				

TABLE F.—MONTROSE DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Territorial Waters.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. Jan. 21	Gourdon, .	12	1087	1159	164	...	...	699	681	...	400	...	⅔ large, rest medium and small.	...	Mussels.	Generally fine.
		0·01	1·59	1·70	0·24	...	...	1·02	...	...	...	...				
Feb. 20	. .	...	467	2145	65	...	...	566	538	...	400	...	Mostly large.	...	Mussels.	Generally fine.
		...	0·86	3·98	0·12	...	...	1·05	...	...	...	...				
Mar. 15	" . .	...	509	1524	25	...	...	503	394	...	328	...	Medium.	...	Mussels.	Fair or moderate.
		...	1·29	3·86	0·06	...	...	1·29	...	...	...	...				
Apr. 21	" . .	...	591	1470	86	8	...	544	665	...	420	...	Small.	...	Mussels.	Moderate.
		...	0·38	2·21	0·12	0·01	...	0·81	...	...	...	...				
May 22	" . .	...	440	750	195	...	...	214	723	...	414	...	Small.	...	Mussels.	Fine.
		...	0·60	1·03	0·20	...	...	0·29	...	...	...	...				
June 23	" . .	...	239	604	401	21½	...	134	666	...	506	...	Medium and small.	...	Mussels.	Generally fine.
		...	0·35	0·90	0·60	0·03	...	0·20	...	...	...	...				

TABLE F.—MONTROSE DISTRICT—*continued*.

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Territorial Waters.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July 22	Gourdon, .	...	236	831	403	21½	...	183	533	17 to 26 ft.	132	...	Small.	...	Mussels.	Generally fine.
		...	0·44	1·55	0·75	0·04	...	0·34	...	...	...	...				
Aug. 24	„ . .	43½	194	729	241	12½	...	161	450	...	...	...	Small.	...	Mussels and Herring.	Fine.
		0·09	0·43	1·62	0·53	0·02	...	0·35	...	...	...	...				
Sept. 22	„ . .	...	193	2461	248	33	...	364	610	...	518	...	Small.	...	Mussels.	Fine.
		...	0·31	4·03	0·40	0·05	...	0·59	...	...	...	...				
Oct. 22	„ . .	...	255	1821	272	27	...	...	575	...	372	...	Small.	...	Mussels.	Moderate.
		...	0·44	3·16	0·47	0·04	...	0·60	...	...	...	...				
Nov. 9	„ . .	...	436	317	65	8¼	...	334	244	...	194	...	Small.	...	Mussels.	Moderate.
		...	1·78	1·29	0·26	0·03	...	1·36	...	...	...	...				
Dec. 16	„ . .	45	1451	626	81	6	...	245	434	...	352	...	Medium and small.	...	...	Moderate.
		0·10	3·34	1·44	0·18	0·01	...	0·56	...	...	...	...				

TABLE F.—STONEHAVEN DISTRICT.

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Territorial Waters.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
									No.	*Size.*	*No.*	*Size.*				
1888. Jan. 22	Shieldhill to Skateraw (Stonehaven District)	*Cwts.* 562	*Cwts.* 330	*Cwts.* 1885	*Cwts.* 96	*Cwts.* 43	*Cwts.* 10	*Cwts.* 287	834	16 to 40 ft.	581	16 to 40 ft.	Very large, and large.	...	Mussels and Herring.	Generally fine and frosty.
		0·67	0·39	2·26	0·11	0·05	0·01	0·34	...	...	...	...				
Feb. 21	,,	75	100	2280	23	21	3	260	828	...	857	...	Large.	...	Mussels, Herrings, and Liver.	Generally fine and frosty; sometimes rough.
		0·09	0·12	2·75	0·02	0·02	...	0·31	...	...	...	...				
Mar. 16	,,	...	42	1087	24	17	...	94	662	...	695	...	Large and small, but most medium.	...	Mussels, Herrings, and Liver.	Generally fair; cold westerly.
		...	0·06	1·64	0·03	0·02	...	0·14	...	...	...	...				
Apr 20	,,	...	21	341	51	18½	...	75	403	...	952	...	Mostly medium.	...	Mussels, Herrings, and Liver.	Southerly and fine; westerly and rough; squally.
		...	0·05	0·84	0·12	0·04	...	0·18	...	...	...	...				
May 23	,,	...	23	850	207	16	...	165	498	16 to 30 ft.	594	16 to 61 ft.	Medium, some small.	...	Mussels, Herrings, and Liver.	Southerly and fine; westerly and rough; squally.
		...	0·04	1·70	0·41	0·03	...	0·33	...	...	...	...				
June 26	,,	...	19	1155	498	23	...	127	645	...	1525	...	Medium and small.	...	Mussels, Herrings, and Liver.	Generally fine and warm.
		...	0·02	1·79	0·77	0·03	...	0·19	...	...	...	...				

TABLE F.—STONEHAVEN DISTRICT—*continued.*

Month and Number of Days Fishing.	PLACE WHERE LANDED.	Quantity of Net and Line Fish caught within the Territorial Waters.							Number and Size of Boats Fishing.				Average Size of Fish.	How captured.	Kind of Bait used.	Weather.
		Herring.	Cod.	Haddock.	Whiting.	Soles, Dabs, and Flounders.	Skate and Turbot.	Other White Fish.	Inside the Area.		Outside the Area.					
		Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*	*No.*	*Size.*	*No.*	*Size.*				
1888. July 20	Shieldhill to Skateraw (Stonehaven District)	...	29	383	316	16	...	60	349	16 to 20 ft.	746	16 to 50 ft.	Medium and small.	...	Mussels, Herrings, and Liver.	Generally dull and fine.
		...	0·08	1·09	0·90	0·04	...	0·17	...	...	...	...				
Aug. 24	"	995	17	447	335	23	...	37	501	...	140	...	Medium and small.	...	Mussels and Herrings.	Generally fair.
		1·98	0·03	0·89	0·66	0·04	...	0·07	...	...	...	...				
Sept. 25	"	...	48	441	195	33	...	65	601	16 to 40 ft.	478	...	¼ large, ¾ medium.	...	Mussels and Liver.	Generally fair.
		...	0·08	2·39	0·32	0·05	...	0·10	...	...	...	...				
Oct.	"	1	81	532	196	46	...	45	388	...	922	18 to 45 ft.	Most medium, some large and small.	...	Mussels and Liver.	Generally fair.
		...	0·20	1·37	0·50	0·11	...	0·11	...	...	...	...				
Nov.	"	7	80	315	58	8½	...	20	237	...	352	...	Medium.	...	Mussels and Liver; once Anemone.	Stormy.
		0·02	0.33	1·32	0·24	0.03	...	0·08	...	...	...	...				
Dec. 23	"	978	610	804	68¼	17	...	54¼	597	...	729	...	Large and medium.	...	Mussels, Herrings, and Liver.	...
		1·63	1·02	1·34	0·11	0·02	...	0·09	...		...	...				

TABLE G.—*Showing the Monthly 'Takes' of Cod, Haddock, and Whiting by Forty-one East Coast Fishing Boats in* 1888.

District.	Date.	No. of Trips.	Under 2 Miles.			2 to 3 Miles.			3 to 6 Miles.			Over 6 Miles.		
			Cod and Codling.	Haddock.	Whiting.	Cod and Codling.	Haddock.	Whiting.	Cod and Codling.	Haddock.	Whiting.	Cod and Codling.	Haddock.	Whiting.
Aberdeen.	Jan.	78	11½	152	14	.	294	11	.	238	15	8	2697	249
5 boats.	Feb.	104	27½	1525½	21	.	1175	9	.	492	6	.	159½	.
(The figures	March	69	4½	826½	16½	.	411½	57	.	.	.	.	210	45
give the	April	69	.	343	47	.	104½	16	.	781½	78½	.	818	114
number of	May	59	.	115	.	.	410	58	.	253	55	.	1233	207
'Scores' of	June	60	.	170	6	.	112	.	.	132	42	.	1417	205
fish).	July	73	.	436	374	.	265	251	16	201	107	.	627	200
	August	84	.	402	199	.	814	570	.	443	261	.	.	.
	Sept.	83	.	104	16	.	225½	99	.	253	128	.	2683	595
	Oct.	62	.	342½	64½	.	107	43	.	375½	48	.	1986	154½
	Nov.	37	.	18	.	.	66	4½	.	447	80½	.	742	56½
	Dec.	54	.	.	.	.	21	.	.	132	12	.	2401	227½
		832	43½	4434½	758	.	4005½	1118½	16	3748	833	8	14973½	2053½
	Total	cwts.	5¼	554	94½	.	500	139	2	468	104	1	1871	256
Stonehaven.	Jan.	153	15¼	49	.	23	76¾	.	4	91	.	29	315½	.
11 boats.	Feb.	157	8	173	.	24	131	.	¼	168	.	3	79½	.
(The figures	March	129	10¾	60	.	12¾	76¼	.	4½	146	.	1	4	.
give the	April	99	5¼	16	.	6¼	24	.	23	67	.	143	85½	.
number of	May	106	.	31¾	7¼	1	38½	8¼	.	62	5	486	358	.
cwts).	June	112	3½	27¼	.	.	57¾	26	.	58½	.	363	369	.
	July	69	.	39	1½	.	44¼	.	.	56¾	.	.	99½	.
	August	71	1¼	33	2¼	.	77	9	.	26¼	4¼	.	.	.
	Sept.	135	2½	49¾	3	1	100½	6½	1	188¾	4	3½	213½	.
	Oct.	132	.	128	.	.	38¾	.	.	200	.	.	203	.
	Nov.	47	11	18½	3	8	17	6	.	54	10½	.	13	.
	Dec.	135	67	18½	.	6	29½	.	43¼	54	.	.	152	4½
		1345												
	Total	cwts.	124½	633¾	17	82	711¼	55¾	76	1172¼	23¾	1028½	1892½	4½
Montrose.	Jan.	142	3¼	64	.	27½	33	.	30	145½	5	19	262	6½
12 boats.	Feb.	135	8½	306¼	.	8	21	½	11	176¾	2	5½	307¼	5
(The figures	March	92	21½	121½	.	.	49½	.	6	100½	2	4¾	106½	5¼
give the	April	122	12¼	15¼	.	¾	26¾	2	9¾	127¼	3	43½	276½	16¼
number of	May	122	18	136½	16	.	9	½	5	29½	5¼	63	647¾	48½
cwts).	June	139	31	154¾	26	.	11	4	4½	92¾	20¼	65	603½	58¾
	July	79	8	51	1	.	.	.	4½	114	9½	14	221	18
	August	87	.	6½	.	.	5½	.	1	96¾	1½	8	59¾	12½
	Sept.	158	1¼	119	19½	½	18½	1	1	123	4	30	648¾	47½
	Oct.	175	4	105½	7	.	36¼	2½	4	109½	13½	23½	570	60½
	Nov.	58	¼	20¾	.	5	19	1	27	98	3	17½	98½	4½
	Dec.	152	10½	2	2	5¼	7	.	69	190¾	6	84	219¾	6½
		1461												
	Total	cwts.	118½	1103	71½	47	236½	11½	172¾	1404¼	75	377¾	4021¼	289¾
Anstruther.	Jan.	196	.	170¾	.	.	118¾	.	1¼	181	3	.	50¼	3
12 boats.	Feb.	194	6½	122¾	.	1	170¾	.	.	320½	.	.	17½	.
(The figures	March	150	7½	52¾	.	7	96¼	.	8¼	236	¼	6	9½	.
give the	April	188	4½	82½	.	¾	73¼	.	.	312¼	5¾	.	37	6½
number of	May	178	.	137¾	.	.	73¾	.	.	198½	.	2	89	6
6-stone boxes	June	177	.	152½	.	.	120	.	.	181½	1	1	17	2
or baskets).	July	138	.	132¼	1	.	2½	.	.	224	.	.	.	.
	August	138	.	113½	16	.	28	.	.	200¼	.	.	.	.
	Sept.	108	.	93	.	.	24	.	.	157¼	.	.	.	.
	Oct	204	.	214¾	¾	.	125¼	2	.	211¾	.	.	60	.
	Nov.	89	.	62½	.	.	99¾	.	.	11	.	.	.	.
	Dec.	210	.	127	.	.	117	.	.	291¾	.	.	.	.
		1970	18½	1462	17¾	8¾	1049¼	2	9½	2525¾	10	9	280¼	17½
	Total	cwts.	14	1096½	13¼	6½	787	1½	7	1894¼	7½	6¾	210	13

Table G.—*continued.*

District.	Date.	No. of Trips	Under 2 Miles.			2 to 3 Miles.			3 to 6 Miles.			Over 6 Miles.		
			Cod and Codling.	Hadd0ck.	Whiting.	Cod and Codling.	Haddock.	Whiting.	Cod and Codling.	Haddock.	Whiting.	Cod and Codling.	Haddock.	Whiting.
Leith. 3 boats. (The figures give the number of stones).	Jan.	.	No	entrie	s	.	.	.	.	.	.	.	.	.
	Feb.	?	.	.	.	.	.	.	.	108	.	80	130	.
	March	18	.	.	.	.	.	.	.	643	.	.	480	.
	April	24	.	.	.	.	.	.	.	144	.	.	850	.
	May	24	.	.	.	.	.	.	.	.	.	.	2621	.
	June	17	.	.	.	.	.	.	.	.	.	600	9668	.
	July	.	No	entrie	s	.	.	.	.	.	.	.	.	.
	August	.	No	entrie	s	.	.	.	.	.	.	.	.	.
	Sept.	13	.	.	.	.	.	.	.	.	.	.	1382	.
	Oct.	28	.	.	.	.	.	.	.	.	.	.	3485	.
	Nov.	18	.	.	.	.	.	.	30	.	.	.	1394	.
	Dec.	16	.	.	.	.	.	.	.	.	.	.	3420	.
		158	.	.	.	.	.	.	30	895	.	680	23430	.
	Total	cwts.	.	.	.	.	.	.	2¾	112	.	85	2928¾	.
Total for the	Year	5766	262¼	3387½	196¼	135½	2234¾	207¾	260½	5050¾	210¼	1499	10923½	56[illegible]¼

TABLE H.—Showing the Monthly Amounts in cwts. of Round and Flat Fish landed by Line Fishermen and Beam Trawlers on the East Coast of Scotland during 1888.

	Northern Section.				Southern Section.				Whole East Coast.			
	Round Fish.		Flat Fish.		Round Fish.		Flat Fish.		Round Fish.		Flat Fish.	
	Line.	Beam Trawl.	Line.	Beam Trawl.	Line.	Beam Trawl.	Line.	Beam Trawl.	Line.	Beam Trawl.	Line.	Beam Trawl.
January,	75,852	4,725	4,252½	5,893	47,971	7,204	2,218	1,106¼	123,823	11,929	6,470½	6,999¼
February,	86,645	3,827	6,666½	5,530	51,944	5,172	1,557¼	526½	138,589	8,999	8,223¾	6,056½
March,	62,704	7,392	5,603½	4,189	30,959	5,218	1,884½	715½	93,663	12,610	7,488	4,904½
April,	52,061	4,046	7,843	2,285	38,875	3,441	1,815	513	90,936	7,487	9,658	2,798
May,	47,609	5,757	5,642¾	4,011	60,973	5,168	3,368¾	1,403½	108,582	10,925	9,011½	5,414½
June,	50,689	5,960	4,671¾	2,890	51,557	7,973	3,891	2,124½	102,246	13,933	8,562¾	5,014½
July,	15,984	8,425	822	2,308	17,405	14,253	747½	3,081	33,389	22,678	1,569½	5,389
August,	16,970	9,352	654	2,805	13,211	8,934	813½	1,979½	30,181	18,286	1,467½	4,784½
September,	47,065	12,135	1,221½	3,634	26,301	18,851	1,442½	2,004	73,366	30,986	2,664	5,638
October,	52,117	11,388	1,370	3,657	38,933	10,260	1,216	1,543	91,050	21,648	2,586	5,200
November,	26,558	6,102	780	2,089	12,238	2,309	610	355½	38,796	8,411	1,390	2,444½
December,	65,141	6,772	1,052½	8,395	40,199	4,410	608½	1,685½	105,340	11,182	1,660¾	10,080½
Totals	599,395	85,881	40,579¾	47,686	430,566	93,193	20,172½	17,037¾	1,029,961	179,074	60,752¼	64,723¾

II.—REPORTS FROM HER MAJESTY'S DIPLOMATIC AND CONSULAR OFFICERS ABROAD ON THE BEST MEANS OF INCREASING THE DEMAND IN FOREIGN COUNTRIES FOR SCOTCH-CURED HERRINGS AND OTHER FISH.

(Abstracts, together with a Statistical Account of the Scottish Herring Fishery, by T. WEMYSS FULTON, M.B.)

This paper, which is the outcome of reports obtained by the Board at the instance of Professor Ewart, deals chiefly with the export trade in Scottish-cured herrings.

Among all the fisheries of Scotland that for herrings is by far the most valuable and important, and the number of persons mainly dependent upon it for their livelihood is greater than in the case of all the other fisheries combined. Thus, while the aggregate value of the Scottish sea fisheries last year amounted to £2,113,157, the value of the herring fishery alone was £1,262,076, or nearly sixty per cent. of the total amount. The prosperity of the herring industry depends chiefly upon the export trade; the amount of fresh and cured herring consumed in Scotland being always much less than the amount sent to other countries. The value of the cured herrings last year was £1,174,815, and of the herrings sold fresh £87,261; of the amount cured no less than 774,193 barrels of the value of £851,612 were exported, by far the greater proportion going to the Continental markets, chiefly Germany and Russia. Table I. shows the quantity and value of the herrings caught during each of the years 1882 to 1888 inclusive, the quantity cured, the number of barrels branded, and the number exported.*

A glance at this table at once shows that the great markets for Scotch herrings are in Germany and Russia; the mean for the last seven years being for these countries 909,187 barrels, or 96·2 per cent. of the total amount exported. As the mean number of barrels cured during these years was 1,365,276, we find that Germany and Russia alone absorbed about 66·5 per cent., or considerably more than half of all the herrings cured in Scotland.

It will be seen that from 1882 to 1884 inclusive, there was a gradual

* The statistics of the Scottish herring fishery might be considerably improved. The statistical tables now published vary only in slight details from those given in the early reports, eighty years ago. While uniformity for a long period has advantages, it may also have distinct drawbacks. For instance, at present the *total quantity* of herrings caught cannot be ascertained from the published tables; the amounts of fish sold fresh, and the amounts cured are stated in different terms, namely, crans and barrels respectively, and no information is given which might enable one to convert crans into barrels or *vice versa*. While the total value of *cured* herrings is given, there is no indication of the value of the quantities branded and those unbranded, nor of the value of the quantities under the different brands. No details are given of the amounts and values of unbranded herrings, and of the herrings under the various brands, exported to different countries. There is no information as to the export of smoked herrings, such as kippers, bloaters, and red herrings. These are consumed in various southern countries, such as Italy, in much larger quantities than the pickled fish; but there is nothing to show whether the Scotch fish participate in this trade.

It is also very desirable that the Fishery Board should be furnished with detailed returns showing the amounts and values of the different kinds of fish imported into this country. Such returns are at present not published, and there is evidence that seems to show we may be to some extent neglecting home markets, while regarding those abroad. For, instance, it appears from a recent Consular Report from Gothenburg, that that port alone during the winter herring-fishery of 1888–89 exported to Great Britain no less than 8752 tons of fresh herrings.

TABLE I.—Showing the Annual Catch and Value of Scottish Herrings from 1882 to 1888, with the Amounts Cured, Branded and Exported.

Year.	Total Quantity caught.		Cured.		Branded.					Number of Barrels Exported.					
	Crans.*	Value.	Barrels.	Value.	Crown Full.	Crown Matties.	Crown Spent.	Crown Mixed.	Total.	Ireland.	Germany.	Russia.	Other Places on the Continent.†	Extra European.	Total.
		£		£											
1882	...	...	1,282,973½	...	244,177½	128,690½	61,201	28,543½	462,612½	40,377	707,359½	74,593¼	603¼	3029½	825,982¾
1883	...	2,053,551	1,269,412½	1,904,118	143,739½	234,584	38,860½	53,811½	470,995½	25,870	750,128½	112,762¾	753¼	1246	890,760½
1884	...	2,272,066	1,697,077¼	2,121,346	197,096	323,644	71,662	61,023	653,425	35,299½	988,043	160,206	707½	964½	1,185,220½
1885	...	1,694,986	1,572,952¼	1,572,952	220,491½	313,258	86,744½	68,831	689,325	22,711	944,400	159,368	937½	1173	1,128,589½
1886	...	1,461,251	1,312,223¼	1,377,834	224,076½	115,951½	126,824	52,142½	518,994½	27,538½	778,007	129,102	1787¼	1934½	938,369½
1887	...	1,128,480	1,303,424¼	1,042,739	181,899	175,110½	95,300½	37,688½	489,998½	35,982¼	702,107¼	123,935½	878	3008¼	865,911¼
1888	...	1,262,076	1,118,872¼	1,174,815	187,146	88,026	86,290½	22,518	383,980½	34,038½	605,718	128,576½	906½	4924	774,193

* See footnote on opposite page.

† Chiefly Holland.

rise in the number of barrels exported, and from 1885 to 1888 a gradual and progressive decline. This rise and fall is participated in both by Germany and Russia. In 1884 the exports to these two countries reached a maximum of 1,148,249 barrels, out of a total export of 1,185,220½ barrels, and a total number cured of 1,697,077 barrels. In 1888 the total had fallen to 734,294½ barrels, out of an export of 774,193 barrels and a total number cured of 1,118,872¼, or a decrease of 413,955 barrels exported to Germany and Russia as compared with 1884, which is the lowest quantity during the past seven years. The significance of such figures, however, can only be rightly understood if they are reduced to percentages. In the seven years for which we have statistics, we find the percentages of exports to Germany and Russia to be as follows:—

	Germany.		Russia.	
	Percentage of Total cured in Scotland.	Percentage of Total Exports.	Percentage of Total cured in Scotland.	Percentage of Total Exports.
1882	55·1	85·6	5·8	9·0
1883	59·0	84·2	8·8	12·6
1884	58·2	83·3	9·4	13·5
1885	60·0	83·6	10·1	14·1
1886	59·2	82·9	9·8	13·7
1887	53·8	81·0	9·5	14·3
1888	54·1	78·2	11·4	16·6

These figures are very significant, we see that the percentage of exports *direct* to Russia have risen gradually and considerably, and that the exports to Germany have fallen. The causes which produce these fluctuations are no doubt various and complex. It must be remarked, however, that Russia receives very large quantities of Scotch herrings, *viâ* Germany, and these figures seem to show that this direct trade with Russia is increasing at the expense of the indirect trade. We have no information as to the amount of this indirect trade or how it has varied in recent years. As is stated below, Russia a few years ago raised the import duties from about 4s. 8d. to nearly 7s. per barrel of 10 poods or 360 lbs., and this undoubtedly has checked the trade, but it would appear only the indirect trade, for if the percentage of the total exports from Scotland to Germany and Russia combined are considered, we find that in 1882 it was about 94·6; in 1883 96·8; in 1884 96·8; in 1885 97·7; in 1886 96·6; in 1887 95·3; and in 1888 94·8. The increase in the direct trade with Russia is of course due to the fact that the German import duties are escaped.

It will be found from the Consular Reports from Germany and Russia, referred to below, that in recent years grave allegations have been made as to the trustworthiness of the Scottish Crown brands. It is stated in some of them that the brands no longer always represent what the barrels contain, and that their value as a commercial guarantee has become depreciated. This matter might be cleared up if statistics were available showing the proportions of branded and unbranded barrels exported to different countries, and the proportions under the different brands. Unfortunately, such statistical information is not published. But if the figures given in Table I. of the total number of barrels cured, and the total number branded are reduced to percentages we find that in recent years there has been a considerable falling off in the proportion of barrels of cured herrings which received the official brand, the proportion for last year being the lowest during the seven years under consideration.

The percentage of the branded barrels are as follows:—

1882	1883	1884	1885	1886	1887	1888
36·0	37·1	38·4	43·8	39·5	37·5	34·3

These figures refer only to the total amounts branded in Scotland, and not to the amounts exported, but they may be taken as a pretty safe guide as to the value placed on the brand on the Continent, and taken alone they seem to support the allegations made against the increasing untrustworthiness of the brand.

We have no information as to the imports into Germany or Russia of cured herrings from other countries; but there is such information with reference to one German port, Stettin, which imports nearly a half of the Scotch herrings exported. Stettin being, therefore the great Continental mart for Scottish-cured herring, it is desirable to consider in some detail the fluctuations in the market during recent years, and the degree to which the cured herrings from other countries have competed with the Scotch fish. During the seven years 1882 to 1888 inclusive, the average number of barrels of Scotch-cured herrings imported into Stettin was 336,476, or a mean of slightly over 70 per cent. of the total imports of cured herrings from all countries. In Table II. the imports from the various countries supplying the market are given.*

TABLE II. Showing the number of Barrels of Cured Herrings imported into Stettin from various countries during 1882–88.

	1882	1883	1884	1885	1886	1887	1888
Scotch	267,231	321,532	389,391	402,932	371,954	310,191	292,105
Norwegian	90,959	84,613	71,247	108,498	123,245	186,653	130,571
Dutch	10,851	19,107	12,993	13,905	21,771	5,876	11,610
Swedish	11,646	6,602	2,614	675	576	1,295	9,627
French	21,075	4,653	6,378	...	...	...	1,137
Bornholm	6,909	2,712	3,161	3,031	1,264	598	1,766
Pomeranian	...	21	67	...	...	...	...
Totals,	408,671	439,240	485,851	529,035	518,810	504,613	446,816

It will be seen that, so far as Stettin is concerned, the great competitor of Scotland is Norway. The supplies of Dutch fish are much smaller and more fluctuating; but it must be borne in mind that by far the greater quantity of the exports from Holland to Germany reach the latter country by the Rhine, by rail, and *viâ* Hamburg. Swedish herrings are also imported at Stettin in comparatively small amounts; the Swedish 'fulls' do not appear to suit the market so well as the Scotch 'fulls,' but there is now a considerable competition of the Swedish 'spents' with the Scotch 'spents.'

Confining our attention to the comparison between the imports from Scotland and Norway, it will be found that during recent years, while the quantity of Scotch fish has been declining, the quantity of Norwegian

* Extracted from *Stettins Handel, Industrie und Schiffahrt, Jahresbericht der Vorsteher der Kaufmannschaft.*

has been increasing. This is shown when the percentages for each year are brought out as follows :—

	1882.	1883.	1884.	1885.	1886.	1887.	1888.
Scottish,	65·3	73·2	80·1	76·1	71·6	61·4	65·3
Norwegian,	22·2	19·2	14·6	20·5	23·7	36·9	29·2

Thus while in 1884 out of every 100 barrels brought into the market about 80 were Scotch, and only about 14½ Norwegian, there occurred in subsequent years, a gradual decrease in the former, and increase in the latter, until in 1887 out of every 100 barrels about 61 were Scotch, and about 37 Norwegian. Last year there was, however, a slight rise in the proportion of Scottish herring and a fall in the Norwegian. The fluctuation in the amounts from the two countries may largely depend upon the productiveness of the fishery during the years under review; but the figures alone bring out very clearly the fact that during recent years Norwegian-cured herring have been to a considerable extent replacing the Scotch fish in the Stettin market. It will appear later that the main reason for this is probably not so much actual deterioration in the condition of the Scotch fish, as the increased efforts made by Norway and other countries to improve the cure, assortment, and packing of their fish in order to meet the requirements of the markets. It may be worth while to consider the proportions in which Scotch herrings under the different brands have been imported. The following table gives the percentages.

	Crown Fulls.	Spents.	Matties.
1882,	43·7	6·1	50·0
1883,	26·7	4·7	68·5
1884,	24·2	6·4	69·3
1885,	30·1	5·2	64·6
1886,	43·5	9·9	46·4
1887,	34·3	4·4	61·2
1888,	41·0	9·9	48·9

Thus the proportion of barrels of full herrings fell gradually from 1882 up to 1885, and has since then risen; while the proportion of maties rose during the former period reaching a maximum of 69·3 per cent. in 1884, and has generally declined since. While the proportions of the different descriptions of herrings imported at Stettin are the result of the demand there for them, they also indicate to some degree the annual variation in the character and size of the herrings cured in Scotland.

Having now given an account, based upon the statistics available, of the export trade in Scotch-cured herring during the last eight years, I shall give a *résumé* of the Reports from British Ambassadors and Consuls abroad, as to the trade in Scottish herrings in various countries, and how it might be extended and improved. The most important of these Reports have been published by the Government.* But a large number, chiefly from colonies and extra-European States, which contain little of importance have not been published.

I. Reports From European States.

Reports were received from one or more centres in the following countries :—Spain, Portugal, Italy, Greece, Montenegro, Servia, Roumania, Turkey, Switzerland, France, Denmark, Sweden, Norway, Belgium, the Netherlands, Austria, Russia, Germany.

It may be convenient to consider these in three groups :—(1) a Mediterranean group, including Portugal; (2) a North-Sea group, (3) Germany, Russia and Austria.

* 'Scotch Herring Trade :—Reports from Her Majesty's Diplomatic and Consular Officers abroad, on the subject of the best means of increasing the demand in Foreign countries for Scotch-cured herrings and other fish,' 1st and 2nd Series C.–5530, 5530–1, 1888.

A. *Mediterranean Group.*

1. *Spain and Portugal.*—In Portugal there is no demand for Scotch-cured herrings; attempts at their introduction have proved unremunerative. Codfish are largely used, chiefly Newfoundland and Norwegian.

In Spain information was received from Madrid, Coruna, Bilbao, Cadiz, Malaga, Carthagena, Aguilas, Almiera, Adia, Marbella, Granada, and from the dependency of Teneriffe. The general result of the inquiries is that cured herrings are little used in Spain, Scotch herrings being practically unknown, and not likely to be a success, because (1) there is a general preference for other fish, especially dried cod, (2) such demand as there is, is met by cheap local supplies, (3) there is an import duty on foreign fish of £4, 8s. 0d. per ton of 1000 kilos. Several Consuls point to the superiority of Scotch-cured herring, and suggest that small consignments might be sent on trial.

2. *Italy.*—Italian Reports were received from Cagliari, Genoa, Naples, Florence and Palermo. The Reports from Italy are of much interest, and serve to show (what will be conspicuously evident when discussing the Reports from Germany and Russia) how important is the attention to such details as packing, appearance of fish, &c. At Genoa, the Consul points out that the fish which sell are English or French cured Labrador codfish, Norwegian stockfish, Cornish pilchards and Yarmouth bloaters; and that Scotch herrings have failed to please, and are not likely to please until the curing is varied. He is told there might be a market for Scotch herrings pickled in brine, if carefully prepared and brought to market in a nice looking, attractive condition; the Italians being 'an artistic 'people and like things not only to be good but to look pretty.' The Consul at Naples says the cure of Scotch herrings does not suit the market there, since they 'are as a rule over-smoked;' while Yarmouth herrings are the only ones suited for the consumer. At Florence herrings from Yarmouth, Holland and Norway, are used, but very few Scotch. To enable Scotch herrings to compete, it is said 'they should be packed 'in small barrels, carefully selected for uniformity of size, care being 'taken that they be not too salt.' At Ancona and Venice, also, Yarmouth herrings are almost the only ones imported, and stress is laid on their being 'large, full, slightly smoked, bright, silvery fish,' packed in barrels of about 165 lbs. each. These have driven the Scotch and Norwegian herrings from the markets. From these Reports it appears that the demand for pickled herrings in Italy is not large; and that to make a market, great attention must be paid to details of selection, appearance, and cure.

3. In *Greece* the demand for cured herrings seems to be large. The Consul at Corfu states that Scottish-cured herrings, 'which is the only 'sort of fish largely consumed in the Ionian Islands,' are imported yearly in large quantity; but from the great competition of the Yarmouth shippers the market is overstocked, and at the end of the season several hundred barrels have to be thrown into the sea. The Consul at the Piraêus believes 'that Greece presents a fair field for competition in the 'dry fish trade;' and it is suggested that a central depôt might be established to supply the Greek markets, under the charge of a person from England.

4. *Servia.*—The cured herrings at present imported come from Hamburg and Bremen, but cannot compare with the Scotch-cured herrings. Sample consignments are recommended, and a list of dealers is given.

5. *Montenegro.*—The demand for fish is small; local supplies are more than sufficient.

6. *Roumania.*—Local supplies are large; imports chiefly come from Russia and France. Dutch-cured herrings are imported *viâ* British ports. Agents to push the sales and study the local tastes and habits are recommended.

7. *Turkey.*—Most of the numerous Reports state that there is no likelihood of opening a market. At Smyrna seven-eighths of the imported herrings come from Yarmouth (2000 barrels yearly), and a few from France and Holland; but from the prevalence of smuggling, prices are low. Greek merchants, with agents in Manchester, control the trade. The British Chamber of Commerce at Constantinople, state that there is a cheap and abundant local supply of fish. The yearly importation of herrings into Constantinople is from 500 to 800 barrels from France, and 1000 to 1500 barrels from the United Kingdom. It would be difficult to increase the sale; but the Chamber suggest that if the Fishery Board consign a small barrel to them they will put it into the market under the most favourable circumstances at their disposal.

B. *The North Sea Group.*

In this group may be included France, Belgium, Holland, Denmark, Norway and Sweden; Switzerland may be considered here also.

8. *France.*—The Reports from France are of much interest, but they serve to negative the probability of increasing the sales of Scottish-cured herrings in that country. It is said to be 'difficult, if not impossible, to 'make any suggestions as to the best means for increasing the demand 'for Scotch-cured herrings or other fish in France,' for 'the tendency of the 'legislation of France in respect of its fishing population generally, and the 'sale of fish in particular, has always been to prevent or to limit the effects 'of competition from abroad.'

At present the trade with France is practically *nil*, although the superior quality of the Scotch fish is freely admitted. The French Government has recently been endeavouring to discover means to improve their fisheries, and the official Commission which lately sat at Boulogne-sur-Mer recommended among other things:—(1) that the herring fishing be not allowed to begin before the 25th of July; (2) that the French Railway Companies be asked to lower their rates for the carriage of fresh, lightly salted, and smoked fish; (3) that the present duty of 5 francs per 100 kilog. on the import of foreign fish, or of 10 francs per 100 kilog. on foreign dried, salted, or smoked fish, should be raised to a general and equal duty all round of 15 francs per 100 kilog. It is obvious that although commercial treaties secure to us until 1892 the present rate of duties, the prospect of developing a market for Scotch fish in France is not encouraging.

The statistics of the imports of dried, salted, and smoked herrings from Great Britain into France make no distinction between Scotch and other fish; but they show considerable recent increase:—

	Kilog.
1884, ...	49,099
1885, ...	34,313
1886, ...	91,418

On the other hand the exports of dried, salted, and smoked herrings from France to Great Britain are very much larger:—

	Kilog.
1884, ...	829,124
1885, ...	1,265,363
1886, ...	530,419

The reasons for this are various :—

(1) It appears the bulk of the French boats catch their herrings off the coasts of Scotland and England, first about Peterhead and Aberdeen, next in the area from about Montrose to St Abbs' Head, and finally near Yarmouth; (2) they carry salt free of duty, and can sell the surplus of their catches free of duty at British ports; (3) they land their fish in France free of the import duty of 10 francs per 100 kilog., and free of the salt duty of 10 francs per 100 kilog.

9. *Belgium.*—The trade in the capital is almost a monopoly and little could be done to establish a market without the co-operation of the limited number of fish merchants in whose hands it is. Scotch-dried herrings are almost unknown, and the smoked fish come almost exclusively from Holland. There are three sorts of Dutch-smoked herrings :—one slightly smoked, preferred in Brussels and in the French provinces; a highly smoked variety, sold in the Walloon districts; and the third moderately smoked, known as the 'Hareng doré,' and which appears to be increasing in favour all over Belgium. It is stated that fish salesmen both in Brussels and Antwerp appear to be ready to introduce Scotch herrings, provided they are full of roe, and not split, but left whole, and cured as nearly as possible in the way of the Dutch fish. The general opinion seems to be that fish in barrels will not sell; hampers or similar light packing being recommended, each containing from 100 to 200 fish. In the height of the season about 800,000 herrings packed in this manner reach the Brussels' salesmen weekly. The gross price realised for the best Dutch varies from 8 francs per hamper of 200 fish in the beginning of the season (about August) to about 5½ francs later; about 10 per cent. may be deducted for carriage, commission, &c. Ostend is supplied chiefly with Dutch-salted herrings, prices running from about 35 to 40 francs per barrel of 130 to 140 kilog. The significant statment is made that 'It would appear a considerable amount 'of Scotch fish find their way indirectly into Belgium *viâ* Holland, 'where the barrels are unpacked and the contents mixed with Dutch 'fish and repacked in light hampers or boxes.'—Of the total of 10,365,775 kilos. of herrings imported into Belgium for home consumption in 1886 (and valued at 3,834,000 francs) 1,983,543 kilos., of the value of 733,911, francs came from the United Kingdom, and not less than 7,599,634 kilos., valued at 2,811,865 francs came from Holland. The hold of Holland in the Belgium herring market is no doubt chiefly due to its propinquity, but there can be little doubt that the greater care taken in the assortment, &c., to meet the local requirements have something to do with it. It is stated that the summer months would be an unfavourable time for the sale of Scotch herrings; and that September would be the best month.

10. *Netherlands.*—It appears there used to be at one time a fairly good market for Scotch herrings in Holland; now only a few hundred barrels come into the market early in the season, before the Dutch fish are ready. The Dutch fish are stated to be much superior in quality to the Scotch, owing to the fact that they are cleaned and slightly salted on board the cutters immediately on being caught. The new Dutch herring craft are large and furnished with every appliance; they cost about £1800 each, while a good Scotch boat costs about £200.* The question of increasing the demand for Scotch herrings lies in a nutshell :—(1) the Scotch curers must either compete by reducing the prices for the quality they now supply, (2) or they must supply a quality at least equal to the Dutch-cured fish.

* A good Scotch herring boat costs from £250 to £300.

11. *Denmark.*—Large quantities of cured herrings are yearly imported into Denmark, but very few, if any, are Scotch. The following table shows the imports of cured herrings in 1886:—

From Great Britain, . . .	907 lbs.
,, Norway, ...	12,817,30 ,,
,, Sweden, ...	144,260 ,,
,, Germany, ...	120,455 ,,

In other words while Norway supplies nearly 98 per cent. of the total imports, Great Britain furnishes the minute fraction of 0·0006 per cent. It is stated that increased demand for Scotch herrings can only be obtained by a greater perfection in the mode of curing, and by a reduction in price. They are dearer than Norwegian herrings which are offered in different sizes, and being caught in the autumn are fatter than the Scottish. The price quoted per barrel in June last year for Norwegian herrings was as follows for the various kinds:—K.K.K., 23 kroner; K.K., 16 kroner; K., 14 kroner; M., 12½ kroner (18 kroner are equal to £1). The import duty on cured herrings is 60 öre (8d) per 100 lbs. gross weight, equal to about 2 kroner per barrel.

12. *Norway and Sweden.*—These countries appear to take no Scottish herrings at all, unless they receive a few barrels included under the heading 'other places on the Continent' in Table I. This no doubt is owing chiefly to the fact that these countries, especially Norway, are large exporters themselves. Nevertheless it seems that at certain periods of the year, or in the case of certain qualities of herrings, importations take place into Norway, while Sweden imports largely; and it is possible that by careful consideration of the requirements of the markets in these countries at various times of the year and the exercise of a little enterprise, a trade might be opened up for Scotch herrings. For instance, H.B.M. Consul at Christiania, states that in the larger towns of Norway, such as Christiania, Dutch spring herrings, imported in small kegs, are considered great delicacies and fetch a high price, and he suggests that the herrings prepared specially at Wick for the Russian market could be sold in these Norwegian towns. There is no duty on the importation of fish into Norway.

So also in Sweden large importations of Norwegian herrings take place and smaller importations of Dutch herrings, but all attempts hitherto made to introduce Scotch herrings have failed, the reason assigned being that in comparison with the Norwegian fish they prove to be of inferior quality and higher in price.

In 1886 Sweden imported 12,714 tons of salted herrings, of the value of £102,421, from Norway; 1112 tons, of the value of £13,897, from Denmark; and 17 tons of the value of £216, from Great Britain.

13. *Switzerland.*—The trade in cured herrings, most of which come from Germany and Holland, is very small. The Report from Lausanne states that Scotch merchants could only compete with the French exporters in that part of Switzerland if they are able to supply smoked herrings in small barrels, containing 126 herrings at the price of something under 40 francs per eight barrels. The appointment of two agents, one for French Switzerland and the other for German Switzerland is recommended.

C. *Germany, Russia, and Austria.*

The Reports dealt with above refer almost entirely to those countries which do not at present import much or any Scotch herrings; they have, therefore, chiefly a prospective interest, so far as it is possible to open up new markets. It is very different, however, in the case of Russia and Germany, which are the great consumers, and hence it is of special importance to closely study the Consular Reports from these countries, in order to ascertain how best the demand may be increased.

13. *Russia.*—The Reports from Russia show that the great obstacle to extension of the trade in Scottish herrings is the high import duty, which was some time ago increased from about 4s. 8d. to nearly 7s. per barrel, and which if maintained cannot fail to still further diminish the importations.

The Russians are one of the great fish-eating nations, fish forming a staple article of diet in the case of the peasantry and poorer classes, and the high import duty affects chiefly the lower qualities of herrings which are mainly consumed by them. The result is that the cheaper qualities 'are not imported into Russia, to the disadvantage of the labouring 'population of the country, who are consequently obliged to provide them-'selves with inferior Russian herrings from the Caspian, the Volga, and 'Archangel.' It will be seen from Table I., however, that Russia imports very large quantities of Scotch-cured herrings.

It is stated that a point on which the Russian merchants lay great stress is, 'that if the curers wish to find a good market and a greater 'demand for their fish, more attention should be paid to quality, cure, and 'packing, and it is also suggested there should be an obligatory Govern-'ment inspection.'

14. *Germany.*—As has been said, Germany is the great market for Scottish herrings, and exports large quantities of them to Russia and Austria. The chief ports at which Scottish herring are imported are, in the order of amounts received, Stettin, Danzig, Hamburg, and Königsberg; and smaller quantities are landed at Memel, Bremen, &c. The only reports received from British Consuls at these places are from Stettin and Königsberg. At Königsberg where 91,192 barrels of Scotch herrings were unshipped in 1888, most of which were sent on by rail to Russia, the Consul reports that—'Great complaints are made of 'the careless way the barrels are now branded by the packers. Many 'marked with the highest or Crown brand on being opened are found to 'contain fish of an inferior quality. This inaccurate marking is so frequent 'that the trade no longer attach any value to the Scotch herring brands.'

The Report from Consul Powell at Stettin, where nearly half of all the herrings exported from Scotland are landed, is in the same strain. This Report, from the intrinsic evidence it bears of thorough investigation into the case, and from the fact that Stettin is the largest emporium in the world for cured herrings, demands attentive consideration. The Consul after careful inquiry, recommends:—

1st. That the herrings should be sized, and those of equal size should be packed together.

2nd. That there should be a certain number of equal size packed in each barrel, and that the number and quality contained should be distinctly and accurately marked on the barrel, say, in lots of 600, 700, 720, and 800.

3rd. Also that more care should be taken in cleaning and curing the fish. The complaint on this head is that Scotch herrings are packed without the roes.

Mr Powell goes on to say:—'But a better selection of fish is the 'chief requirement. It is the retail merchants that suffer most, and say, 'with apparent justice, that if they purchase a lot which is stated to be, 'say, Scotch Crownfulls, and which by the invoice purports to be Crown-'fulls of a certain number, when opened they turn out to be fish of all 'sizes.

'On the other hand, the Dutch and Norwegian fish are most carefully 'packed, selected, and marked, so that, in buying, the purchaser is fully 'certain of obtaining what he requires. A further complaint is made 'against Scotch herrings that those sent over to this market are often not 'fully matured fish.' Mr Powell encloses an extract from one of the principal retail herring merchants in Stettin, which supports the Consul's statements in detail. It is as follows:—

'As to your questions, I have to answer that it is a fact that parti-'cularly Dutch herrings have been competing more and more successfully 'with Scotch herrings, particularly in Saxony and all parts of Austria. 'One reason particularly as to Austria, may be that the herrings from 'Holland are brought at very cheap rates to the centre of Austria by the 'Rhine and the Danube, but the principal reason is, that the selection of 'the Dutch herrings has become very careful, that a *certain* number of 'herrings packed in each barrel, giving a clear idea of the size buyers and 'retailers have to expect, is warranted by the Dutch curers, and dealers. 'This is not the case with Scotch herrings. Crownfull branded herrings 'may have 600–800 herrings per barrel; they ought never to have more 'than 700–720, but the standard that the "Board of Fisheries" have given 'to their officers for the size of Crownfull herrings is too low, and enables 'curers to use the brand even for small full fish. If large full herrings 'were kept *distinct* under the Crownfull brand, and all other full herrings 'under the size 700–720 per barrel were packed together, perhaps under 'a new "small full brand" containing 750–950 herrings, this would prove 'a very successful competition against Dutch herrings that particularly 'in Saxonia have gained much ground just by this size and selection, a 'herring of this size and *full* being most in demand as a suitable fish for 'the retailers at 5 pfennings a-piece.

'Scotch herrings have till now no such selection. Next to the Crown-'full brand with Scotch herrings comes the 'Crown mattie' brand, but this 'brand gives just as little guarantee as to the size and number of herrings 'as the Scotch "Crownfull" brand.

'We get Crown mattie herrings; best individual selections of even the 'most careful curers show only *nearly* all full fish, very seldom only full 'fish, but mostly mixed with "spent" and small immature herrings that 'have not yet any roe and milt, containing perhaps about 900–950 'herrings; but in the most frequent cases "Crown mattie" mixed with 'small full fish spent, and very small immature herrings in the most different 'proportions, contains 1,050,-1,120–1,200, and even more herrings per 'barrel. A dealer in the interior buying Crown mattie herrings of Scotch 'origin knows just as little what size of herrings he gets as a dealer buying 'Scotch Crownfull branded herrings; whilst buying Dutch herrings 'he knows exactly that with buying "Superior" herrings he gets about '620–700; "Primer sortier" about 750–800; "Primer" about 850–900; '"Small fulls" 950–1,000 *real full* fish.

'If your Government could induce Austria to reduce the very high duty 'on herrings there, about 10 marks per barrel against 3 marks in Germany, 'this would considerably improve the sale of herrings to Austria. Austria 'would, by a greater importation, by-and-by, not sustain any loss, and 'would provide to her poor population a better access to a very nourishing 'and wholesome food.'

15. *Austria.*—The imports of all sorts of herrings into Austria in 1887 amounted to about £150,000 in value, showing an increase over the previous year of about £23,000. Cured herrings are nearly all Scotch, and reach Austria *viâ* Stettin. No direct trade exists with Scotland for the reason that the Stettin merchants draw at three months' date on their customers in Austria, while Scotch exporters require a banker's credit in England, which mode of payment is too expensive. Endeavours to intro-

duce Dutch herrings have hitherto failed as only the Scotch herrings are in demand. Bloated herrings are imported from Bergen in Norway. In Hungary on the other hand, the cured herrings consumed are practically of exclusively Dutch origin, which can be brought into market cheaper than can the Scotch.

II. Reports from Places out of Europe.

Reports have been received from a large number of extra-European States and Colonies, but their value is almost purely negative. The great distances and the cost of carriage, import duties, the competition of local fish supplies, the difficulty of keeping even well-cured fish in tropical climates, and in some places the absence of any demand for fish, are all given as causes tending to prevent the introduction of Scotch-cured herring. In the United States the existence of import duties and of large local fisheries are the main causes that tend to keep out the Scotch fish. Nevertheless considerable amounts of cured herrings are imported; they are consumed chiefly by Scandinavians, who prefer the fish packed in Holland or Germany. In 1886, 318,000 lbs. of smoked or dried herrings, of the value of £1,125, and 48,247 barrels of pickled or salted herrings, of the value of £86,400, were imported into New York, of which not 5 per cent. came from Great Britain. Nearly one-third was received from Canada and Newfoundland, and the remainder from Holland, Germany, Sweden and Norway: the price of Canadian herrings is much less than what Scotch could be sold for. It is freely admitted that the Scotch fish are of superior quality.

It would appear that considerable quantities of Scotch-cured herrings are repacked in Germany in small kegs and sent to America. Last year the direct trade with Scotland was much increased, a considerable number being exported to America, chiefly in whole, half, quarter, eighth, and sixteenth barrels. About 35,000 of the smaller casks were shipped last year direct from Leith, Greenock and Aberdeen.

SUMMARY.

These Consular Reports from a large number of countries show how difficult it will be to open new markets, either by reason of a superabundant local supply of fish, the hold of Dutch and Norwegian herrings in the markets, or the distance, cost of carriage, and the high import duties levied. It has been shown that France, for instance, bars the way to her markets by prohibitive protective tariffs, and that Russia is doing the same.

In regard to the chief markets for Scottish herrings, those in Germany and Russia, what has been stated above shows that the competition of other countries, especially of Norway and Holland, is seriously affecting the imports of Scotch fish. Complaints also are made that the same attention is not paid by Scotch curers to the selection and assortment of the herrings as is paid by other countries. It is declared that the Crown brand is not always a guarantee of what the barrels contain, and what they are stated to contain. The statement of the Consul at Königsberg is very explicit on this point, viz., 'many barrels marked with the highest or 'Crown brand on being opened are found to contain fish of an inferior 'quality. This inaccurate marking is so frequent that the trade no longer 'attach any value to the Scotch herring brands.' So also the report sent by Consul Powell from Stettin, in which it is stated that the Scotch system is inferior to the Dutch. 'A dealer in the interior 'buying Crown mattie herrings of Scotch origin knows just as little what 'size of herrings he gets as a dealer buying Scotch Crownfull branded 'herrings; whilst buying Dutch herrings he knows exactly' what he is getting for his money. Whether this defective assortment depends upon an actual deterioration in comparison with former years or only in the sense that it is inferior to the assortment of the Dutch and Norwegian herrings now brought into the market does not signify; for the Scotch herrings have now to compete keenly with these foreign fish. The figures in Table I. giving the exports of 'mixed' herrings, that is, herrings of different sizes and quality, show a great decrease compared with other brands; this supports the view that the requirements of the markets are becoming more exacting. The figures given on page 160 show very clearly that Scotch herring-curers during the past few years have not been using the brand to the same extent as formerly; and this seems to indicate that its value as a special guarantee has diminished. At the same time there is no doubt that the recent decline in the amounts of herrings exported from Scotland is to a large extent due to the glutting of the markets in 1883, 1884, and 1885 with small-sized and inferior fish. Table I. (p. 159), shows that the export of matties in these years was excessive, a circumstance which was pointed out by Professor Ewart two years ago as due mainly to the use of small-meshed nets, the earlier commencement of the fishing, and the greater prevalence of surface-net-fishing. It is self-evident that by thus flooding the market with inferior fish, serious loss is occasioned. This is shown by the record for last year (Table I.), when although 184,552 fewer barrels were cured than in 1887, the value of the cured herring was £132,076 greater; a slight increase having occurred in Crownfulls, and a very large decrease in matties.

In a long established and extensive system like that embracing the export trade in Scottish herrings, there is risk of methods and practices becoming stereotyped, and conditions which in the past may have suited the markets becoming ineffective now to keep a firm hold on them. The Continental nations competing with us are nearer the great markets, and more ready to adapt themselves to their requirements. The superior excellence of the Scottish herring is very generally admitted, and there can be little doubt that the reason that the Norwegian and Dutch herrings are now being largely preferred is chiefly owing to their better assortment and packing. Scotch curers seem to place too much reliance upon the superior reputation of their herrings *per se*. It also appears from the Consular Reports that in many countries herrings packed in special ways, such as in small kegs, &c., meet with a ready sale, while those packed in any other way can scarcely be sold; it may be worthy of consideration whether some latitude in this respect might not be introduced in the Scotch system.

It seems obvious from what has been stated above, that if the Scottish-cured herrings are to maintain their hold on the Continental markets, much greater care will require to be taken in the selection of the fish, and their assortment into sizes and qualities than is now the case.

It may be said that the onus of providing a remedy in this respect lies mainly on the curers themselves, since they are the persons chiefly concerned. But the *gravamen* of the complaint is that the official brand of the Fishery Board for Scotland is untrustworthy, and does not always represent what it should represent; it is obvious, therefore, that steps should be taken to inquire into the matter and remedy it. A study of the Consular Reports leaves the strong impression on the mind, that before any new measures of an administrative nature are resorted to, it would be wise and judicious to send some one well-versed in the methods of cure and assortment practised in Scotland to visit the Continental markets and curing-establishments, in order to study on the spot the modes of cure, the assortment, packing, &c. This course is urged in many Reports, and especially by Acting Vice-Consul Reid of Stettin, who has a very wide practical knowledge of the requirements of the markets. Other countries have taken similar steps. Sweden has a permanent agent in Germany, and Consul Joachim Anderssen was recently sent from Norway as a Special Commissioner to inquire into and report upon the German markets, with the view of obtaining all information possible to aid in pushing the trade in Norwegian herrings. When it is borne in mind that the herring trade is the backbone of the Scottish fishery industry; that the mainstay of the herring-fishery is the export trade to the Continent; and that the prosperity of this trade is threatened by the keenest foreign competition, it will be evident that effective remedial measures should be taken as speedily as possible.

III.—ABSTRACT OF REPORTS BY MR THOMAS SCOTT ON HIS SPECIAL INVESTIGATIONS ON BOARD STEAM TRAWLERS. (Prepared by T. Wemyss Fulton, M.B.)

In addition to superintending the routine work on the 'Garland,' Mr Scott was requested to undertake special trips occasionally on board steam beam trawlers working off the East Coast, mainly for the purpose of comparing the results with those obtained by the 'Garland' in the inshore waters. The chief points inquired into were:—(1) the presence of ripe fish; (2) the distribution of large and small fish; (3) the presence of floating fish eggs.

I. Moray Firth.

The first trip (January 21–24, 1889). was to the important fishing ground, the Smith Bank, which lies off the Caithness Coast, about 15 or 16 miles east of the Ord of Caithness. This bank, which is much resorted to by trawlers, is of irregular shape, and has an extreme length of about 7 miles, and an extreme breadth of about 5 miles. The depth of water over the bank averages about 20 fathoms; the bottom consists chiefly of sand. The steam trawler which Mr Scott accompanied on this trip was the 'Southesk,' which has a trawl beam of 51 feet. During the 4 days the 'Southesk' was engaged on, or in the vicinity of, Smith Bank, about 17 hauls of the trawl were made, none of the takes being, however, very large.

Flat Fish.—Among the flat fish caught, plaice were by far the most numerous, and generally of large size, the smallest obtained not being less than 12 inches, while the majority ranged from 16 or 18 to 27 inches in length. The greater number of those under 20 inches were males, and the greater number of those over 20 inches were females. The reproductive organs of both males and females were nearly or fully mature, a large number of the fish were spawning, and a considerable number were spent.*

* On the 16th of February Mr Scott examined at Montrose 6 boxes of plaice, caught a little south of Smith Bank, and found a number of them, both males and females, quite ripe or partly spent, showing that plaice were still spawning in the Moray Firth at that date.

Besides plaice, specimens of all the commoner flat-fishes were obtained, including turbot, brill, witches (*Pleuronectes cynoglossus*), sail flukes (*Arnoglossus megastoma*), lemon dabs, common dabs, long rough dabs, and one or two soles (*Solea vulgaris*). Lemon dabs, common dabs, and long rough dabs were the most abundant. The roe and milt of the long rough dabs were well developed, many being nearly ripe; in the others, they were mostly immature. A few specimens of skate (*R. batis*, *R. clavata*, and *R. radiata*) were captured.

Round-Fish.—Haddocks were taken in considerable numbers, but they were mostly small, ranging from 10 to 14 inches; a few, however, were larger, measuring from 17 to 23 inches. Cod, as a rule, were scarce. A lythe, a few congers, ling, cat-fish, and gurnards were also obtained; and a number of angler-fish were brought up at each haul. The reproductive organs of the round-fish, with the exception of a few gurnards, were immature. About a dozen gurnards altogether were taken; 4 were partly spent, and the others immature.

Tow-Nettings.—The tow-net was used night and day as often as possible. There were comparatively few organisms caught at the surface, especially during daylight, but fish eggs were abundant, large numbers being undoubtedly the ova of plaice. In the bottom tow-net, fixed to the beam of the trawl, Schizopods, Copepods, and *Sagittæ* were found in abundance, but there were few fish eggs.

II. St Andrews Bay.

As it was desired to test the condition of St Andrews Bay and the adjoining waters with a large beam trawl, arrangements were made for the 'Southesk' to trawl along certain lines, on February 1st partly within and partly without the area where trawling is prohibited. The first line was elliptical in form, beginning in the vicinity of the Abertay Spit, passing southward parallel to the shore, and turning northwards opposite Barbet Ness to near the point where it commenced. The fish obtained consisted almost entirely of plaice (5 boxes); there were also 3 small cod, 4 skate, and 6 other fish. The largest plaice measured 17 inches, the average length being about 13 inches. The reproductive organs were in all cases immature, but the quality of the fish was good. The second line started from the mouth of the Eden, and it was intended that it should pass eastwards for 10 or 15 miles. The state of the wind and tide interfered with this arrangement. The course steered was east-south-east for 8 miles, and then north-east by east in the direction of the Bell Rock. The trawl was down for 4 hours, the take consisting of scarcely one box of plaice, one box of small cod and haddocks, a small turbot, and a few other flat fish. The tow-nets were kept constantly at work, but no floating fish eggs were obtained.

III. Firth of Forth.

These inquiries were carried on, on the 5th and 6th of February, on board Mr Gunn's steam trawler, 'Ocean Rover.' The lines selected for trawling operations were:—(1) an axial line from the neighbourhood of Oxcar to 15 miles beyond May Island; (2) a transverse line from Largo Bay to Gullane Ness. The trawl was to be lifted at regular intervals. These lines were not strictly adhered to, however, owing to the risk to the net from bad ground, &c. Eight hauls were made. The main results, which correspond to those obtained by the 'Garland,' may be stated as follows:—(1) while some moderately large cod and haddock were got, the majority of round-fish were small; (2) flat fish, especially plaice, were comparatively scarce; (3) the fish were very unequally distributed in different parts of the firth, and were, on the whole, rather scarce; (4) with the exception of a few long rough dabs (*Hippoglossoides limandoides*) and a few herring, which were nearly or about mature, the reproductive organs of all the fish were more or less immature. No floating fish eggs were obtained.

IV. Lybster Bay.

From February 18 to 22 the 'Southesk' was engaged off the Caithness Coast, in the vicinity of Lybster Bay. Seventeen hauls of the trawl were made, and although the same kinds of fish were got as at the Smith Bank at the end of January they were more 'mixed' in regard to size. There were fewer plaice and more small individuals amongst them; a great many appeared to be spent, some were evidently spawning, and some were immature. Cod and lemon soles were more abundant. All the cod were immature, except one male which was ripe; cod appear to spawn in the Moray Firth chiefly about the end of March and the beginning of April. One female long rough dab was ready to spawn. Three small halibuts, and one *Gadus luscus*, were also obtained. Although the surface and bottom tow-nets were kept well employed, only a few fish eggs were obtained on 4 occasions in the surface-net. In the bottom-net (fixed to the beam of the trawl) considerable numbers of Schizopods (chiefly *Boreophausia*) were obtained; also a number of specimens of *Anonyx denticulatus*. On one occasion a broken piece of a long line was brought up; one or two cod attached to the hooks were partially decayed, and contained a large number of specimens of the Amphipod, *Callisoma crenata*. Mr Scott succeeded in fertilising a considerable number of plaice eggs, development proceeding at first very rapidly; and he preserved specimens at intervals of from half an hour to 72 hours after fertilisation.

V. Off the Caithness Coast.

On the 25th of February one haul was made off the Caithness Coast, about 6 or 7 miles south of Wick. The weather was stormy. The take was poor, consisting mainly of plaice, the large ovas chiefly females and the smaller males; they were principally spent fish. There were also a few round-fish, mainly haddocks and codlings. In the surface tow-net were a few fish eggs, Schizopods, Copepods, and *Sagittæ;* in the bottom-net, abundance of Schizopods (chiefly *Boreophausia*) and a few fish ova.

The next haul was made about 12 miles north-north-west of Lossiemouth early in the morning of the 26th. Owing to an obstruction the net was hove up in 3 hours, and contained a small quantity of fish, mainly haddocks, codlings, and small witch soles (*Pleuronectes cynoglossus*). The surface-net contained fish ova and a few very young fish.

The third haul was made early in the forenoon in the vicinity of the Smith Bank. The catch was small, and consisted chiefly of plaice; also a few cod, haddocks, and gurnards. None were mature; there were a few fish ova in the surface-net. Other 3 hauls were made here with a very similar result. Schizopods were very abundant in the bottom tow-net. Several hauls were then again made off Lossiemouth, in from 50 to 60 fathoms of water. Large numbers of cod and haddock were taken. A considerable number of the haddocks were small, but some were large—16 to 20 inches long. About half a dozen haddocks were quite ripe, but the great majority were only about half mature. One or two male cod were ripe; the others more or less immature. A few hake were caught; and in one haul a considerable number of witches (*P. cynoglossus*) and lemon dabs (*P. microcephalus*), but few of these were large. Plaice were remarkably scarce in the Moray Firth. Mr Scott succeeded in fertilising a few plaice ova, and also tried the effect of cod milt on plaice eggs. He states that about half an hour after the contact of the milt a slight depression appeared on the side of each of the plaice eggs, but after some were placed in Perenny's fluid they resumed their normal contour. Their appearance some hours afterwards 'seemed to show that development had proceeded to a slight extent.' These eggs, after the cod milt was added, lost their buoyancy and sank to the bottom (probably the indentation and descent were due to alteration of specific gravity).

The surface tow-net caught a considerable number of pelagic fish ova so far developed that the eyes of the young fish could be plainly seen with the naked eye. The surface temperature ranged from 41° F. to 43°·1 F.; but this difference did not affect the numbers of floating eggs. Mr Scott learned that haddocks, as well as cod, spawn in great numbers in the Moray Firth at the end of March and the beginning of April.

VI. Moray Firth.

The third visit to this important area took place between the 26th and 29th March. Very stormy weather was experienced. Eleven hauls were made about 12 miles or so north-east of Lossiemouth. The great bulk of the catches consisted of haddocks, the large ones ranging from about 14 to 24 or even 27 inches in length, the medium sized ones being an average 13 or 14 inches long, but ranging from a few at 10 inches to 14 inches. Altogether about 100 boxes of large sized haddocks and about 50 boxes of medium sized haddocks were obtained. The great majority of the haddocks were ripe and spawning. The most abundant flat fish was the witch sole or long flounder (*P. cynoglossus*) (about 14 boxes), and the next the lemon sole (*P. microcephalus*, (about 2 boxes). Considerable numbers of the long rough dab (*Hippoglossoides limandoides*), the common dab (*P. limanda*), monk-fish, cod, and whiting were obtained; also a few ling, hake, skate, saithe, &c. Comparatively few plaice were taken, not indeed enough to fill a single box from the 11 hauls. The depth varied from 20 to 40 fathoms, and the temperature of the surface water from 40°·2 F. to 42°·8 F. In regard to the prevalence of pelagic fish ova, this expedition, like the one in January, was noteworthy. The bottom-net contained chiefly Schizopods, and a few *Saggitæ*, and *Calanus;* but the surface-net contained enormous quantities of fish ova; Mr Scott remarks that he never saw pelagic ova so abundant. The greater proportion were haddock ova, no doubt derived from the shoals of ripe haddocks revealed by the trawl-net; but cod ova also were present. Some of the latter obtained on the 27th hatched out on the 29th, the young fish exhibiting the peculiar and characteristic banded appearance. Mr Scott, referring to the young cod, says :—'I find that as soon as the young fish hatch out 'they seek down, but whether they proceed to the bottom or nor I have 'not been able to discover.'

Mr Scott artificially fertilised some ova of the haddock on the 27th, about 2 p.m., and on the 31st, at 10 a.m., the outline of the embryo fish could be clearly made out. He points out that in the case of the plaice ova 8 days elapsed before the outline of the embryo could be made out, and indicates that haddock ova, therefore, appear to hatch much sooner than do the ova of the plaice.

Of the few ling obtained, a female was found quite ripe, a cupful of ova flowing freely; but no male was among the two or three others on deck at the time, and artificial fertilisation could not therefore be accomplished. None of the cod obtained were either ripe or spent; the floating and well-developed cod spawn must have been derived from another source. No fish but the haddocks and the one ling were found ripe. A large specimen of *Luidia ciliaris*, measuring 18 inches across the arms, was brought up.

VII. Off the Forfarshire Coast.

This series of trawlings (also by the 'Southesk') was much interfered with by reason of tempestuous weather. The first haul was made on the 1st April, about 7 or 8 miles east of Montrose, and yielded only about 4 boxes of fish—chiefly haddocks, with a few plaice, witches, sail flukes (*Arnoglossus megastoma*), whitings, dabs, &c. The surface-net contained a very few fish ova; the surface temperature being 41° F. Other 3 drags were made with poor results, and the wind and sea increasing in violence, the vessel had to run to port. On the 3rd April the trawl was let down again about 40 miles east south-east of Montrose, but the catch was very small. A few fish ova were got in the surface-net. The next haul was made between 70 and 80 miles east of Montrose. About 10 boxes of fish were obtained, chiefly of haddocks; about 1 box of plaice and 1 of lemon soles were also got, besides whiting, skate, and several large cod. The surface-net, which was towed for 3 hours, contained a considerable quantity of *Sagittæ* and Schizopods, but very few fish ova. Very few of the haddocks or cod appeared to be mature. The weather continued so stormy that the vessel had again to run to harbour.

IV. SOLWAY SHRIMP AND FLOUNDER FISHINGS. By J. H. Fullarton, M.A, B.Sc.

The Solway fishings may be roughly divided into two, according to whether the fish sought are salmon, or white fish and shrimps. Besides, in such places as Wigtown Bay, enormous quantities of splendid mussels grow, but nothing is done to foster this industry, although good prices are obtained for those sent from Creetown for consumption in Manchester, Oldham, and other English towns.

It is almost impossible to dissociate the salmon and the white fish, as great numbers of the latter are caught in the traps of the fixed stake-nets, and in order to promote the fishing industry, it might be advisable to compel the owners of all such fixed engines as stake-nets and paidle-nets, as well as the movable nets of the white-fishing boats, to return all undersized flat-fish to the sea.

When I visited Annan, which is the chief port of the trawling smacks, I made arrangements with one of the fishermen to go trawling with me, and, accordingly we set out a little after 2 o'clock on the morning of Friday, 19th April. After getting our gear on board, we left Annan Waterfoot with ebb tide, and beat down the Firth against a stiff breeze of westerly wind to below Southerness Lighthouse, a distance of 16 miles. About 6 o'clock in the morning we took off all sail and immediately let go our stern shrimp-trawl. In a few minutes we also sent over the second shrimp-trawl from the bow, the smack heading north, and drifting broadside with the tide and against the wind. In half an hour we drew in both trawls, the produce of our draw being about twelve quarts of shrimps (*Crangon vulgaris*). Besides shrimps, we also had—

Young plaice (*Pleuronectes platessa*, L.). Very abundant.
Young flounder (*Pleuronectes flesus*, L.). Very abundant.
Young sole (*Solea vulgaris*, L.). One.
Young whiting (*Gadus merlangus*, L.). One.
Young agonus (*Agonus cataphractus*, C.). Few.
Young sting fish (*Trachinus vipera*, Cuv. and Val.). Abundant.
Hermit crab (*Eupagurus*, sp.). One.

Having made sail for a run to leeward, the fisherman riddled the produce in a specially constructed shrimp sieve, and also picked out everything but the large shrimps. All except the large shrimps were then thrown overboard, the small fish and small shrimps being alive and active.

We came to anchor abreast of Burn Point at 8 o'clock, and till 9 o'clock were engaged in boiling the large shrimps and cooking breakfast. We proceeded still further up the Firth, and at 9.30 A.M. we put the flounder-trawl overboard opposite the mouth of the Nith, and trawled for 15 minutes or so. The produce of this haul was only four flat-fish. Proceeding still further with the quickly flowing tide till we were 4 miles east of the Nith, we again sent the trawl overboard, and in a quarter of an hour obtained 1½ stones of flounder and plaice. The smaller flat-fish were at once returned to the sea.

Having therefore seen the *modus operandi*, we ran alongside of two or three of the whemmle boats that were fishing for salmon with their drift-nets, and then with a fair wind and tide made for Annan, which we reached shortly before 1 o'clock in the afternoon.

History.

In 1854 two Morecambe fishermen began shrimping at Annan, but soon left. This kind of fishing has been carried on at Morecambe since the beginning of this century, and is still pursued there, and at Fleetwood and other places along the English coast.

The Annan shrimp fishing has been carried on continuously since the spring of 1856, and the numbers engaged in it are now greater than they have ever been.

Time.

From the middle of February till the beginning of November the fishermen go shrimping, and during the winter months they are engaged in fluke fishing. Almost thirty years ago herring fishing was carried on in the Solway in May, June, July, September, October, and November, but now the men do not prosecute this fishing so regularly. For almost a month last year there was a good herring fishing. The herrings are landed at Whitehaven, Workington, and Maryport, and consequently are not included in the Returns of the Fishery Board for Scotland; and a like remark applies to the skate fishing, which is not, however, so important.

Boats and Nets.

There are 52 trawl boats at present in Annan, 8 at Bowness in Cumberland, and 8 at Creetown in Wigtown Bay. These boats are rigged with mainsail, foresail, gib, and topsail, and are about 33 feet keel, 9 feet beam, and 4 feet in depth. When the men go shrimping, there are either one or two men on board of each boat; but in the season for flounder trawling in the winter, there are always two men on board. So that in Annan alone there are fully 100 men who are fishermen pure and simple, and an additional 60 who are at times fishing and at other times are engaged in land occupations. Most of the men, however, combine trawling with whemmle or drift-net fishing for salmon. There are 34 whemmle boats in Annan, and three men are necessary as crew for each boat.

The net used for shrimping is a small beam-trawl with a beam 20 to 22 feet long, the net being triangular in shape, and the mesh being about ½ inch from knot to knot. In order to preserve the net, and to make it 'sharp,' it is 'barked' with a mixture of boiled oil and red lead. In this condition it appears as if it were made of catgut.

The trawl for flat-fish has a beam of about the same size as the shrimp-trawl, and the mesh of the net is two inches from knot to knot.

Stake-nets for salmon, and miniature stake-nets called paidle-nets, also capture great quantities of flat-fish.

Fishing.

Shrimping is chiefly carried on between Annan and Buoy No. 5 by the Annan boats, and the Creetown shrimpers trawl in the upper reaches of Wigtown Bay. The depth of the water on the best shrimping ground is 8–15 feet, while 10–20 feet depth is best for flounders.

In the early months of the year the shrimps are to be got by the Annan boats chiefly about 16 miles or so below the mouth of the Annan; but as the season advances and the weather becomes warmer, the shrimps ascend the Firth, and great quantities of them can be got. In cold weather they are chiefly caught off Southerness, but during the warmer months of the year they are caught from below Powfoot as far up as Newbie.

While the fishermen begin shrimping in the middle of February, their time is about equally divided between shrimp fishing and whemmle-net fishing. In the months of June, July, and August, and particularly the last, they obtain the greatest quantities. During some years the boats have caught as many as 200 quarts each in one tide, but this is an unusually large quantity. Mr John Holmes told me that he obtained 400 quarts once. The best season that ever the Annan boats had was during three months in 1877, when the shrimps not only were thick, but the price was good. Generally speaking, the shrimps command their best price in the market during May. The average price for Annan shrimps is 4d. per quart, and as it is reckoned that there are 75 quarts in 1 cwt., the price is therefore 25s. per cwt. In summer, however, the price generally is 2d. to 2½d. per quart, and last spring it was 6d. per quart. One fisherman obtained as much as 9¼d. per quart, but he describes this price as 'very rare.' The largest shrimps are caught in March, April, and May, and in September, October, and November.

Flounder fishing is confined to the winter months. The fishermen trawl for them above the Solway viaduct; but the best ground is below Powfoot, and the ground is good between the latter and Southerness, when the channel leads right. The Annan fishermen go also to Luce Bay to trawl, and the flounders they get there are larger than in the Upper Solway. From September to November the fluke trawling is chiefly carried on on hard ground.

Fishing for flat-fish also takes place by means of fixed engines—paidle-nets. The arm of the paidle-net is 25 yards long, and the cross arm is also 25 yards in length.

Most of the boats are owned by the men who go fishing, but there are three or four boats which are owned by others than fishermen. In all cases one share is reckoned as the boat's share, and is credited to the owner, while the remaining two shares belong to the two men or the one man who fishes in the boat. In the summer when the boats are not far distant, and when the weather is settled, one man oftener than two goes shrimp-fishing, but in the winter always two men are on board the fluke trawler. The fishermen, however, allege that it pays much better for two men to be in the boat. Doubtless this will be the case so far as the owner is concerned, for his share is the same in either case; but there may be room for doubt in the case of the one man who receives two-thirds of the produce of the fishing.

The herring fishing was very general thirty years ago in the Solway, and it was prosecuted during May, June, and July, and during September, October, and November. Now it is not nearly as regularly followed. Last year, for about a month or so, there was a good fishing of herrings, but it is nothing like the value of flounder-trawling.

The fact of the Solway lying between Cumberland and the South Coast of Scotland makes it unique, in so far as the laws in regard to fishing are not the same in both countries. The subject of trawling there is in an entirely different position from that in any of the inshore waters of Scotland. The swiftness of the tidal currents prevents line fishing in the upper reaches of the Firth, and compels the fishermen to catch flat-fish either by fixed engines or by trawling. Besides, trawl-net fishing seems the only method by which shrimping can be carried on in the Solway.

Most of the flat-fish and many of the shrimps are small. The Annan fishermen, acting in their own interest, riddle the shrimps, and return the small ones alive to the sea, and also throw overboard the smaller fish. At Creetown, on the other hand, the selection by riddling does not take place till the shrimps are boiled, the result being that great injury is done to the possible crustacean life which might be present in the neighbouring sea.

It might be advisable to enact (1) that all flat-fish under a certain size be returned alive to the sea, not only by the trawlers but also by all owners of fixed engines; (2) that all shrimps be riddled in a sieve or riddle of a fixed mesh, and that the smaller forms be returned alive to the sea. Both of these provisions would be helpful to the fishing communities, and would render obligatory on all a policy which the greater number of the Solway fishermen pursue. In this way the destruction of immature forms would be prevented, and the presence of small forms would not detract from the market value of the catch.*

V. ABSTRACT OF A REPORT ON THE FISHERY STATISTICS OF SCOTLAND. By Alfred Daniell, M.A., D.Sc.

(Prepared by T. Wemyss Fulton, M.B.)

During an investigation by the Scientific Committee into the statistics of the Scottish fisheries, it became evident that in many respects the present system required reconsideration and amendment. The Committee having requested Professor Cossar Ewart to take steps to inquire into the alleged incompleteness of the statistical returns from certain parts of the coast, it was discovered that the official records in the case

* *Vide* the note on the French Shrimp Fishery, p. 394.

investigated showed considerable discrepancies when compared with the returns obtained from the fishermen, or the railway and steamboat agencies by which the fish were sent off. It was also discovered that considerable quantities of fish are landed in certain places without any provision being made to have a record made of them. The investigation further revealed the fact that the statistics of the Scottish fisheries, as at present tabulated, are imperfect and incomplete, in comparison with those now published by many other countries.

It was consequently felt to be of great importance that the whole statistical scheme in connection with the Scottish sea fisheries should be made the subject of careful inquiry. The Board therefore empowered the Scientific Committee to obtain the services of an expert to make an exhaustive examination of the fishery statistics of this and other countries, and Dr Alfred Daniell was engaged to undertake the task.

Dr Daniell, after carefully studying the Scottish statistics as at present collected and tabulated, and the statistics published by Continental countries and on the American Continent, drew up an elaborate report, of which the following is a very brief abstract in which it is not possible to represent the detail with which the subject is treated.

Dr Daniell discusses the functions of the various Boards or Commissions in different countries, and shows that they may be chiefly advisory and promotive, or regulative and protective, or both, as in the case of the Scottish Board. Norway appears to be taking very energetic measures to make the organisation of its fisheries as complete as possible.

The statistics of the Scottish Board divide themselves into three classes, (1) Commercial and Economic, (2) Administrative, and (3) Scientific. After pointing out that while the first should be as nearly as possible uniform for long periods so far as is consistent with complete representation of the data, and that the second and third classes may without detriment undergo more frequent changes, the author considers each group in detail. The economic statistics of some countries, such as the United States and Canada, are so tabulated as to furnish ready comparison with those of all other countries, indicating the amount of trade in each variety of produce. The Scottish tables lay overwhelming stress on the trade in cured herrings with the Continent (and even these are incomplete and require modification), and no details are given of the trade with other countries, which in former years took large quantities of Scottish fish. Dr Daniell discusses *seriatim* the different tables published, and shows that while some of the data are antiquated survivals from the times of Acts of Parliament now obsolete, most of the tables call for amendment or remodelling. The tables dealing with the export trade require modification, especially those relating to branded herrings and smoked herrings. Tables I., II. and III. ought to be combined to form one table, as might also be the first three tables in Appendix B dealing with cod and ling. Appendix C should be expanded to embrace separately the various kinds of fish and shell-fish landed. But it is not emendation on the existing lines that is required to make the Fishery Statistics of Scotland satisfy modern requirements so much as a reorganisation of them, and it is to this that Dr Daniell devotes the larger part of his report.

The fishery industry should be treated as a whole—special attention being paid to the more important departments. The condition of the industry should be fully represented as to appliances, capital invested in various forms, the success of the fishery operations, the disposal of the catch, and the economic conditions of the various workers. The arrangement of the material should present the subject in a certain historical order, so that the complicated story narrated in successive tables may begin at the beginning and go on clearly and consecutively to the end; and the tables should, as far as possible, admit of comparison with those drawn up by the corresponding Boards of other countries.

Dr Daniell has drawn up a series of tables representing what he thinks the most desirable statistical system ought to be. The first table deals with fishery harbours, the location, depth of water, area, &c., the number of boats usually frequenting the harbour, the facilities for landing fish, the distance (in time) to the nearest railway station, the number of tons of fish landed and the fishing population. When there is no harbour and boats are simply beached, the fact should be indicated. Such tables might be published every five years. Another table represents the apparatus and capital under four main heads, (1) Vessels, boats, &c., (2) catching appliances, (3) shore appliances, (4) vessels incidentally employed. The first class includes all kinds of fishing vessels and fish carriers, their registered number, tonnage, value, &c.; the second class all kinds of nets, lines, trawls, dredges, &c.; the third, the requisites for treating and packing the fish, the value of curing establishments, &c.; and the fourth, vessels occasionally employed, as in the importation of cask-wood, salt, and in the coast and export carrying trade. The next table represents the ownership of boat and vessels, and then comes a synopsis of the boats, gear, &c. lost during the year. The next table represents the activity of the fishing fleets in each district, the number of boats laid up, the number of voyages and the area where the fishing is carried on, and the number and nationality of boats fishing off the Scottish shore in a selected week. In this table details concerning salt, ice, &c. find a place. Table 6 deals with loss of life. Table 7 represents the persons employed in the various fisheries, distinguishing between those who are fishermen wholly and those also engaged in other pursuits or only partially employed, and on shore, distinguishing between coopers, gutters and packers, curers, &c., and showing the number of persons engaged in the fishing industry during a selected week. Table 8 relates to the economic conditions and the risks to life of the persons employed.

Table 9 represents the total catch in the various districts, distinguishing between the different fish and shell-fish, and between the winter, spring and summer catches of herrings. It is also suggested that a special record should be made of the seal and whale fisheries, as is now done by the United States, Canada, Norway, &c. The values of the total fish landed in each district, based upon the prices obtained by the fishermen, is shown, and thus, by comparison with the previous tables, the average return to the fishermen can be estimated. The next series of tables deals with the disposal of the fish when landed, and of the fish cured in various ways, and shows the number of barrels cured and branded under the various brands in the different districts. Another table deals with the curing of cod, ling and hake, and the next with fish prepared in special ways. It is very striking, in perusing foreign statistics, to note in what a variety of ways fish are now being prepared to suit different markets, and the care taken to utilise the bye-products. A special table deals in quantities and values with the exports to various countries of the world, both of fish and fish products, and it is suggested that returns should be obtained from the railway agents at Berwick and Carlisle to show the inland trade with England. Another table represents the railway traffic and rates from each district to some of the great consuming centres, the terminal charges, &c., with supplementary information as to the coast trade.

In addition to the economic tables, periodical local reports should contain particulars as to local fishings at different seasons, the prices obtained, the principal markets and the cost of transport thither, the kind, quantity and value of the bait used and whence obtained, the financial results and economic condition of the fishermen.

The report then deals with Administrative Statistics. It is suggested that in addition to the tables now published (Appendix D., Tables VI. and VII.) which deal with proceedings under the Sea Fisheries Acts of 1868, 1883 and 1885, injuries to the gear of fishermen, and the registration of boats, a table might be added showing the work of the Fishery officers in keeping up the uniformity of the cran or other measures, in passing or rejecting barrels for export, and barrels for branding.

The Special or Scientific Statistics are then considered. Their importance is pointed out in connection with the promotion and protection of the fisheries, and in insuring that administrative interference will be beneficial and not injurious. A list is given of the more important scientific questions requiring treatment, embracing what has been or is being done.

The author then considers Supplementary Administrative Statistics, in addition to those referred to above, embracing (1) a statement of telegraphic information sent to fishermen, as to the movements of shoals, as is done in some countries, such as Norway; (2) as to the maintenance and repair of fishery harbours; (3) as to leases of oyster and mussel beds, showing rent, cost of survey, results, &c.; (4) as to hatcheries.

In regard to salmon fisheries it is suggested that the following tables would be serviceable; (1) showing the drainage area of the Scotch rivers and principal tributaries, for which it would suffice to refer to the third Annual Report of the Board; (2) showing the annual close times on all the salmon rivers and coast fishings in each salmon district, distinguishing between rod and net fishings, and stating when the close time was instituted; (3) abstract of bye-laws of District Boards; (4) list of ladders, &c. erected, return above these, miles of water above, and loch area; (5) salmon return per river, loch and coast, salmon fixed-engine fishing, numbers, values, weights, number of nets, number of men employed, &c.; (6) statistics of pollution cases.

Finally, it is suggested that the co-operation of the Coastguards for the collection of statistics, &c. should be obtained, as in England and Ireland. In the United States the Customs officers assist the Fish Commission in preparing statistics, and much useful information is thus obtained.

SECTION B.—BIOLOGICAL INVESTIGATIONS.

I. INQUIRIES INTO THE NATURE OF THE FOOD, THE SPAWNING, HABITS, &c., OF MARINE FOOD-FISHES. By T. Wemyss Fulton, M.B.

I. Introductory.

It has been long admitted by all scientific fishery authorities that exact knowledge of the food, propagation, and habits of fishes is of fundamental importance in furnishing a trustworthy basis for the proper regulation of fisheries, and in the selection of means for the active promotion of fishery interests. Any one who cares to examine the numerous and various laws which have been passed by the Legislature for the regulation or ostensible improvement of sea fisheries will find ample evidence that they have too frequently been founded upon misconception or error. It goes without saying that any measures that may be taken to augment the supply of fish, such as systematic culture, must be based upon accurate knowledge of their life-history. In recent years considerable progress has been made in this department of fishery work. The organisms which constitute the food of fishes have been, to some extent, investigated; and several valuable papers on this subject have appeared in previous Reports of the Fishery Board.*

Researches on the nature of the ova, the embryology, and development of many of the food-fishes have also been extensively carried on; and these have been frequently shown to have an immediate practical importance in the consideration of fishery questions, as, for example, the demonstration by Sars, Ryder, Raffaele, Ewart, M'Intosh, Hensen and others, that the spawn of almost all the economic fishes is buoyant and floats at or near the surface of the sea.

But the wider and more complicated questions in connection with the study of fishes and other marine forms under natural conditions in the sea—their distribution, migrations, mode, time, and place of propagation, &c., notwithstanding their great importance, alike from a scientific and practical point of view, have hitherto seldom engaged the continuous attention of naturalists. This has resulted partly from the difficulties which surround work of this kind, and partly from the difficulty of independent workers carrying on extensive inquiries and researches bearing on a wide field for a prolonged period. It might be supposed that on many of these points fishermen, who are almost daily engaged in the capture of fish, would be able to furnish valuable and trustworthy information. But a perusal of the evidence led before the various Commissions, which have during the last ten or fifteen years been from time to time engaged in fishery inquiries, reveals a remarkable opposition of opinion, and frequently great ignorance

* *Fourth Report*, p. 100, 1886; *Fifth Report*, pp. 317, 326, 1887; *Sixth Report, Part iii.*, p. 225, 1888.

as to the life-history and habits of the food-fishes. For example, the idea is widespread and general among fishermen, and it has been supported sometimes by fishery experts, such as the late Mr Buckland, that most ripe fish seek the shallow waters of estuaries and bays for the purpose of depositing their spawn. This notion, which has exercised considerable influence in shaping the course of fishery regulations, is apparently dependent chiefly on the fact that the fry are found in abundance in the shallow waters; the assumption being that where the fry are found the spawn was deposited. As will be shown in detail below, the scientific evidence recently obtained leads to a very different conclusion.

In order to determine these and other important matters, I was requested by Professor Ewart, early in last summer, to prepare and put in operation a scheme for their systematic investigation. The scheme embraces the following points in relation to all the marine food-fishes:—

1. The nature of the food at different periods of the year.
2. The place, time, and duration of spawning.
3. The minimum size of each kind of fish on reaching maturity.
4. The numerical proportions of the sexes and their relative sizes at different seasons.
5. Their migrations throughout the year.

The form which was drawn up for the collection of data under the first four heads is shown at p. 184; and since the scheme was begun upwards of 6000 fish, comprising over 30 species have been methodically examined; the results being given in the following Reports. Most of the fish were examined on board the 'Garland' by Mr Thomas Scott, who has devoted great care and assiduity to the work; some were examined at St Andrews' Marine Laboratory by Mr W. L. Calderwood, and others by Mr Peter Jamieson at the Natural History Department of the University of Edinburgh. The observations made by Mr Calderwood and Mr Jamieson were upon fish obtained from fishmongers; and hence, although precision in regard to the locality of capture was always carefully sought for, there is not the same certitude in this respect as in the case of the fish obtained by the 'Garland' during the ordinary trawling operations and in the prosecution of the experiments on bait, where the locality and the physical and other conditions of capture were carefully recorded.

With the view of obtaining similar information regarding the fish captured in the inshore and offshore waters along the greater part of the East Coast, and especially at the great fishing banks and grounds, it was decided to send Mr Thomas Scott to accompany the trawlers working in these districts. Mr James Johnston of Montrose, a member of the Fishery Board, who has most cordially co-operated with the Scientific Department in their investigations, kindly granted every facility for the purpose, and Mr Scott's investigations have been carried on on board the 'Southesk' and other steam trawlers belonging to Mr Johnston's firm. A summary of these important and interesting observations is given at p. 171. Tow-netting in the surface, subsurface, and bottom waters was constantly carried on.

It would be of the greatest importance if regular investigations similar to those carried on on board the 'Garland,' could be conducted in the offshore fishing grounds, lying from 10 to 50 miles from shore. It appears to be on these banks that the majority of the important economic fishes congregate for spawning. The further and longer the work is carried on in the inshore waters, the more apparent does it become, that many results can only be fully comprehended, and many questions solved, by comparative inquiries at considerable distances off shore.

Besides the information obtained by the means above described, a modified scheme relating to the time, duration, and place of spawning has been put into operation at points around the greater part of the coast of Scotland ; and it may thus be possible in the near future to indicate exactly where and when the food-fishes spawn in the waters adjoining our coasts. The form drawn up for this purpose is shown on the opposite page, and already upwards of 16,000 fishes have been examined, and the results recorded.

It will be evident from the details given in the following Reports, that by carrying on this system of investigations for a series of years very substantial additions to our knowledge of the natural history of the marine food fishes will be made. And since the information obtained is being studied in relation to the observations concurrently made as to the physical changes in the sea, and the distribution of the invertebrate fauna, it will soon be possible to solve many problems relating to the habits and migrations of the food-fishes which cannot at present be explained.

SCIENTIFIC INVESTIGATIONS.—STATION II.*—MORAY FIRTH.

C.—Record of Condition of Reproductive Organs and Stomach in Fish Caught.

Date.	Name of Fish.	Size in Inches. M.	Size in Inches. F.	Condition of Reproductive Organs.	Amount and Nature of Contents of Stomach.
1889. June 26	Sandy Ray (*R. circularis*).	15	...	About half mature.	Empty.
,,	Plaice.	...	20	Immature.	A piece of *Solen*.
,,	,,	...	24	Spent.	1 *Nautica catena*, 1 *Hyas coarctus*.
,,	,,	...	$21\frac{1}{2}$	Immature.	1 *Solen pellucida*.
,,	,,	$20\frac{1}{2}$	...	About half mature.	Fragments of *Solen ensis* (?).
,,	,,	...	21	Immature.	,, ,,
,,	Common Dab.	...	$9\frac{1}{2}$	,,	Empty.
,,	,,	...	$8\frac{1}{2}$	Mature.	Parts of a small *Solen*.
,,	,,	...	8	Immature.	*Amphiura*, sp. (?) remains.
,,	,,	...	9	About half mature.	Empty.
,,	,,	...	8	Immature.	*Amphiura*, sp. (?) remains.
,,	,,	...	8	,,	,, *Eupagurus*.
,,	Haddock.	...	15	,,	Remains of *Eupagurus* and 2 *Echinocyamus*.
,,	,,	...	19	,,	*Ophiura texturata* and *Amphiura* remains.
,,	,,	15	...	,,	*Eupagurus*, Lamellibranch and *Amphiura* remains.
,,	,,	16	...	,,	Pieces of *Terebella* tubes.
,,	Cod.	...	12	Very immature.	1 *Ampelisca*, and *Crangon* remains.
,,	Lythe.	28	...	Immature.	*Eupagurus bernhardus* remains.
,,	Gurnard.	...	12	About half mature.	Remains of *Crangon vulgaris*.
,,	,,	11	...	Immature.	Empty.

* The various Stations of the 'Garland' are described in the *Fifth Report* (p. 52, Pl. I.), the *Sixth Report* (pp. 31, 32, Pl. V.) and the present *Report* (p. 18).

SCIENTIFIC INVESTIGATIONS.—STATION, MONTROSE.

F.—Weekly Record of Ripeness of Fish Landed.

Note.—(1) The condition of the following fish should be noted :—
Plaice, Common Dabs, Lemon Dabs, Long Rough Dabs, Flounder, Turbot, Halibut, Brill, Haddock, Cod, Ling, Whiting, Herring. By "ripe" is meant that the roe or milt can be expressed by gentle pressure.
(2) The condition of Skates and Rays should be noted.
(3) The number of fish examined should always be inserted, although none may be ripe.

Date	Kind of Fish.	Where Caught, and Distance from Shore.	Number Examined.	Number Ripe.		Remarks.
				M.	F.	
1889. Apr. 23	Haddock.	25 to 30 miles E. from Montrose.	40	3	4	Others all spent; but a few of the small not ripe.
„ „	Cod.	„ „	30	3	2	Others mostly spent; a few not ripe.
„ „	Ling.	80 miles E. from Montrose.	9	...	...	None ripe.
„ 24	Whiting.	20 „ „	10	...	...	None ripe.
„ „	Turbot.	50 „ „	3	...	1	Others not ripe.
„ „	Brill.	„ „	3	...	3	Beginning to spawn.
„ „	Lemon sole.	„ „	4	...	...	No appearance of milt or roe.
„ 26	Plaice.	„ „	6	...	...	All spawned.
„ „	Ray.	„ „	8	...	...	None ripe but well developed.
„ „	Skate.	„ „	2	...	...	„ „
„ „	Saithe.	100 „ „	14	...	1	Others all spawned.
„ „	Dabs.	3 „ E.S.E. „	10	...	...	None ripe, but well developed.
„ 27	Haddock.	20 „ E. „	20	...	...	A few of the smaller size not quite ripe, but the larger all spent.

II. REPORT ON THE SPAWNING OF THE BRITISH MARINE FOOD-FISHES. By J. C. Ewart, M.D., Regius Professor of Natural History, University of Edinburgh; and T. Wemyss Fulton, M.B.

Introductory.

Hitherto our knowledge of the spawning of the British marine fishes has been imperfect, and has been chiefly derived from the empirical observations of fishermen and the more or less isolated inquiries of marine zoologists. A reference to works on Ichthyology, therefore, not unnaturally shows that very divergent opinions have been held both as to the place and the time of spawning of even the commoner kinds of marine fishes. This has arisen largely from the fact that many observers have formed conclusions frequently from too few specimens, or from the statements of fishermen and others; but, no doubt, in many cases from the observations having been made at different parts of the coast. A perusal of the evidence led before the various Commissions appointed to inquire into fishery questions in recent years will make it evident that, as a rule, the statement of those engaged in fishing cannot be trusted in these matters, for a somewhat remarkable opposition of views is brought out even in the same districts.

A very general opinion, and one prevalent not only among fishermen but among many who have written on fisheries, is that most marine fishes at maturity migrate to the inshore waters and there deposit their spawn. This idea appears to be based partly on the fact that fishermen occasionally obtain quantities of the spawn of molluscs and other invertebrates, of the lump-sucker, herring, and of small or unimportant littoral forms, on their lines and nets close inshore; and partly because very young fishes are found in great abundance, especially during the hot months of the year, in the shallow waters around the shore. The result of our observations, however, go to show that the deposition of the spawn of the food-fishes close inshore on the East Coast is exceptional, for it appears that at the approach of the spawning time most of the food-fishes congregate in shoals in the waters lying at some distance from the coast, and there the ova are cast forth and fertilised.

It is now well known from the observations of Sars, Hensen, Raffaele and others that the spawn of almost all the marine food-fishes float, in a dispersed and isolated condition, at or near the surface of the sea. So far as observations have been made this is true of all the marine food-fishes, with the exception of the herring, and of certain small or unimportant littoral forms whose ova are deposited at the bottom more or less close to the shore.

The investigations, the results of which are embodied in this paper, have been carried on for a year, more especially in the Firth of Forth, St Andrews Bay, and the adjoining waters. In addition, a large number of fish from inshore and offshore grounds in the Moray Firth have been examined, and a considerable number from other districts on the East Coast of Scotland. Altogether, nearly 23,000 fish have been examined, comprising the following species:—plaice, lemon soles, turbot, brill, halibut, long rough dabs, common dabs, flounder, witch soles (*P. cynoglossus*), sail fluke or merry sole (*Arnoglossus megastoma*), little sole (*Solea lutea*), various species of skates and rays, cod, ling, tusk, hake, haddock, whiting, gurnard, dragonet, saithe, lythe, catfish, angler, lump-sucker, weever (*Trachinus draco*), cobbler (*Cottus scorpius*), brassie (*Gadus luscus*) and herring. Comparatively few specimens of the rarer forms were, however, obtained; and the observations in regard to the various species of skates and rays, and the herring, are not extensive enough for definite conclusions to be founded upon them.

Above 6000 of the fish were carefully measured, the precise place and time of capture noted, and the nature of the food found in the stomach recorded. These records were almost entirely made by Mr Thomas Scott, on board the 'Garland.' The tables at the end of this report give an abstract of most of the information obtained, so far as the reproductive organs are concerned. Above 16,000 of the fish were examined by fishery officers during April, May and June 1889, chiefly on the East Coast, but also in the Orkney and Shetland Isles, and in certain districts on the West Coast. These fish were not measured, but the place of capture was ascertained from the fishermen, and the number examined and the number found ripe recorded.*

It will, therefore, be seen that the information upon which our Report is based is of a very extensive nature.

It must be borne in mind that the words 'mature' and 'immature' refer solely to the condition of the reproductive organs, and are not, therefore, synonymous with the terms as popularly used.

I. Flat Fish.

Plaice (*Pleuronectes platessa*).

The investigations into the spawning of the plaice have been of much interest, enabling comparison to be made between the inshore waters at various parts of the coast and certain important offshore grounds. The number of fish examined was over 1400,—of which 222 were examined by fishery officers on the East Coast, above 1100 on board the 'Garland' or 'Southesk,' and over 100 at the University. The latter, which were obtained from a fishmonger, are stated to have been caught at a distance of 20 or 30 miles off May Island. Of the specimens examined on board the 'Garland,' 479 were obtained from the Firth of Forth, 335 from St Andrews Bay, and 187 from Montrose Bay, Aberdeen Bay, and the Moray Firth. All these were obtained from the inshore, and the great majority from the territorial waters. The 172 examined on board the 'Southesk' were, on the other hand, all obtained from the offshore fishing grounds in the Moray Firth, at distances of from 7 to 18 or 20 miles from shore. It will be convenient to consider the fish obtained from the territorial waters separately from those caught offshore.

Territorial Waters.—The striking fact is revealed by the records that of 1000 fish obtained from the territorial waters at short intervals during the entire year, only one was found mature. This solitary individual was a female, caught at Station I.† in St Andrews Bay, on September 18th, and was 26 inches long. Not a single ripe plaice was got in the Firth of Forth or at the stations just outside it. Eight individuals, nearly mature or three-fourths mature, were caught in the Firth of Forth in October, November, December and January; but the rest in these months, and all the others examined in the other months, were immature. In the Moray Firth, plaice were examined

* We have specially to thank Mr Donald Miller, Montrose; Mr John Murray, Newhaven; and the officers at Stonehaven, Peterhead, Macduff, Fraserburgh, Buckie, Lybster, Lerwick, and Campbeltown, for the care with which they have kept the records, and also Mr W. Ramsay Smith, B.Sc. for preparing the tables at the end of the report.

† *Vide* footnote on p. 182.

at the stations in the territorial waters only in June 1889. Most of these were of very large size; none were ripe, the majority of the largest specimens were spent, and a few of the latter and all the medium-sized and small ones were more or less immature. It appears very probable that many of these fish belonged to the shoals found in the offshore grounds in January and February, and referred to below. Those obtained in Aberdeen Bay and in Montrose Bay, in July 1888, and in June 1889, were all immature, one alone being recorded as spent in Aberdeen Bay, and this was the largest specimen obtained.

Offshore Waters.—The specimens examined on board the 'Southesk' were obtained in January and February 1889. At the Smith Bank, a well known fishing ground lying about 15 or 16 miles east of the Ord of Caithness, where the depth of water averages about 20 fathoms, and the bottom consists chiefly of sand and shells, a shoal of spawning plaice was discovered by the 'Southesk' on January 21st. Seventeen hauls of the trawl were made, the plaice being by far the most abundant flat fish obtained, and varying in length from 14 to 27 inches. The reproductive organs of all were nearly or fully mature. Of 100 specimens examined seventy-one were fully mature or spawning, and twenty-eight nearly mature (p. 219). Large numbers of fish eggs were obtained in the tow-net, the majority belonging to the plaice.

Captain Mackay, the master of the 'Southesk,' states that at the beginning of January spawning plaice were obtained in the inshore waters in the Pentland Firth. Some specimens from the Pentland Firth were examined at Montrose, on January 11th, by Mr Peter Jamieson, and found 'about ripe' or three-quarters ripe.

In February, from the 19th to the 27th, a number of hauls were again made at or in the vicinity of Smith Bank. Of the sixty-four plaice examined sixty were quite mature, actively spawning or partially spent, and four nearly mature.

If the data obtained from these various sources are combined and compared, the following conclusions seem warranted :—(1) plaice do not spawn in the Firth of Forth or St Andrews Bay, and probably not in Montrose Bay, Aberdeen Bay, Cruden Bay, or the territorial waters of the Moray Firth; (2) they spawn chiefly in January and February; (3) they congregate for spawning purposes in vast shoals in certain portions of the offshore grounds on the East Coast, as at Smith Bank—further, according to the statement of Captain Mackay, of the 'Southesk,' they spawn in immense numbers in the territorial waters of the Pentland Firth, as at Sandside Bay.

Lemon Sole (*Pleuronectes microcephalus*).

The number of lemon soles examined was 617. Of these 334 were obtained in the Firth of Forth, seventeen in St Andrews Bay, two in Aberdeen Bay, seventeen at the Garland's stations in the Moray Firth, and thirteen by the 'Southesk' at Smith Bank, in the Moray Firth; while 101, examined at the University, were obtained 20 or 30 miles east of May Island, and 133 were examined by fishery officers.

Of the 334 caught in the Firth of Forth, only three were fully ripe, at Station V., in June 1889. Two were found nearly mature in October. From then to March all were immature. In March, three were nearly mature near the mouth of the Firth. In June 1889, besides the three ripe ones, eight were found 'nearly mature,' and four three-quarters mature, nearly all of these being obtained near or at the mouth of the

Forth. The seventeen specimens caught in St Andrews Bay (from July 1888 to June 1889) were all more or less immature. None of those obtained at the 'Garland' Stations in the Moray Firth and in Aberdeen Bay were mature; of fourteen obtained at the end of June 1889, at the 'Garland' Stations in the Moray Firth, two were ripe, one nearly ripe, and one spent. Three caught at Smith Bank, in January and February 1889, were immature. Smith Bank was again visited at the end of June and beginning of July. Of ten lemon soles examined, eight were found fully ripe. Of those examined by fishery officers those caught in April were forming roe and milt; eight, out of twelve, on June 5th, caught from 25 to 30 miles south east of Montrose, were ripe, and the others not yet ripe; and on June 20th, six, out of eight, obtained from 16 to 20 miles from Montrose, were ripe, the other two being spent.

The lemon sole, therefore, appears to spawn chiefly in June, and mainly on offshore grounds, although a few may spawn somewhat close to the shore, as in the Moray Firth.

Common Dab (*Pleuronectes limanda*).

The number of specimens of the common dab examined was 1259. On these 448 were obtained in the Firth of Forth, 273 in St Andrews Bay, thirty-five in Montrose Bay, seventy-seven in Aberdeen Bay, eight in Cruden Bay, twenty-seven at the stations in the Moray Firth, 152 at Smith Bank and vicinity; ninety-nine were examined at the University, and obtained 20 or 30 miles east of May Island, and 130 were examined by fishery officers.

In the Firth of Forth one was found mature in June 1888, one nearly ripe, and four three-quarters mature. In August and September all were more or less immature. In October nearly all were immature, but two were nearly mature. In January and February seven were nearly ripe. In March, out of 102, five were fully ripe, and forty nearly mature. In April, out of twenty-six examined, four were fully ripe, and eight nearly ripe. In May, out of twenty-four examined, four were fully mature, and three nearly ripe. In June, out of forty-five, three were quite ripe, and twenty-three nearly mature. Of those caught in St Andrews Bay, one, out of forty-one, was ripe in July 1888, and two nearly mature. None were found mature again until March, when out of forty examined, two were mature, and fourteen nearly mature. In April, out of twenty-two examined, two were ripe, and four nearly ripe. In June, out of forty, two were ripe, and seven nearly mature. Twenty-five obtained at Montrose in July 1888, and nine in June 1889, were all more or less immature. Of forty-nine caught in Aberdeen Bay in July 1888, none were ripe; of twenty-eight obtained in June 1889 one was fully ripe and one was nearly ripe. Eight got in Cruden Bay, in July 1888, were all immature. Of thirty-seven obtained on June 26 and 27, 1889, from the 'Garland' stations in the Moray Firth, eleven were fully mature, and six nearly ripe. Among the 128 caught at Smith Bank and neighbourhood, nine, out of fifty-nine, were nearly ripe in January, but none were mature; in February none of the forty-nine examined were mature or nearly mature. Of forty-four examined on June 28 and July 5, 1889, at Smith Bank, thirteen were fully ripe, and fifteen nearly ripe. In the case of the ninety-nine examined at the University, and obtained in the offshore waters east of May Island, none were mature, but these records include only the period from July 1888 to January 1889. Of the 130 specimens examined by fishery officers, five, out of eighteen, were fully ripe on June 6 and 17, and these were caught from 4 to 8 miles off the shore at Montrose. On April 23 and 27, of twenty-two caught within $1\frac{1}{2}$ miles off Arran, eleven were fully mature.

It is apparent from these observations that the spawning period of the common dab is later than that of the long rough dab, and that the spawning largely occurs in the inshore waters. In the Firth of Forth spawning appears to begin in March, and continues till the end of June. It also appears that the common dab, like the long rough dab, spawns chiefly in the waters close to the shore; but there is not sufficient information in regard to their condition in April, May and June, on off-shore grounds, to say whether they spawn to any large extent there also.

In regard to the distribution of the ripe fish in the waters of the Firth of Forth, they were found at all the groups of stations, but they were not so abundant at the inner group as at the stations situated at the mouth of the Firth. Taking the totals of common dabs for the year (ripe and unripe) it appears, that they are much more abundant at the inner group of stations than at those at or beyond the mouth of the Firth; they also average about 2 inches longer at the inner group of stations than at the outer. There can be little doubt, therefore, that, as in the case of the long rough dab, the centre of distribution of the common dab in the Forth is in the wide area east of Inchkeith. The data in regard to the distribution of the ripe fish are, however, not sufficient to warrant the apparent conclusion from the above facts, viz., that at maturity the common dab migrates seawards to a greater extent than does the long rough dab.

Witch Sole (*Pleuronectes cynoglossa*).

Of the 90 specimens examined, sixty-four were obtained by the 'Garland' in the Firth of Forth, and twenty-six by fishermen east of May Island. Of the former none were found ripe in any month during the year. In June 1888, two, and in August, three, were three-fourths mature; in February one was nearly mature.

Only one of the witch soles was caught at the inner stations, all the others being obtained at the mouth of the Firth. Of those caught east of May Island two were nearly ripe and two quite ripe in September; all the others were immature.

It appears from the rather slender data that the witch sole does not spawn in the Forth, and that the spawning period is probably late in the summer.

Flounder (*Pleuronectes flesus*).

Of 160 examined, eighty-five were obtained by the 'Garland' in the Firth of Forth, twenty-two in St Andrews Bay, and two in Aberdeen Bay; fifty-one were examined by fishery officers. Those from the Firth of Forth were all obtained during March, April, May and June 1889. In March, of thirty-three examined, one was ripe, and thirteen were nearly ripe. In April, four, out of twenty-one, were ripe, and eight nearly ripe. In May, one, out of eleven, was ripe. In June, two, out of fourteen, were ripe, and seven nearly mature. Of the twenty-two caught in St Andrews Bay, seven, out of seventeen, were ripe in April. and four nearly ripe; in June, out of five, two were nearly ripe. One of the two obtained in Aberdeen Bay in June was nearly ripe. Of the fifty-one examined by fishery officers, six were ripe; five, out of ten, in

April, a mile and a half from Arran, and one, out of four, in May, 40 miles east of Stonehaven.

The above data in regard to the flounder are not very extensive. In the Firth of Forth, and probably also in St Andrews Bay, they spawn chiefly in April, May, and June. Most of the mature specimens were obtained at the outer stations, but a few also from the inner stations.

Little Sole (*Solea lutea*).

On the 5th July, 1889, the 'Garland' came upon a shoal of this somewhat rare fish, at Smith Bank, in the Moray Firth, congregated there for spawning purposes. Seventy-seven specimens were obtained, sixty in one haul. Of thirty-five specimens examined by Mr Thomas Scott, five females were fully ripe,and two males nearly ripe.

It may be presumed that in the Moray Firth this species spawns chiefly in July, and in the offshore waters.

Long Rough Dabs (*Hippoglossoides limandoides*).

The number of long rough dabs examined was 821. Of these 614 were obtained from the Firth of Forth, fifty-one from St Andrews Bay, twenty-four from Montrose Bay and Aberdeen Bay, and 132 from Smith Bank or neighbourhood. The results of the inquiries in regard to the spawning of this flat-fish are of much interest. In the Firth of Forth none were found fully ripe or nearly ripe in 1888, in June, August, or September. In October and November none were fully mature, but eighteen were nearly mature, and eight three-fourths mature. In December thirteen were quite mature, and one nearly mature. In January, out of ninety-seven examined, eleven were fully ripe, and fifty-nine nearly ripe; and in February forty-six, out of fifty-nine, were nearly ripe. In March, out of ninety-seven examined, fifteen were quite mature, and forty-five nearly. In April, two out of twenty-five were fully ripe, and one nearly mature; in May, out of twenty-one, only one was nearly mature and none ripe; in June fifty-nine were examined, and all were more or less immature. Of those obtained in St Andrews Bay none were found mature. One was three-quarters ripe and one nearly ripe in September; in October six were nearly ripe; in December seven; in June one was nearly ripe. In Aberdeen Bay eight in July 1888, and six in June 1889, were all more or less immature, and in Montrose Bay in the same months all were more or less immature. Of the 133 obtained from Smith Bank, and other offshore grounds in the Moray Firth, seventy-three were found nearly mature in January, and six three-quarters mature, but none were fully ripe. In February, out of forty-six examined, three were fully ripe and thirty-seven nearly ripe. In July 1889, one was immature. It appears from these data that the long rough dab begins to spawn in the Firth of Forth in December, and continues spawning until April. It appears also to spawn in early spring at the offshore grounds in the Moray Firth; but we have no data in regard to their condition in the inshore waters of the Moray Firth at the same period. The observations in the Firth of Forth were very carefully made throughout the year, and they show that the majority of the ripe fish were obtained at the inner group of stations (I. to IV.) west of Inchkeith, and especially at those situated in mid-channel. A few ripe fish were also obtained from the stations at the mouth of the Firth. From an analysis of the records it appears that the largest specimens are obtained at the inner stations, those got beyond the mouth of the Firth averaging about half an inch less in length. They are also relatively most abundant at the inner stations. There appears little doubt, therefore, that this area of the Firth is the local centre of distribution of the long rough dab.

Turbot (*Rhombus maximus*).

The number of turbot examined was 237. Of these thirty-five were obtained by the 'Garland'—eight in the Firth of Forth, thirteen in St Andrews Bay, four in Montrose Bay, four in Aberdeen Bay, two in the Moray Firth at the Garland's stations, four at Smith Bank or vicinity; 202 were examined by fishery officers. None of those obtained by the 'Garland' were mature; two caught in St Andrews Bay in June were about three-fourths mature, but the others were immature, and as a rule small in size. Four fairly large specimens obtained at Smith Bank in January and February were 'rather immature.' Of those examined by fishery officers, one was ripe at the end of April, eighteen in May and twenty-five in June. They were all got on the East Coast at distances of from 50 to 150 miles from shore.

It appears that the turbot spawns chiefly in May and June, and at great distances from shore.

Brill (*Rhombus laevis*).

Sixty-one brill were examined; seven obtained by the 'Garland' in the Firth of Forth, three at Smith Bank, and the remainder by fishery officers. Those from the Firth of Forth and Smith Bank were unripe; one from the mouth of the Forth, in June, being, however, nearly ripe. Of the fifty-one examined on the East Coast by fishery officers, thirty-seven were ripe; twenty-seven in April, 15 to 50 miles from shore, and ten in May, 20 to 30 miles from shore.

The brill appears to spawn earlier than the turbot, and, as a rule, not so far from shore.

Halibut (*Hippoglossus vulgaris*).

All the halibut examined (329) were examined by fishery officers, and were caught at distances varying from 10 to 140 miles off the East Coast. Four were found to be ripe; one, out of twenty-six, in May, caught 35 miles off Berwick, and three, out of eight, on June 6th and 7th, caught from 100 to 150 miles east of May Island.

From the notes of the fishery officers it appears that the halibut spawns later than the turbot, and, like it, at great distances from shore.

Other Flat-fish.

Specimens of Sail Fluke or Merry Sole (*Arnaglossus megastoma*) were also examined, but so few specimens were caught that only imperfect conclusions can be based upon the information obtained.

II. Round-Fish.

Haddock (*Gadus æglefinus*).

The number of haddocks examined was 7412. Of these, 513 were examined on board of the 'Garland'; 363 in the Firth of Forth, 107 in St Andrews Bay, sixteen in Montrose Bay, twenty-three in Aberdeen Bay, seven in Cruden Bay, and sixteen in the Moray Firth. At Smith Bank 109 were examined, and at the University 103, obtained 20 to 30 miles east of May Island. The fishery officers examined 6668.

Of those obtained by the 'Garland' in the Forth, at intervals since June 1888, all were more or less immature until January, when one, out of sixty-nine, was ripe, and three nearly ripe. In February, seven, out of twenty-one, were nearly ripe, but none quite mature. In March, out of seventy-one, three were quite ripe and three nearly mature. In April, out of twenty, all were immature. In May, the ten examined, and in June, the thirty-eight were all immature. In St Andrews Bay none were found ripe in any of the months; one was nearly ripe in December, three in January, one in March, and one in April. All those obtained in July and June at Montrose Bay, Aberdeen Bay, Cruden Bay, and the Moray Firth stations were more or less immature. Those examined at the University, and caught from July to January, east of May Island, were all immature, except seven in January, which were three-quarters mature. At or near Smith Bank seventy-four were caught in January and thirty-five in February. Of the former none were ripe, but eleven were nearly ripe and three three-quarters mature. Of the latter nine were nearly mature. Off Lossiemouth, in February, a large haul of haddocks was made in from 50 to 60 fathoms; a few were quite ripe, but the great majority were only about half mature. Between March 26th and 29th a great shoal of large haddocks was discovered, about 12 miles off Lossiemouth, the great majority of which were ripe and spawning, and enormous numbers of their floating eggs were collected from the surface of the sea.

Of the large number of fish examined by fishery officers in April, May and June, seventy-three were ripe; sixty-four in April and nine in May. They were caught at distances varying from 1 or 2 to 20 or 30 miles from shore. Most of those obtained in May and April were spent fish. The notes of the fishery officer at Montrose show the successive proportions from the end of March to the end of June as follows:—

On March 30th, haddocks were largely spent; all the larger fish, if not spawned or spent, were quite ripe; on April 6th the large ones were mostly spawned or ripe and spawning; on April 13th most of the large ones had spawned; on April 23rd a few were spawning, but most were spent, a few small ones being still unripe; on April 29th all the large fish were spent and most of the small fish; on May 8th a few were spawning, but the great majority spent; on June 29th forty examined were all spent. At Aberdeen, on April 27th, they had 'just spawned.' At Peterhead, on April 19th, most had spawned, but a few had still to spawn.

From the data obtained it is evident that haddocks spawn chiefly in March and April, and on the East Coast at moderate distances from shore, but beyond the territorial waters. Of the mature and nearly ripe specimens got by the 'Garland' in the Firth of Forth all the ripe ones were obtained at the stations at the mouth of the Firth; and only two of the specimens nearly mature were caught at the inner group of stations. We have very little information from the West Coast as to the spawning of the haddock, but ripe fish were obtained a mile or two off Arran, where the water is deep.

WHITING (*Gadus merlangus*).

The number of whiting examined was 2360. On board the 'Garland,' 350 were obtained in the Firth of Forth, seventy-six in St Andrews Bay, and forty-three in Montrose Bay, Aberdeen Bay, and the Moray Firth. Those obtained by fishermen 20 to 30 miles east of May Island numbered 106. At Smith Bank thirty-seven were caught, and fishery officers examined 1748. Of those obtained in the Firth of Forth, all obtained from June 1888 to January 1889 were more or less immature. One, three-quarters mature, was caught on January 7th. In February two were nearly ripe and three three-quarters ripe; all being obtained at the mouth of the Firth. In March, out of sixty-six, four were quite ripe (at the mouth of the Firth), and twenty-three nearly ripe,—nearly all occurring in the outer or seaward part. In April, out of twenty-six, one was fully mature (at an inner station), and six nearly ripe. In May, out of seven, one was ripe and two nearly ripe. In June, out of twenty-seven, two were quite mature and one nearly mature; in May and June the ripe fish were caught at the mouth of the Firth.

The whitings caught in St Andrews Bay were all immature up to January. There is no record of their condition in February or March; but in April one ripe fish was obtained; in May one, out of two; in June five caught were more or less immature. All those obtained in Montrose Bay, Aberdeen Bay and the Moray Firth (in July and June) were more or less unripe; as were also those caught at Smith Bank, in January and February and on July 5th. The 106 caught east of May Island, from June to January, were all unripe; one in January was three-fourths ripe.

Of those examined by fishery officers two were ripe in March, fifty-three in April, fifty-eight in May, and forty-six in June. They were obtained at distances of from 1 or 2 to 30 or more miles from shore; it appears that the majority of those spawning in June were caught much closer to shore than those spawning at the beginning of the season, except in the case of those caught in deep water off Arran. The following observations of the fishery officer at Montrose are of special value:—

On March 30th, whiting were improving in condition, but none of them were nearly ripe; on April 13th a large number were nearly ripe; towards the end of April a few were ripe, but the great majority unripe; in the middle and towards the end of May a large number were nearly ripe, a few quite ripe and a few spent; on June 17th, fifteen, out of twenty, were ripe, the others being mostly spent; on June 25th, eighteen, out of forty, were ripe, the others being spent. At most of the other stations they were also mostly spent in June.

It appears that the spawning period of the whiting begins at the end of March and extends to the end of June, and that they do not spawn to any extent in the territorial waters.

LYTHE (*Gadus pollachius*).

Only nine specimens were examined. One obtained in the Firth of Forth in October, two at Smith Bank in January and February, four caught 8 miles east of May Island in April, and one in the territorial waters in the Moray Firth in June, were all immature. The only ripe specimen was obtained in May, 50 to 60 miles east of May Island.

Saithe (*Gadus virens*).

The number examined was 354. Two obtained in the Firth of Forth by the 'Garland' in June were small and immature. Of 351 examined by fishery officers, only two were ripe, one, out of eighteen, in April, 100 miles east of Montrose, and one, out of eight, on 5th July, 100 miles east of May Island. The others, got in April, May and June, at distances varying from 2 to 120 miles from shore, were more or less immature or spent.

Saithe appears to spawn much later than cod, probably chiefly in June, at considerable distances from shore.

Cod (*Gadus morrhua*).

The number of cod examined was 3667. On board the 'Garland' 520 were examined from the Firth of Forth, fourteen from St Andrews Bay, and five in the Moray Firth and Aberdeen Bay. At Smith Bank 75 were examined; the great majority, 3053, were examined by fishery officers. Not a single ripe cod was obtained in the Firth of Forth. All were more or less immature from June to December, when one three-fourths mature was caught. In February, out of thirty-five, four were nearly mature and four three-fourths mature.

In March, out of seventy-eight, all those obtained within the limits of the Firth were more or less immature; just beyond the limits one was found ripe, and four nearly ripe. In April, May and June all were found more or less immature. It is therefore evident that cod do not spawn in the Firth of Forth.

In St Andrews Bay the cod examined were obtained in October, December, January and March, and they were all more or less immature, as were also those obtained at Aberdeen Bay, and at the stations in the Moray Firth.

At Smith Bank twenty-two were examined in January; they were immature except two, which were three-fourths mature. At the end of February, fifty-two were examined; four were quite ripe, and twenty-two nearly mature.

Of those examined by fishery officers, 312 were ripe; 135 in April, 171 in May and 6 in June. They were caught at distances varying from 6 to 170 miles from shore.

The great spawning period for cod seems to extend from the end of March well into May. At the end of March 1889, Mr T. Scott obtained considerable numbers of cod ova from the surface of the Moray Firth. Some of these hatched two days later.

Ling (*Molva vulgaris*).

1431 specimens of ling were examined. Four obtained in the Firth of Forth in August, December, February and March were more or less immature. Of 1427 examined by fishery officers, 337 were ripe; eighty-three in April, 173 in May, and eighty-five in June. These fish were obtained at distances varying from 10 to 170 miles from shore.

Ling seems to spawn in April, May and June, and mostly at great distances from shore.

Hake (*Merluccius vulgaris*).

The number of specimens examined was forty-nine. Only one specimen was examined on the 'Garland' (from Aberdeen Bay, on 21st June), and that was nearly mature. Three obtained at Smith Bank in February were not ripe. Of forty-five examined by the fishery officer at Fraserburgh, on 5th June, and caught 50 to 60 miles off shore, eighteen were ripe.

The hake seems to spawn late, and offshore.

Common Gurnard (*Trigla gurnardus*).

The number of common gurnards examined was 837; 289 in the Firth of Forth, ninety-seven from 20 to 30 miles east of May Island, 167 in St Andrews Bay, twelve in Montrose Bay, twelve in Cruden Bay, twenty-eight in Moray Firth, twenty-two at Smith Bank, and eighty-five by fishery officers.

Of those obtained from the Firth of Forth, three, out of fifty-five, were ripe in June 1888, four nearly mature, and seven three-fourths mature. In August, out of thirty-six, one was mature, four nearly mature, and five three-fourths mature. In September thirty-six were more or less immature. In October, out of nineteen, one was nearly mature, and in November, out of ten, one was nearly mature. In April, out of nine, four were nearly mature. In May, out of thirty-two, one was quite ripe, and twelve nearly ripe. In June, out of fifty-six, fourteen were fully ripe, twelve nearly ripe, and twelve three-fourths mature.

Of those obtained in St Andrews Bay, nine, out of twenty-eight, were nearly ripe, and six three-fourths ripe in July. In August, two, out of twenty-eight, were quite mature, and five nearly mature. In September and October, out of forty, all were unripe, as were two obtained in December. There is no record of their condition in St Andrews Bay in January, February and March, but in April, out of twenty-three examined, two were quite ripe, and thirteen nearly ripe. In May, out of thirteen examined, six were nearly mature, and six three-fourths mature. In June, out of thirty-three, sixteen were in a spawning condition, ten nearly ripe, and two three-fourths mature.

Of twenty-two obtained in Montrose Bay, in July 1888, all were unripe, but on June 19, 1889, of twelve examined, five were found quite mature, and three nearly mature. Of fifty-seven obtained in Aberdeen Bay, in July 1888, three were nearly ripe, and five three-fourths mature; and of thirty-four obtained in June 1889, fifteen were nearly ripe, but none quite mature. In Cruden Bay, of twelve obtained on July 19, two were mature. At the stations in the Moray Firth, of twenty-eight examined at the end of June 1889, seven were fully ripe, and two nearly ripe. At Smith Bank, of ten examined in January, four were fully ripe, and of twelve examined in February all were more or less unripe. Of 34 obtained at the end of June and the beginning of July 1889, four were quite mature, and eleven nearly mature. The fishery officers examined eighty-five, of which fifty-two were ripe; twenty-eight out of sixty-five in May, 20 to 30 miles off Montrose; and twenty-four, out of thirty, in June, in the same area.

The period during which common gurnards are found quite ripe is therefore a prolonged one, ripe fish having been obtained in January, April, May, June, July and August, but they seem to spawn chiefly in May and June, and both in and beyond the territorial waters. The ova of the gurnard were on several occasions obtained in the surface tow-net, in the Moray Firth, Firth of Forth and elsewhere, from 10 to 65 miles from shore.

Tusk (*Brosmius brosme*).

Of eighty specimens examined by fishery officers sixty were found ripe, seven in April, and fifty-three in May. They were obtained on the East Coast.

Catfish (*Anarrhichas lupus*).

Of nineteen specimens obtained in the Firth of Forth, three obtained in February, towards the mouth of the Firth, were ripe, and one nearly ripe. All the others obtained in January, April, June, August and November were unripe, but one in August was nearly mature.

Angler (*Lophius piscatorius*).

Of thirty-two specimens obtained chiefly in the Firth of Forth during August, September, October, November, February and March, and also in the Moray Firth in June and July, all were more or less unripe.

Other Fish.

Specimens of the father-lasher or cobbler (*Cottus scorpius*), dragonet (*Callionymus lyra*), lump-sucker (*Cyclopterus lumpus*), brassie (*Gadus luscus*), greater weever (*Trachinus draco*), and pogge (*Agonus cataphractus*) were obtained, but they were so few that little positive information was derived from their examination. Of eight specimens of the dragonet obtained in the Firth of Forth, one was ripe in June, and two nearly ripe in May, and one in St Andrews Bay in June was quite ripe. Two specimens of the pogge obtained in the Forth in May were nearly ripe. Of two specimens of the lump-sucker obtained in the Forth in March one was quite ripe and one nearly mature.

I. FIRTH OF FORTH.

Kind of Fish.	Date.	Station.	Males.		Females.		Three-fourths Mature.		Nearly Mature.		Mature.	
			Number.	Total length in inches.	Number.	Total length in inches.	M.	F.	M.	F.	M.	F.
Plaice.	Jun. 12	II.	6	70¾	4	49	.	.	.	.	.	.
	,, 12	III.	5	60½	5	70	.	.	.	.	.	.
	,, 14	IV.	1	16½	.	.	.	.	.	.	.	.
	,, 15	V.	4	53	1	10	.	.	.	.	.	.
	,, 15	VI.	4	57½	7	113	.	.	.	.	.	.
	,, 19	VIII.	1	12	3	38½	.	.	.	.	.	.
			21	270¼ 12·8	20	280½ 14·0	.	.	.	.	.	.
	Aug. 1	I.	4	55	4	64	.	.	.	.	.	.
	,, 1	II.	1	12	5	62½	.	.	.	.	.	.
	,, 1	III.	4	52	4	51½	.	.	.	.	.	.
	,, 2	IV.	1	13½	4	57	.	.	.	.	.	.
	,, 5	V.	2	27½	3	42	.	.	.	.	.	.
	,, 3	VI.	2	35½	3	58	.	.	.	.	.	.
	,, 2	VII.	3	39¼	3	42	.	.	.	.	.	.
			17	234¾ 13·8	26	377 14·5	.	.	.	.	.	.
	Sept. 10	I.	2	25	3	38	.	.	.	.	.	.
	,, 7	II.	4	50	1	13½	.	.	.	.	.	.
	,, 7	V.	1	14½	4	59½	.	.	.	.	.	.
	,, 7	VI.	5	74½	.	.	.	.	.	.	.	.
	,, 6	VII.	2	27	3	37½	.	.	.	.	.	.
	, 6	VIII.	2	28	3	40½	.	.	.	.	.	.
	,, 6	IX.	.	.	1	19	.	.	.	.	.	.
			16	219 13·6	15	208 13·8	.	.	.	.	.	.
	Oct. 6	I.	2	28	4	57	.	.	.	.	.	.
	4	II.	4	49½	2	25½	.	.	.	.	.	.
	,, 8	III.	3	35	4	50½	.	.	.	.	.	.
	,, 8	IV.	6	81	4	58	.	.	.	.	.	.
	,, 3	V.	1	14	.	.	.	.	.	.	.	.
	,, 3	VI.	1	13½	7	104	.	.	.	.	.	.
	,, 2	VII.	5	64	3	59	.	.	.	3	.	.
	,, 2	VIII.	.	.	2	26½	.	.	.	.	.	.
			22	285 12·9	26	380½ 14·6	.	.	.	3	.	.
	Nov. 8	III.	.	.	1	13	.	.	.	.	.	.
	,, 30	III.	7	99	1	13	.	.	.	1	.	.
	,, 1	VIII.	2	31½	.	.	1	.	.	.	.	.
			9	130½ 14·5	2	26 13·0	1	.	.	1	.	.
	Dec. 1	III.	.	.	1	15	.	.	.	.	.	.
	,, 21	IV.	5	61	11	142½	.	.	1	.	.	.
			5	61 12·2	12	157½ 13·1	.	.	1	.	.	.
	Jan. 3	IV.	7	90	6	79¾	.	.	2	.	.	.
	,, 9	VI.	.	.	2	28	.	.	.	.	.	.
	,, 8	IX.	.	.	1	13	.	.	.	.	.	.
			7	90 12·8	8	120¾ 15·6	.	.	2	.	.	.

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Plaice.	Feb. 12	I.	2	25	1	14	.	.	.	.	.	.
	,, 11	II.	7	91	3	38	.	.	.	.	.	.
	,, 5	IV.	7	92½	6	79	.	.	.	.	.	.
	,, 1	VI.	10	141	5	77	.	.	.	.	.	.
	,, 6	VII.	.	.	2	29	.	.	.	.	.	.
	,, 6	VIII.	.	.	1	17½	.	.	.	.	.	.
			26	349½ 13·4	18	254½ 14·1	.	.	.	.	.	.
	Mar. 11	I.	4	45	3	39	.	.	.	.	.	.
	,, 8	II.	2	30	7	96½	.	.	.	.	.	.
	,, 11	III.	2	28	1	14	.	.	.	.	.	.
	,, 9	IV.	8	99	15	192	.	.	.	.	.	.
	,, 8	V.	1	15½	1	12	.	.	.	.	.	.
	,, 8	VI.	2	39½	9	132	.	.	.	.	.	.
	,, 8	VII.	1	14	5	70½	.	.	.	.	.	.
	,, 4	IX.	.	.	3	45	.	.	.	.	.	.
			20	271 13·5	44	601 13·6	.	.	.	.	.	.
Lemon Sole.	Jun. 12	II.	4	40½	6	71	.	1	.	.	.	.
	,, 12	III.	3	31	7	71½	.	.	.	.	.	.
	,, 14	IV.	2	18	5	54	.	1	.	.	.	.
	,, 15	V.	2	17½	6	66	.	.	.	.	.	.
	,, 15	VI.	1	11	5	55	.	.	.	.	.	.
	,, 19	VIII.	4	37	5	46	1	.	.	.	.	.
			16	155 9·6	34	363½ 10·6	1	2	.	.	.	.
	Aug. 1	I.	1	12	5	59½	.	.	.	.	.	.
	,, 1	II.	1	11	5	51½	.	.	.	.	.	.
	,, 1	III.	1	11½	7	79½	.	.	.	.	.	.
	,, 2	IV.	.	.	6	67	.	.	.	.	.	.
	,, 3	VI.	2	24	3	37½	.	.	.	.	.	.
	,, 2	VII.	1	9	4	46	.	.	.	.	.	.
	,, 2	VIII.	3	33½	1	10	1	.	.	.	.	.
			9	101 11·2	31	351 11·3	1	.	.	.	.	.
	Sept. 10	I.	.	.	5	59½	.	.	.	.	.	.
	,, 7	II.	1	12½	4	51	.	.	.	.	.	.
	,, 7	V.	3	34	2	22½	.	.	.	.	.	.
	,, 7	VI.	2	23	2	26	.	.	.	.	.	.
	,, 6	VII.	1	10	4	46½	.	.	.	.	.	.
			7	79½ 11·3	17	205½ 12·0	.	.	.	.	.	.
	Oct. 6	I.	.	.	6	76½	.	.	.	.	.	.
	,, 4	II.	1	12	6	77	.	.	.	.	.	.
	,, 8	III.	.	.	8	102½	.	.	.	.	.	.
	,, 3	V.	1	11	1	16	.	.	1	1	.	.
	,, 3	VI.	2	20½	4	47	.	.	.	.	.	.
	,, 2	VII.	1	11	2	21½	.	.	.	.	.	.
			5	54½ 10·9	27	340½ 12·6	.	.	1	1	.	.
	Nov. 8	I.	.	.	3	39	.	.	.	.	.	.
	,, 8	III.	.	.	5	61	.	.	.	.	.	.
	,, 30	IV.	5	53	1	13	.	.	.	.	.	.
	,, 1	VIII.	1	12½	3	35	.	.	.	.	.	.
			6	65½ 10·9	12	148 12·3	.	.	.	.	.	.

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Lemon Sole.	Dec. 1	I.	.	.	2	25	.	.	.	.	.	.
	,, 1	III.	.	.	1	9½	.	.	.	.	.	.
	,, 20	I.	3	38	6	81½	.	.	.	.	.	.
			3	38	9	116	.	.	.	.	.	.
				12·6		12·8						
	Jan. 10	I.	.	.	5	57½	.	.	.	.	.	.
	,, 7	III.	.	.	3	38	.	.	.	.	.	.
	,, 8	VII.	.	.	1	14	.	.	.	.	.	.
			.	.	9	109½	.	.	.	.	.	.
						12·1						
	Feb. 12	I.	1	9½	5	60	.	.	.	.	.	.
	,, 5	IV.	.	.	3	29	.	.	.	.	.	.
	,, 11	VI.	.	.	2	25	.	.	.	.	.	.
	,, 6	VII.	.	.	1	13	.	.	.	.	.	.
	,, 6	VIII.	1	14½	1	9	.	.	.	.	.	.
	,, 6	IX.	1	9½	1	12	.	.	.	.	.	.
			3	33½	13	148	.	.	.	.	.	.
				11·1		11·3						
	Mar. 11	I.	1	11½	8	91	.	.	1	.	.	.
	,, 8	II.	.	.	3	39½	.	.	.	1	.	.
	,, 11	III.	1	10	5	57½	.	.	.	.	.	.
	,, 8	V.	1	12	1	16	.	.	.	.	.	.
	,, 8	VI.	1	11	1	14½	.	.	.	.	.	.
	,, 8	VII.	2	26	.	.	.	.	2	.	.	.
	,, 4	IX.	.	.	1	13	.	.	.	.	.	.
			6	70½	19	231½	.	.	3	1	.	.
				11·7		12·1						
Long Rough Dabs.	Jun. 12	II.	1	8	6	57¼	.	.	.	.	.	.
	,, 12	III.	.	.	4	39½	.	.	.	.	.	.
	,, 14	IV.	.	.	8	64½	.	.	.	.	.	.
	,, 15	V.	.	.	10	81	.	.	.	.	.	.
	,, 19	VIII.	.	.	13	103½	.	.	.	.	.	.
			1	8	41	245¾	.	.	.	.	.	.
				8·0		8·4						
	Aug. 1	I.	.	.	6	63	.	.	.	.	.	.
	,, 1	II.	.	.	5	51½	.	.	.	.	.	.
	,, 1	III.	.	.	5	52½	.	.	.	.	.	.
	,, 2	IV.	.	.	2	19	.	.	.	.	.	.
	,, 5	V.	.	.	5	44½	.	.	.	.	.	.
	,, 2	VII.	.	.	6	66½	.	.	.	.	.	.
	,, 2	VIII.	.	.	5	47½	.	.	.	.	.	.
			.	.	34	344½	.	.	.	.	.	.
						10·1						
	Sept. 1	I.	.	.	1	10	.	.	.	.	.	.
	,, 7	II.	.	.	5	49½	.	.	.	.	.	.
	,, 7	V.	.	.	5	41	.	.	.	.	.	.
	,, 7	VI.	.	.	3	33½	.	.	.	.	.	.
	,, 6	VII.	.	.	6	72	.	.	.	.	.	.
	,, 5	VIII.	.	.	5	40½	.	.	.	.	.	.
	,, 6	IX.	.	.	5	41	.	.	.	.	.	.
			.	.	30	287½	.	.	.	.	.	.
						9·5						

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Long Rough Dabs.	Oct. 4	II.	.	.	7	68½	.	.	.	2	.	.
	" 8	III.	.	.	6	63	.	.	.	5	.	.
	" 3	V.	.	.	5	44½	.	.	.	4	.	.
	" 2	VII.	.	.	9	105	.	.	.	.	.	.
	" 2	VIII.	.	.	6	50½	.	.	.	6	.	.
	" 2	IX.	.	.	8	69	.	.	.	4	.	.
			.	.	41	400½ 9·7	.	.	.	16	.	.
	Nov. 8	I.	.	.	9	81½	.	.	.	.	.	.
	" 8	III.	.	.	10	89	.	.	.	.	.	.
	" 30	IV.	11	101½	1	8	8	.	2	.	.	.
	" 7	VII.	.	.	3	23	.	.	.	.	.	.
	" 1	VIII.	1	7½	9	75	.	.	.	.	.	.
			12	109 9·0	32	276½ 8·6	8	.	2	.	.	.
	Dec. 1	I.	1	5½	7	70	.	.	.	.	.	.
	" 1	III.	.	.	1	10	.	.	.	.	.	.
	" 6	V.	1	6½	8	63	.	.	.	.	.	.
	" 5	VII.	.	.	3	22½	.	.	.	.	.	.
	" 5	VIII.	1	5½	7	53½	.	.	.	.	.	.
	" 5	IX.	4	24	10	71½	.	.	.	.	.	.
	" 20	I.	5	31½	16	129½	.	.	.	.	2	11
	" 21	IV.	.	.	1	8	.	.	.	1	.	.
			12	73 6·0	53	428 8·0	.	.	.	1	2	11
	Jan. 10	I.	2	14	26	212	.	.	1	14	1	8
	" 10	II.	.	.	12	101	.	.	.	10	.	2
	" 7	III.	.	.	6	45¾	.	.	.	3	.	.
	" 3	IV.	.	.	5	48	.	.	.	4	.	.
	" 9	V.	1	5½	15	116¼	.	.	1	12	.	.
	" 9	VI.	.	.	1	8	.	.	.	.	.	.
	" 8	VII.	2	13	5	39	.	.	1	3	.	.
	" 8	VIII.	.	.	10	75	.	.	.	.	.	.
	" 8	IX.	1	5¼	11	79	.	.	.	10	.	.
			6	37¾ 6·2	91	725 7·9	.	.	3	56	1	10
	Feb. 12	I.	1	6	20	169	.	.	1	13	.	.
	" 5	III.	.	.	2	17	.	.	.	1	.	.
	" 11	V.	7	44	18	149	.	.	3	18	.	.
	" 6	VII.	.	.	3	27½	.	.	.	3	.	.
	" 6	VIII.	.	.	3	25	.	.	.	3	.	.
	" 6	IX.	1	6½	4	38	.	.	.	4	.	.
			9	56½ 6·2	50	425½ 8·5	.	.	4	42	.	.
	Mar. 11	I.	.	.	9	84½	.	.	.	5	.	.
	" 8	II.	.	.	2	14	.	.	.	2	.	.
	" 11	III.	.	.	8	68½	.	.	.	3	.	.
	" 8	V.	.	.	6	56	.	.	.	3	.	3
	" 8	VII.	.	.	9	65½	.	.	.	3	.	.
	" 4	VIII.	1	6½	6	39½	.	.	1	3	.	3
	" 4	VIII.	.	.	5	50½	.	.	.	2	.	3
	" 4	IX.	.	.	5	54	.	.	.	2	.	3
			1	6½ 6·5	50	432½ 8·6	.	.	1	23	.	12

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Witch Soles.	Jun. 14	IV.	.	.	4	69	.	2	.	.	.	.
	,, 15	V.	3	46	4	62½	.	.	.	.	.	.
	,, 19	VIII.	2	28½	1	17	.	.	.	.	.	.
			5	74½ 14·9	9	148½ 16·5	.	2	.	.	.	.
	Aug. 5	V.	.	.	1	16½	.	.	.	.	.	.
	,, 2	VIII.	1	14½	5	89	1	2	.	.	.	.
			1	14½ 14·5	6	105½ 19·0	1	2	.	.	.	.
	Sept. 7	V.	.	.	5	79½	.	.	.	.	.	.
	,, 5	VIII.	.	.	6	105	.	.	.	.	.	.
	,, 6	IX.	1	15½	.	.	.	.	.	.	.	.
			1	15½ 15·5	11	184½ 16·7	.	.	.	.	.	.
	Oct. 2	VII.	.	.	1	17	.	.	.	.	.	.
	,, 2	VIII.	.	.	5	87	.	.	.	.	.	.
			.	.	6	104 17·3	.	.	.	.	.	.
	Nov. 1	VIII.	.	.	3	52	.	.	.	.	.	.
	,, 1	IX.	1	15	1	17	.	.	.	.	.	.
			1	15	4	69 17·2	.	.	.	.	.	.
	Dec. 3	VII.	.	.	1	19	.	.	.	.	.	.
	Jan. 9	V.	1	15	1	16½	.	.	.	.	.	.
	Feb. 5	IV.	.	.	1	15	.	.	.	1	.	.
	,, 11	V.	2	31	5	89	.	1	.	.	.	.
	,, 6	VIII.	1	9	2	36	.	.	.	.	.	.
			3	40 13	8	140	.	1	.	1	.	.
	Mar 8	V.	2	34	1	15	.	.	.	.	.	.
	,, 4	VIII.	.	.	1	17½	.	.	.	.	.	.
	,, 4	IX.	1	16½	1	15½	.	.	.	.	.	.
			3	40½ 13·5	3	48 16·0	.	.	.	.	.	.
Common Dabs.	Jun. 12	II.	1	8	9	72	.	1	.	.	.	.
	,, 12	III.	3	23¾	3	25	1	1	.	.	.	.
	,, 14	IV.	5	40½	1	8	.	.	.	.	.	.
	,, 15	V.	4	29¾	5	36½	.	.	.	.	.	.
	,, 15	VI.	.	.	5	33	.	.	.	.	.	.
	,, 19	VIII.	3	25	5	38½	1	.	.	1	.	1
			16	127 7·9	28	213 7·6	2	2	.	1	.	1

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Common Dabs.	Aug. 1	I.	.	.	7	61	.	.	.	.	.	.
	,, 1	II.	1	8	4	36	.	.	.	.	.	.
	,, 1	III.	2	21	5	51½	.	.	.	.	.	.
	,, 2	IV.	6	.	6	54½	.	.	.	.	.	.
	,, 5	V.	4	33¾	1	9½	.	.	.	.	.	.
	,, 3	VI.	.	.	3	21	.	.	.	.	.	.
	,, 2	VII.	1	8	5	44	.	.	.	.	.	.
	,, 2	VIII.	1	7½	4	29	.	.	.	.	.	.
			9	78¼ 8·6	35	316½ 9·0	.	.	.	.	.	.
	Sept. 10	I.	.	.	3	26	.	.	.	.	.	.
	,, 7	II.	2	17	3	25½	.	.	.	.	.	.
	,, 7	V.	.	.	5	41½	.	.	.	.	.	.
	,, 7	VI.	1	7	4	31	.	.	.	.	.	.
	,, 6	VII.	2	18	4	37	.	.	.	.	.	.
	,, 6	VIII.	2	16½	3	24½	.	.	.	.	.	.
			7	58½ 8·3	22	185½ 8·4	.	.	.	.	.	.
	Oct. 4	II.	.	.	6	59½	.	.	.	.	.	.
	,, 8	III.	1	9	6	54	.	.	1	1	.	.
	,, 3	V.	2	17	3	26½	.	.	.	.	.	.
	,, 3	VI.	.	.	1	7½	.	.	.	.	.	.
	,, 2	VII.	.	.	5	45	.	.	.	.	.	.
	,, 2	VIII.	1	7½	.	.	.	.	.	.	.	.
			4	33½ 8·3	21	192½ 9·1	.	.	1	1	.	.
	Nov. 8	I.	1	8½	.	.	.	.	.	.	.	.
	,, 8	III.	.	.	6	49½	.	.	.	.	.	.
	,, 30	IV.	2	15½	2	15½	.	.	.	.	.	.
	,, 7	VII.	1	6	4	32	.	.	.	.	.	.
	,, 1	VIII.	2	15¼	5	40½	.	.	.	.	.	.
	,, 1	IX.	7	56½	4	32½	.	.	.	.	.	.
			13	101¾ 7·8	21	170 8·0	.	.	.	.	.	.
	Dec. 1	I.	1	7½	4	37	.	.	.	.	.	.
	,, 1	III.	2	13	.	.	.	.	.	.	.	.
	,, 6	V.	1	7	8	65½	.	.	.	.	.	.
	,, 5	VIII.	3	20	2	14½	.	.	.	.	.	.
	,, 5	IX.	1	7	2	17	.	.	.	.	.	.
	,, 20	I.	1	7	2	15	.	.	.	.	.	.
			9	61½ 6·8	18	149 8·2	.	.	.	.	.	.
	Jan. 10	I.	.	.	2	14	.	.	.	.	.	.
	,, 10	II.	1	6½	3	24	.	.	.	.	.	.
	,, 3	IV.	.	.	2	18	.	.	.	.	.	.
	,, 9	V.	1	7½	.	.	.	.	1	.	.	.
	,, 8	VII.	2	14½	4	35½	.	.	2	.	.	.
	,, 8	VIII.	1	12	4	30½	.	.	1	.	.	.
	,, 8	IX.	1	7½	10	81¾	.	.	1	.	.	.
			6	48 8·0	25	203¾ 8·1	.	.	5	.	.	.

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Common Dabs.	Feb. 12	I.	.	.	4	29½	.	.	.	.	.	.
	,, 5	IV.	.	.	6	56	.	.	.	.	.	.
	,, 11	V.	.	.	2	17	.	.	.	.	.	.
	,, 6	VII.	.	.	1	19½	.	.	.	.	.	.
	,, 6	VIII.	2	16	.	.	.	.	2	.	.	.
	,, 6	IX.	1	9	3	30	.	.	.	.	.	.
			3	25 8·3	16	142 8·9	.	.	2	.	.	.
	Mar. 11	I.	3	28½	5	46	.	.	1	.	1	.
	,, 8	II.	2	20½	5	41	.	.	2	.	.	.
	,, 11	III.	3	25½	3	27½	.	.	3	.	.	.
	,, 9	IV.	.	.	5	44	.	.	.	.	.	.
	,, 8	VI.	1	8	8	77	.	.	.	3	.	.
	,, 8	VII.	2	19½	7	57½	.	.	2	.	.	.
	,, 4	VIII.	3	25	3	27½	.	.	3	2	.	1
	,, 4	IX.	1	8½	5	38	.	.	.	2	.	.
			15	135½ 9·0	41	358½ 8·7	.	.	11	7	1	1
Skate.	Jun. 19	VIII.	2	Breadth 32	.	Breadth .	.	.	.	.	.	.
	Aug. 1	I.	2	35½	.	.	.	.	.	.	.	.
	,, 1	II.	.	.	1	14	.	.	.	.	.	.
	,, 1	III.	1	20	4	77	.	.	.	.	.	.
	,, 2	IV.	3	62½	3	66	.	.	.	.	.	.
	,, 2	VII.	1	15	.	.	.	.	.	.	.	.
			7	133 19·0	8	157 19·6	.	.	.	.	.	.
	Sept. 10	I.	.	.	1	15	.	.	.	.	.	.
	,, 7	II.	1	18	1	15½	.	.	.	.	.	.
	,, 6	VII.	1	14	2	23	.	.	.	.	.	.
	,, 6	VIII.	1	16	1	17	.	.	.	.	.	.
	,, 6	IX.	.	.	1	17	.	.	.	.	.	.
			3	48 16·0	6	87½ 14·5	.	.	.	.	.	.
	Oct. 6	I.	1	20	1	20	.	.	.	.	.	.
	,, 8	III.	1	16½	2	32½	.	.	.	.	.	.
	,, 3	VI.	.	.	1	29	.	.	.	.	.	.
	,, 2	VII.	1	18½	2	34	.	.	.	.	.	.
	,, 2	IX.	1	22	2	41	.	.	.	.	.	.
			4	77 19·2	8	156½ 19·5	.	.	.	.	.	.
	Nov 8	I.	1	15	1	15	.	.	.	.	.	.
	,, 8	III.	.	.	2	39	.	.	.	.	.	.
	,, 30	IV.	2	23	.	.	.	.	.	.	.	.
	,, 7	VII.	1	20	.	.	.	.	.	.	.	.
	,, 1	VIII.	1	17	.	.	.	.	.	.	.	.
			5	75 15·0	3	54 18·0	.	.	.	.	.	.
	Dec. 1	I.	2	26	1	17	.	.	.	.	.	.
	,, 6	V.	1	13	1	14	.	.	.	.	.	.
	,, 5	VII.	.	.	1	12	.	.	.	.	.	.
	,, 6	VIII.	.	.	2	28	.	.	.	.	.	.
			3	39 13·0	5	71 14·2	.	.	.	.	.	.

FIRTH OF FORTH—*Continued.*

Kind Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Skate.	Jan. 9	V.	1	17	.	.	.	.	.	.	.	.
	„ 8	VII.	.	.	1	10	.	.	.	.	.	.
	„ 8	IX.	.	.	1	14½	.	.	.	.	.	.
			1	17 17·0	2	24½ 12·2	.	.	.	.	.	.
	Feb. 12	I.	1	18	1	12	.	.	.	.	.	.
	„ 6	VII.	.	.	1	14	.	.	.	.	.	.
	„ 6	IX.	.	.	1	45	.	.	.	.	.	.
			1	18 18·0	3	71 23·6	.	.	.	.	.	.
	Mar. 11	I.	.	.	1	14	.	.	.	.	.	.
	„ 11	III.	.	.	2	31	.	.	.	.	.	.
	„ 8	VII.	.	.	1	10½	.	.	.	.	.	.
	„ 4	VIII.	.	.	1	12½	.	.	.	.	.	.
			.	.	5	68 13·6	.	.	.	.	.	.
	Jun. 15	V.	13	Length 137	6	Length 62	.	.	.	.	.	.
	„ 15	VI.	.	.	2	25	.	.	.	.	.	.
			13	137 10·5	8	87 10·8	.	.	.	.	.	.
	Aug. 1	I.	.	.	3	43	.	.	.	.	.	.
	„ 1	II.	.	.	3	76	.	.	.	.	.	.
	„ 1	III.	.	.	3	53	.	.	.	.	.	.
	„ 2	IV.	.	.	4	52¾	.	.	.	.	.	.
	„ 5	V.	.	.	2	42½	.	.	.	.	.	.
	„ 3	VI.	1	14	1	18½	.	.	.	.	.	.
	„ 2	VII.	1	12½	3	44½	.	.	.	.	.	.
	„ 2	VIII.	2	74	.	.	.	.	.	.	.	.
			4	100½ 25·0	19	330¼ 17·3	.	.	.	.	.	.
	Sept. 10	I.	.	.	.	.	.	.	.	.	.	.
	„ 7	II.	.	.	.	.	.	.	.	.	.	.
	„ 7	V.	.	.	2	25	.	.	.	.	.	.
	„ 7	VI.	1	14	.	.	.	.	.	.	.	.
	„ 6	VIII.	.	.	1	12½	.	.	.	.	.	.
	„ 6	IX.	1	17	.	.	.	.	.	.	.	.
			2	31 15·5	3	37½ 12·5	.	.	.	.	.	.
	Oct. 6	I.	1	28	4	150	.	.	.	.	.	.
	„ 4	II.	.	.	1	23½	.	.	.	.	.	.
	„ 8	III.	.	.	1	15	.	.	.	.	.	.
	„ 3	V.	1	24½	.	.	.	.	.	.	.	.
	„ 3	VI.	.	.	1	17	.	.	.	.	.	.
	„ 2	VII.	.	.	1	29½	.	.	.	.	.	.
	„ 2	VIII.	3	94½	4	126	.	.	.	.	.	.
			5	147 29·4	12	361 30·0	.	.	.	.	.	.

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total breadth in inches.	Females. Number.	Females. Total breadth in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Cod.	Nov. 8	I.	2	57	.	.	.	.	.	.	.	.
	,, 8	III.	.	.	4	98	.	.	.	.	.	.
	,, 30	IV.	5	108	.	.	.	.	.	.	.	.
	,, 7	VII.	.	.	5	158½	.	.	.	.	.	.
			7	165	9	256½	.	.	.	.	.	.
				23·5		13·5						
	Dec. 1	I.	2	54	3	102	.	1	.	.	.	.
	,, 1	III.	1	36	4	106	.	.	.	.	.	.
	,, 6	V.	1	36	4	149	.	.	.	.	.	.
	,, 5	VII.	3	93	3	103	.	.	.	.	.	.
	,, 5	VIII.	.	.	1	41	.	.	.	.	.	.
	,, 5	IX.	1	33	3	51	.	.	.	.	.	.
	,, 20	I.	1	27	1	36	.	.	.	.	.	.
	,, 21	IV.	.	.	1	19½	.	.	.	.	.	.
			9	279	20	607½	.	1	.	.	.	.
				31·0		30·3						
	Jan. 10	I.	5	94½	3	56	.	.	.	.	.	.
	,, 10	II.	2	41	2	40½	.	.	.	.	.	.
	,, 7	III.	1	26½	7	155½	.	.	.	.	.	.
	,, 3	IV.	3	62	2	32	.	.	.	.	.	.
	,, 9	V.	1	24	2	25	.	.	.	.	.	.
	,, 9	VI.	3	29	7	84¼	.	.	.	.	.	.
	,, 8	VII.	1	34	2	23¾	.	.	.	.	.	.
	,, 8	VIII.	.	.	2	51	.	.	.	.	.	.
			16	311	27	468	.	.	.	.	.	.
				19·4		17·3						
	Feb. 12	I.	1	32	4	125	.	2	.	.	.	.
	,, 11	II.	.	.	.	.	.	.	.	.	.	.
	,, 5	III.	2	62	3	55½	1	.	.	.	.	.
	,, 5	IV.	3	51½	4	92½	.	.	.	1	.	.
	,, 11	V.	1	21½	1	21½	.	.	.	.	.	.
	,, 11	VI.	1	18	3	67	.	.	.	.	.	.
	,, 6	VII.	.	.	3	55½	.	.	.	1	.	.
	,, 6	VIII.	2	62	3	74½	.	.	.	.	.	.
	,, 6	IX.	2	62	2	76	.	1	1	1	.	.
			12	309	23	567½	1	3	1	3	.	.
				25·7		24·6						
	Mar. 11	I.	5	98	3	51	.	.	.	.	.	.
	,, 11	III.	1	17	.	.	.	.	.	.	.	.
	,, 9	IV.	.	.	1	20½	.	.	.	.	.	.
	,, 8	V.	.	.	1	10½	.	.	.	.	.	.
	,, 8	VI.	.	.	1	18	.	.	.	.	.	.
	,, 8	VII.	4	71½	6	108	.	.	.	.	.	.
	,, 4	VIII.	3	62	2	28	.	.	1	.	.	.
	,, 4	IX.	.	.	3	62½	.	.	.	.	.	.
			13	248½	17	298½	.	.	1	.	.	.
				19·1		17·5						
Haddock.	Jun. 15	VI.	1	11	2	21	.	.	.	.	.	.
	,, 19	VIII.	2	17½	3	27	.	.	.	.	.	.
			3	28½	5	48	.	.	.	.	.	.
				9·5		9·6						

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Haddock.	Aug. 1	I.	.	.	3	32	.	.	.	.	.	.
	,, 1	II.	.	.	3	32	.	.	.	.	.	.
	,, 1	III.	.	.	6	65	.	.	.	.	.	.
	,, 2	IV.	.	.	4	47	.	.	.	.	.	.
	,, 5	V.	2	24	3	34	.	.	.	.	.	.
	,, 3	VI.	.	.	4	42	.	.	.	.	.	.
	,, 2	VII.	.	.	3	30½	.	.	.	.	.	.
	,, 2	VIII.	1	9	2	21½	.	.	.	.	.	.
			3	33 11·0	28	304 10·8	.	.	.	.	.	.
	Sept. 10	I.	.	.	2	25	.	.	.	.	.	.
	,, 7	II.	1	12	3	36	.	.	.	.	.	.
	,, 7	V.	.	.	3	35	.	.	.	.	.	.
	,, 7	VI.	.	.	3	32½	.	.	.	.	.	.
	,, 6	VII.	.	.	3	35	.	.	.	.	.	.
	,, 6	VIII.	.	.	4	53½	.	.	.	.	.	.
	,, 6	IX.	.	.	2	23½	.	.	.	.	.	.
			1	12 12·0	20	240½ 12·0	.	.	.	.	.	.
	Oct. 6	I.	.	.	3	34½	.	.	.	.	.	.
	,, 4	II.	.	.	4	47	.	.	.	.	.	.
	,, 8	III.	2	25½	2	27	.	.	.	.	.	.
	,, 3	V.	2	23	2	25	.	.	.	.	.	.
	,, 3	VI.	.	.	.	.	.	.	.	.	.	.
	,, 2	VII.	.	.	2	24½	.	.	.	.	.	.
	,, 2	VIII.	.	.	4	54	.	.	.	.	.	.
	,, 2	IX.	1	10½	3	33½	.	.	.	.	.	.
			5	59 11·8	20	245½ 12·2	.	.	.	.	.	.
	Nov. 8	III.	1	18	1	10½	.	.	.	.	.	.
	,, 7	VII.	1	14	4	51½	.	.	.	.	.	.
	,, 1	VIII.	3	34	2	23	.	.	.	.	.	.
	,, 1	IX.	2	22½	3	32½	.	.	.	.	.	.
			7	88½ 12·6	10	117½ 11·7	.	.	.	.	.	.
	Dec. 1	I.	2	23½	3	40	.	.	.	.	.	.
	,, 6	V.	.	.	5	76½	.	.	.	.	.	.
	,, 5	VII.	3	37	4	54	.	.	.	.	.	.
	,, 5	VIII.	3	41½	2	23½	.	.	.	.	.	.
	,, 5	IX.	2	24	3	38	.	.	.	.	.	.
	,, 20	I.	1	14	4	53	.	.	.	.	.	.
			11	140 12·7	21	285 13·5	.	.	.	.	.	.
	Jan. 10	I.	.	.	1	19	.	.	.	.	.	.
	,, 10	II.	12	145	13	163½	.	.	.	.	.	.
	,, 7	III.	1	12	2	29	.	.	.	.	.	.
	,, 9	V.	6	81½	4	53	.	.	.	.	.	.
	,, 9	VI.	3	45½	3	42	.	.	.	1	.	.
	,, 8	VII.	4	55	6	88½	.	.	2	.	.	1
	,, 8	VIII.	3	34	4	46½	.	.	.	.	.	.
	,, 8	IX.	3	30½	4	39½	.	.	.	.	.	.
			32	403½ 12·6	37	481 13·0	.	.	2	1	.	1

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males.		Females.		Three-fourths Mature.		Nearly Mature.		Mature.	
			Number.	Total length in inches.	Number.	Total length in inches.	M.	F.	M.	F.	M.	F.
Haddock.	Feb. 12	I.	1	13½	3	37½	.	.	.	2	.	.
	,, 11	II.	1	10	1	11½	.	.	.	.	.	.
	,, 11	V.	2	37	3	47	.	.	.	.	.	.
	,, 6	VIII.	.	.	5	95	.	.	.	3	.	.
	,, 6	IX.	3	47½	2	33½	.	.	.	2	.	.
			7	108 15·4	14	224 16·0	.	.	.	7	.	.
	Mar. 11	I.	1	11	.	.	.	.	.	.	.	.
	,, 8	V.	4	48	3	43½	.	.	.	1	.	.
	,, 8	VII.	.	.	9	110	.	.	.	.	.	.
	,, 4	VIII.	3	36½	8	111½	.	.	.	1	.	1
	,, 4	IX.	2	31½	7	98½	.	.	.	.	.	.
			10	127 12·7	27	363½ 13·8	.	.	.	2	.	1
Whiting.	Jun. 15	VI.	1	9	3	25½	.	.	.	.	.	.
	Aug.	I.	.	.	6	85½	.	.	.	.	.	.
	,, 1	II.	.	.	6	82½	.	.	.	.	.	.
	,, 1	III.	.	.	8	98½	.	.	.	.	.	.
	,, 2	IV.	.	.	2	19½	.	.	.	.	.	.
	,, 5	V.	2	26½	3	40	.	.	.	.	.	.
	,, 3	VI.	2	25½	2	27	.	.	.	.	.	.
	,, 2	VII.	1	12	4	43½	.	.	.	.	.	.
	,, 2	VIII.	.	.	5	58	.	.	.	.	.	.
			5	64 12·8	36	454½ 12·6	.	.	.	.	.	.
	Sept. 10	I.	.	.	4	52½	.	.	.	.	.	.
	,, 7	II.	1	13	3	39	.	.	.	.	.	.
	,, 7	V.	2	25½	1	12½	.	.	.	.	.	.
	,, 7	VI.	.	.	4	53½	.	.	.	.	.	.
	,, 6	VII.	.	.	3	34	.	.	.	.	.	.
	,, 6	VIII.	1	12	2	23½	.	.	.	.	.	.
	,, 6	IX.	2	24½	3	34½	.	.	.	.	.	.
			6	75 12·5	20	249½ 12·4	.	.	.	.	.	.
	Oct. 6	I.	2	25½	3	41½	.	.	.	.	.	.
	,, 4	II.	.	.	3	34	.	.	.	.	.	.
	,, 8	III.	.	.	4	52½	.	.	.	.	.	.
	,, 3	V.	1	11½	1	12	.	.	.	.	.	.
	,, 2	VII.	.	.	3	43	.	.	.	.	.	.
	, 2	VIII.	.	.	5	66½	.	.	.	.	.	.
	,, 2	IX.	.	.	3	40½	.	.	.	.	.	.
			3	37 12·3	22	290 13·1	.	.	.	.	.	.
	Nov. 8	I.	.	.	5	58	.	.	.	.	.	.
	,, 8	III.	2	27	3	39½	.	.	.	.	.	.
	,, 30	IV.	4	41½	1	12½	.	.	.	.	.	.
	,, 7	VII.	3	38	2	29½	.	.	.	.	.	.
	,, 1	VIII.	1	12	3	36	.	.	.	.	.	.
	,, 1	IX.	1	11	.	.	.	.	.	.	.	.
			11	129½ 11·7	14	175½ 12·5	.	.	.	.	.	.

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Whiting.	Dec. 1	I.	2	26	2	24½	.	.	.	.	.	.
	" 1	III.	3	35½	2	33	.	.	.	.	.	.
	" 6	V.	3	35	1	11	.	.	.	.	.	.
	" 5	VII.	3	37	1	14½	.	.	.	.	.	.
	" 5	VIII.	2	17	2	29	.	.	.	.	.	.
	" 5	IX.	5	63	1	13½	.	.	.	.	.	.
	" 20	I.	3	36	3	37½	.	.	.	.	.	.
			21	249½ 11·4	12	163 13·5	.	.	.	.	.	.
	Jan. 10	I.	5	66½	4	53½	.	.	.	.	.	.
	" 10	II.	1	13	4	48½	.	.	.	.	.	.
	" 7	III.	3	38½	5	78	.	.	.	1	.	.
	" 3	IV.	3	22½	2	19	.	.	.	.	.	.
	" 9	VI.	1	10½	2	32¾	.	.	.	.	.	.
	" 8	VII.	1	7½	2	26	.	.	.	.	.	.
	" 8	VIII.	3	29½	2	25½	.	.	.	.	.	.
	" 8	IX.	2	26	1	13	.	.	.	.	.	.
			19	214 11·2	22	296¼ 13·4	.	.	.	1	.	.
	Feb. 12	I.	2	24	4	55	.	.	.	.	.	.
	" 5	III.	.	.	6	53	.	.	.	.	.	.
	" 11	V.	3	46	4	56½	.	1	.	.	.	.
	" 6	VIII.	3	45	2	31½	.	.	.	1	.	.
	" 6	IX.	3	47	2	31	2	.	.	1	.	.
			11	162 14·3	18	227 12·6	2	1	.	2	.	.
	Mar. 11	I.	1	13½	1	11	.	.	.	1	.	.
	" 8	V.	5	70	2	24½	.	.	.	.	.	.
	" 8	VII.	1	10½	4	51½	.	.	.	.	.	.
	" 4	VIII.	5	44	3	42½	.	.	.	1	.	1
	" 4	IX.	6	80	4	54	.	.	.	1	.	2
			18	218 12·1	14	183½ 13·0	.	.	.	3	.	3
Gurnard.	Jun. 12	II.	1	9½	5	47¾	.	1	.	.	.	.
	" 12	III.	1	11	6	55½	1	3	.	.	.	.
	" 15	V.	3	26	2	185	.	.	.	.	.	.
	" 15	VI.	9	67½	19	157½	.	1	.	.	.	2
	" 19	VIII.	1	10½	8	93	.	1	.	4	.	1
			15	124½ 8·3	40	372¼ 9·3	1	6	.	4	.	3
	Aug. 1	I.	1	10	4	44	.	1	.	1	.	.
	" 1	II.	.	.	3	34½	.	.	.	.	.	.
	" 1	III.	.	.	4	55	.	1	.	.	.	.
	" 2	IV.	.	.	6	78¾	.	.	.	.	.	.
	" 5	V.	.	.	2	18	.	.	.	.	.	.
	" 3	VI.	1	10	4	46	.	.	.	2	.	.
	" 2	VII.	.	.	6	81½	.	1	.	1	.	.
	" 2	VIII.	2	21	3	34	.	2	.	.	.	1
			4	41 10·2	32	391¾ 12·2	.	5	.	4	.	1
	Sept. 10	I.	.	.	5	62	.	.	.	.	.	.
	" 9	II.	.	.	5	70	.	.	.	.	.	.
	" 7	V.	1	10	3	36	.	.	.	.	.	.
	" 7	VI.	.	.	5	47	.	.	.	.	.	.
	" 6	VII.	1	13	4	43½	.	.	.	.	.	.
	" 6	VIII.	1	12½	4	33	.	.	.	.	.	.
	" 6	IX.	3	37	4	51	.	.	.	.	.	.
			6	72½ 12·0	30	342½ 11·4	.	.	.	.	.	.

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Gurnard.	Oct. 6	I.	.	.	5	76½	.	.	.	1	.	.
	,, 4	II.	.	.	4	51½	.	.	.	.	.	.
	,, 8	III.	1	13½	.	.	.	.	.	.	.	.
	,, 3	V.	.	.	3	33	.	.	.	.	.	.
	,, 3	VI.	1	10½	1	10	.	.	.	.	.	.
	,, 2	VII.	1	13½	3	33½	.	.	.	.	.	.
			3	37½ 12·5	16	204½ 12·7	.	.	.	1	.	.
	Nov. 1	VIII.	.	.	4	46	.	.	.	.	.	.
	,, 1	IX.	2	18½	4	42½	.	.	.	1	.	.
			2	18½ 9·2	8	88½ 11·0	.	.	.	1	.	.
LESS ABUNDANT FISH.												
Flounder.	June 9	VIII.	.	.	1	7	.	.	.	.	.	.
	Aug. 2	IV.	.	.	1	10	.	.	.	.	.	.
	Mar. 11	I.	1	9	.	.	.	.	.	.	.	.
	,, 8	II.	1	12	.	.	.	.	.	.	1	.
	,, 11	III.	.	.	2	26	.	.	.	2	.	.
	,, 9	IV.	2	21½	2	21	.	.	1	2	.	.
	,, 8	VII.	2	17	1	11	.	.	1	1	.	.
			6	59½ 9·9	5	58 11·6	.	.	2	4	1	.
	Sept. 7	II.	.	.	2	41	.	.	.	.	.	.
	,, 6	VII.	2	30	.	.	.	.	.	.	.	.
			2	30 15·0	2	41 20·5	.	.	.	.	.	.
Turbot.	Oct. 3	VI.	1	20	.	.	.	.	.	.	.	.
	Nov. 7	VII.	.	.	1	16	.	.	.	.	.	.
	,, 1	VIII.	1	20	.	.	.	.	.	.	.	.
			1	20	1	16	.	.	.	.	.	.
	Mar. 8	VI.	1	17½	.	.	.	.	.	.	.	.
	Oct. 3	VI.	1	16½	2	42	.	.	.	.	.	.
Brill.	Feb. 11	VI.	.	.	1	20	.	.	.	1	.	.

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Brill.	Mar. 8	VI.	2	40	1	20½	.	.	.	.	.	.
	,, 8	VII.	1	19	.	.	.	.	.	.	.	.
			3	59 19·6	1	20½ 20·5	.	.	.	.	.	.
Brassie.	June 19	VIII.	1	12	.	.	.	.	.	.	.	.
	Mar. 4	VIII.	.	.	1	7	.	.	.	.	.	.
Lythe.	Oct. 2		.	.	1	31	.	.	.	.	.	.
Ling.	Aug. 1	II.	1	32	.	.	.	.	.	.	.	.
	Dec. 1	I.	1	26	.	.	.	.	.	.	.	.
	Feb. 6	V.	.	.	1	36	.	.	.	.	.	.
	Mar. 8	VII.	.	.	1	30	.	.	.	.	.	.
Saithe.	June 14	V.	.	.	.	.	.	.	.	.	.	.
	,, 19	VIII.	2	24½	.	.	.	.	.	.	.	.
			2	24½ 12·2	.	.	.	.	.	.	.	.
Herring.	Jan. 10	I.	.	.	5	36	.	.	.	.	.	.
	,, 7	III.	1	7	1	7	.	.	.	.	.	.
	,, 3	IV.	2	14½	4	28	.	.	.	.	.	.
			3	21½ 7·1	10	71 7·1	.	.	.	.	.	.
	Feb. 5	III.	.	.	1	7½	.	.	.	.	.	1
	,, 5	IV.	.	.	1	10½	.	.	.	1	.	.
	,, 6	VIII.	.	.	1	11	.	.	.	1	.	.
			.	.	3	29 9·6	.	.	.	2	.	1
Angler Fish.	Aug. 1	II.	1	27	.	.	.	.	.	.	.	.
	,, 1	III.	.	.	4	92	.	.	.	.	.	.
	,, 2	IV.	.	.	.	.	.	.	.	.	.	.
	,, 3	VI.	4	115½	.	.	.	.	.	.	.	.
	,, 2	VIII.	1	24	.	.	.	.	.	.	.	.
			6	166½ 27·7	4	92 23·0	.	.	.	.	.	.
	Sept. 10	I.	.	.	1	28	.	.	.	.	.	.
	,, 7	V.	1	36	.	.	.	.	.	.	.	.
	,, 7	VI.	1	23	.	.	.	.	.	.	.	.
	,, 6	VII.	1	18	2	40½	.	.	.	.	.	.
	,, 6	VIII.	.	.	1	22½	.	.	.	.	.	.
	,, 6	IX.	1	17	.	.	.	.	.	.	.	.
			4	94 23·5	4	91 22·7	.	.	.	.	.	.

FIRTH OF FORTH—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Angler Fish.	Oct. 6	I.	1	46	.	.	.	.	.	.	.	.
	Nov. 8	III.	11	21½	.	.	.	.	.	.	.	.
	,, 1	VIII.	1	18	.	.	.	.	.	.	.	.
			2	39½ 19·7	.	.	.	.	.	.	.	.
	Feb 12	I.	1	19	.	.	.	.	.	.	.	.
	Mar. 11	I.	2	40½	1	18	.	.	.	.	.	.
	,, 11	III.	1	28	.	.	.	.	.	.	.	.
	,, 8	V.	1	30	1	25	.	.	.	.	.	.
			4	98½ 24·6	2	43 21·5	.	.	.	.	.	.
Dragonet.	Sept. 7	V.	1	7	.	.	.	.	.	.	.	.
Catfish.	June 19	VIII.	1	34	.	.	.	.	.	.	.	.
	Aug. 3	VI.	.	.	1	25	.	.	.	1	.	.
	,, 2	VII.	1	38	.	.	.	.	.	.	.	.
			1	38	1	25	.	.	.	1	.	.
	Nov. 8	III.	.	.	1	21½	.	.	.	.	.	.
	Jan. 10	I.	1	32½	.	.	.	.	.	.	.	.
	Feb. 12	I.	.	.	3	99	.	.	.	.	.	.
	,, 11	VI.	1	25	1	27	.	.	.	1	.	2
	,, 6	X.	1	25	1	23	.	.	.	.	.	1
			2	50 25·0	5	149 29·8	.	.	.	1	.	3
Lump-Sucker.	Mar. 8	I.	1	13	1	19	.	.	.	1	1	.
Conger.	Aug. 5	V.	1	34	.	.	.	.	.	.	.	.
Cobbler or Father-lasher.	Mar. 9	IV.	1	8½	1	12½	.	.	.	1	.	.
	,, 8	VII.	.	.	2	18	.	.	.	1	.	.
			1	8½ 8·5	3	30½ 10·1	.	.	.	2	.	.
Greater Weever.	Feb. 12	I.	.	.	1	10	.	.	.	1	.	.

II. ST ANDREWS BAY.

Kind of Fish.	Date.	Station.	Males.		Females.		Three-fourths Mature.		Nearly Mature.		Mature.	
			Number.	Total length in inches.	Number.	Total length in inches.	M.	F.	M.	F.	M.	F.
Plaice.	July 12	I.	5	53	8	89	.	.	.	.	.	.
	,, 12	II.	5	57	4	38	.	.	.	.	.	.
	,, 13	III.	3	35½	7	99	.	.	.	.	.	.
	,, 13	IV.	5	57½	.	.	.	.	.	.	.	.
	,, 13	V.	2	20	3	31½	.	.	.	.	.	.
			20	223	22	237½	.	.	.	.	.	.
				11·1		10·7						
	Aug. 6	I.	3	31½	2	26	.	.	.	.	.	.
	,, 16	II.	8	104½	.	.	.	.	.	.	.	.
	,, 17	III.	2	25½	3	42	.	.	.	.	.	.
	,, 17	IV.	5	64½	2	26	.	.	.	.	.	.
	,, 17	V.	4	47½	6	77	.	.	.	.	.	.
			22	273½	13	171	.	.	.	.	.	.
				12·4		13·1						
	Sept. 18	I.	2	30	3	56	.	.	.	.	.	1
	,, 18	II.	2	25½	3	41½	.	.	.	.	.	.
	,, 18	III.	5	64½	.	.	.	.	.	.	.	.
	,, 18	IV.	3	37½	2	28	.	.	.	.	.	.
	,, 17	V.	3	38½	2	26	.	.	.	.	.	.
			15	196	10	151½	.	.	.	.	.	1
				13·0		15·10						
	Oct. 17	I.	2	27	4	55	.	.	.	.	.	.
	,, 17	II.	.	.	6	90	.	.	.	.	.	.
	,, 17	III.	1	14	6	86½	.	.	.	.	.	.
	,, 16	IV.	2	25½	4	48	.	.	.	.	.	.
	,, 16	V.	6	72	1	13½	.	.	.	.	.	.
			11	138½	21	293	.	.	.	.	.	.
				12·5		13·9						
	Dec. 19	II.	1	14½	.	.	.	.	.	.	.	.
	, 19	III.	.	.	3	46	.	.	.	.	.	.
	,, 18	IV.	9	127½	3	41½	.	.	.	.	.	.
			10	142	6	87½	.	.	.	.	.	.
				14·2		14·5						
	Jan. 21	III.	4	55½	10	146	.	.	.	.	.	.
	,, 21	IV.	4	58	3	42½	.	.	.	.	.	.
	,, 22	V.	.	.	1	17	.	.	.	.	.	.
			8	13½	14	205½	.	.	.	.	.	.
				14·1		14·6						
	Mar. 19	I.	6	80	9	121½	.	.	.	.	.	.
	,, 18	II.	3	40½	9	125½	.	.	.	.	.	.
	,, 19	III.	6	85	12	177	.	.	.	.	.	.
	,, 18	IV.	5	60	8	101½	.	.	.	.	.	.
	,, 19	V.	2	25	3	41	.	.	.	.	.	.
			22	290½	41	566½	.	.	.	.	.	.
				13·1		13·8						
Lemon Soles.	July 12	II.	.	.	1	9	.	.	.	.	.	.
	Aug. 16	II.	.	.	1	9	.	.	.	.	.	.
	,, 17	V.	1	7	3	25	.	.	.	.	.	.
			1	7	4	34	.	.	.	.	.	.
						8·5						

ST ANDREWS BAY.—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Lemon Soles.	Sept. 17	V.	.	.	3	33	.	.	.	.	.	.
	Oct. 17	II.	.	.	1	9	.	.	.	.	.	.
	,, 16	IV.	.	.	2	25	.	.	.	.	.	.
			.	.	3	34 11·3	.	.	.	.	.	.
	Jan. 22		.	.	1	11	.	.	.	.	.	.
Common Dab.	July 12	I.	1	9	9	86	1	.	.	.	.	.
	,, 12	II.	2	17	8	69	.	1	.	.	.	.
	,, 13	III.	1	8½	9	83	.	.	.	1	.	.
	,, 13	IV.	.	.	5	49½	.	.	.	.	.	.
	,, 13	V.	.	.	6	54½	.	.	.	.	.	.
			4	34½ 8·6	37	342 9·2	1	1	.	1	.	.
	Aug. 16	I.	2	17½	3	29	.	.	.	.	.	.
	,, 16	II.	3	38	2	18	.	.	.	.	.	.
	,, 17	III.	1	9	4	40½	.	.	.	.	.	.
	,, 17	IV.	2	20	4	43½	.	.	.	.	.	.
	,, 17	V.	3	30½	2	18	.	.	.	.	.	.
			11	107 9·7	15	149 9·9	.	.	.	.	.	.
	Sept. 18	I.	.	.	5	61	.	.	.	.	.	.
	,, 18	II.	3	29	2	20	.	.	.	.	.	.
	,, 18	III.	.	.	5	49	.	.	.	.	.	.
	,, 18	IV.	.	.	5	54½	.	.	.	.	.	.
			3	29 9·6	17	184½ 10·7	.	.	.	.	.	.
	Oct. 17	I.	1	11½	6	63	.	.	.	.	.	.
	,, 17	II.	3	34	4	48½	.	.	2	.	.	.
	,, 17	III.	1	10	6	67½	.	.	.	.	.	.
	,, 16	IV.	.	.	6	58½	.	.	2	.	.	.
	,, 16	V.	.	.	7	67½	.	.	.	.	.	.
			5	55½ 11·1	29	305 10·5	.	.	4	.	.	.
	Dec. 19	I.	.	.	9	89	.	.	.	.	.	.
	,, 19	II.	3	18½	7	59	.	.	.	.	.	.
	,, 19	III.	2	19	3	26	.	.	1	.	.	.
	,, 18	V.	1	6½	6	44	.	.	.	.	.	.
			6	44 7·3	25	218 8·7	.	.	1	.	.	.
	Jan. 21	III.	.	.	2	18	.	.	.	.	.	.
	,, 22	V.	.	.	3	25	.	.	.	.	.	.
			.	.	5	43 8·6	.	.	.	.	.	.
	Mar. 19	I.	.	.	10	101¼	.	.	.	4	.	.
	,, 18	II.	1	6½	5	46	.	.	.	1	.	.
	,, 18	IV.	2	18¾	8	90¼	.	.	2	2	.	2
	,, 19	V.	7	55	7	60½	.	.	3	2	.	.
			10	80¼ 8·0	30	298 9·9	.	.	5	9	.	2

ST ANDREWS BAY.—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M .	Nearly Mature. .	Mature. M.	Mature. F.
Long Rough Dabs.	July 12	I.	.	.	1	10	.	.	.	.	.	.
	„ 12	II.	.	.	1	8	.	.	.	.	.	.
	„ 13	III.	.	.	1	11	.	.	.	.	.	.
	„ 13	V.	.	.	4	37	.	.	.	.	.	.
			.	.	7	66 9·4	.	.	.	.	.	.
	Aug. 16	I.	.	.	2	19	.	.	.	.	.	.
	„ 16	II.	.	.	2	22	.	.	.	.	.	.
	„ 17	III.	.	.	1	10	.	.	.	.	.	.
	„ 17	V.	.	.	5	56	.	.	.	.	.	.
			.	.	10	107 10·7	.	.	.	.	.	.
	Sept. 18	I.	.	.	5	56½	.	.	.	.	.	.
	„ 18	II.	.	.	4	41½	.	1	.	1	.	.
	„ 18	III.	.	.	1	11	.	.	.	.	.	.
	„ 17	V.	.	.	3	34½	.	.	.	.	.	.
			.	.	13	143½ 11·0	.	1	.	1	.	.
	Oct. 17	II.	.	.	2	20	.	.	.	.	.	.
	„ 17	III.	.	.	1	10	.	.	.	1	.	.
	„ 16	V.	.	.	6	57	.	.	.	5	.	.
			.	.	9	87 9·6	.	.	.	6	.	.
	Dec. 19	I.	.	.	1	8½	.	.	.	.	.	.
	„ 19	II.	.	.	1	11½	.	.	.	1	.	.
	„ 19	III.	.	.	5	52	.	.	.	5	.	.
	„ 18	V.	.	.	2	18	.	.	.	1	.	.
			.	.	9	90 10·0	.	.	.	7	.	.
				Total breadth		Total breadth						
Skate.	July 12	II.	4	57	.	.	.	.	.	.	.	.
	„ 13	III.	1	13½	.	.	.	.	.	.	.	.
			5	70½ 14·0	.	.	.	.	.	.	.	.
	Aug. 16	I.	1	17	.	.	.	.	.	.	.	.
	„ 16	II.	2	35	2	30½	.	.	.	.	.	.
	„ 17	III.	3	48½	1	18	.	.	.	.	.	.
	„ 17	IV.	2	35	2	35	.	.	.	.	.	.
	„ 17	V.	.	.	1	14	.	.	.	.	.	.
			8	135½ 16·9	6	97½ 16·2	.	.	.	.	.	.
	Sept. 18	I.	1	21	1	17	.	.	.	.	.	.
	„ 18	II.	.	.	2	32	.	.	.	.	.	.
	„ 18	IV.	4	84	.	.	.	.	.	.	.	.
			5	105 21·0	3	49 16·3	.	.	.	.	.	.

ST ANDREWS BAY.—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total breadth in inches.	Females. Number.	Females. Total breadth in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Skate.	Oct. 17	I.	.	.	1	7	.	.	.	.	.	.
	„ 17	II.	.	.	2	20	.	.	.	.	.	.
	„ 17	III.	.	.	3	35½	.	.	.	.	.	.
			.	.	6	62½ 10·4	.	.	.	.	.	.
	Jan. 21	IV	2	36	1	12½	.	.	.	.	.	.
				Total length		Total length						
Cod.	Oct. 16	V.	.	.	2	24½	.	.	.	.	.	.
	Dec. 19	III.	.	.	3	32½	.	.	.	.	.	.
	„ 18	V.	.	.	1	14½	.	.	.	.	.	.
			.	.	4	47 11·7	.	.	.	.	.	.
	Jan. 21	IV.	1	31½	2	62	.	.	.	.	.	.
	„ 22	V.	.	.	1	31	.	.	.	.	.	.
			1	31½ 31·5	3	93 31·0	.	.	.	.	.	.
	Mar. 19	III.	.	.	4	127½	.	.	.	.	.	.
Haddock.	July 12	I.	1	10½	9	105	.	.	.	.	.	.
	„ 12	II.	.	.	7	85	.	.	.	.	.	.
	„ 13	III.	.	.	10	102½	.	.	.	.	.	.
	„ 13	IV.	.	.	3	30½	.	.	.	.	.	.
	„ 13	V.	1	14	1	11	.	.	.	.	.	.
			2	24½ 12·2	30	334 11·1	.	.	.	.	.	.
	Aug. 16	I	.	.	3	29	.	.	.	.	.	.
	„ 16	II.	1	15	1	11	.	.	.	.	.	.
	„ 17	III.	.	.	6	66½	.	.	.	.	.	.
	„ 17	IV.	.	.	2	22	.	.	.	.	.	.
	„ 17	V.	.	.	4	44½	.	.	.	.	.	.
			1	15	16	173 10·8	.	.	.	.	.	.
	Sept. 18	I.	.	.	2	19½	.	.	.	.	.	.
	„ 17	V.	.	.	4	47	.	.	.	.	.	.
			.	.	6	66½ 11·0	.	.	.	.	.	.
	Oct. 17	II.	1	15½	.	.	.	.	.	.	.	.
	„ 16	V.	2	36	2	39½	.	.	.	.	.	.
			3	51½ 17·1	2	39½ 19·7	.	.	.	.	.	.
	Dec. 19	III.	4	50½	6	85	.	.	.	1	.	.
	„ 18	V.	.	.	2	19½	.	.	.	.	.	.
			4	50½ 12·6	8	104½ 16·0	.	.	.	1	.	.

ST ANDREWS BAY.—*Continued.*

Kind of Fish.	Date.	Station.	Males.		Females.		Three-fourths Mature.		Nearly Mature.		Mature.	
			Number.	Total length in inches.	Number.	Total length in inches.	M.	F.	M.	F.	M.	F.
Haddock.	Jan. 22	II.	3	36	7	97½	.	.	.	2	.	.
	,, 21	IV.	1	24½	1	19	.	.	.	.	.	.
	,, 22	V.	.	.	1	12	.	.	.	1	.	.
			4	60½ 15·1	9	128½ 14·2	.	.	.	3	.	.
	Mar. 19	III.	1	15½	.	.	.	.	.	.	.	.
	,, 19	V.	1	10	.	.	.	.	1	.	.	.
			2	25½ 12·7	.	.	.	.	1	.	.	.
Whiting.	July 12	I.	5	52½	7	76½	.	.	.	.	.	.
	,, 12	II.	.	.	10	97½	.	.	.	.	.	.
	,, 13	III.	1	13	3	33½	.	.	.	.	.	.
	,, 13	IV.	.	.	3	30	.	.	.	.	.	.
	,, 13	V.	2	24	3	34½	.	.	.	.	.	.
			8	89½ 11·1	26	272 10·4	.	.	.	.	.	.
	Aug. 16	I.	.	.	1	9	.	.	.	.	.	.
	,, 16	II.	.	.	.	.	.	.	.	.	.	.
	,, 17	III.	.	.	1	9½	.	.	.	.	.	.
	,, 17	IV.	1	13	.	.	.	.	.	.	.	.
	,, 17	V.	1	10	3	31½	.	.	.	.	.	.
			2	23 11·5	5	50 10·0	.	.	.	.	.	.
	Sept. 18	I.	.	.	.	.	.	.	.	.	.	.
	,, 18	II.	.	.	1	10	.	.	.	.	.	.
	,, 18	III.	.	.	.	.	.	.	.	.	.	.
	,, 18	IV.	.	.	.	.	.	.	.	.	.	.
	,, 17	V.	1	12	1	11	.	.	.	.	.	.
			1	12	2	21 10·5	.	.	.	.	.	.
	Oct. 17	II.	.	.	1	8½	.	.	.	.	.	.
	,, 16	IV.	.	.	3	34	.	.	.	.	.	.
	,, 16	V.	.	.	4	46½	.	.	.	.	.	.
			.	.	8	89 11·1	.	.	.	.	.	.
	Dec. 19	II.	.	.	2	18½	.	.	.	.	.	.
	,, 19	III.	6	67	2	20	.	.	.	.	.	.
	,, 18	IV.	2	19	1	8½	.	.	.	.	.	.
	,, 18	V.	2	19	.	.	.	.	.	.	.	.
			10	105 10·5	5	47 9·4	.	.	.	.	.	.
	Jan. 22	II.	1	9	.	.	.	.	.	.	.	.
Gurnard.	July 12	I.	.	.	6	54	.	.	.	.	.	.
	,, 12	II.	1	11	6	61	.	1	.	.	.	.
	,, 13	III.	1	14	9	126½	1	.	.	9	.	.
	,, 13	V.	2	26½	3	41½	2	2	.	.	.	.
			4	51½ 12·8	24	283 11·7	3	3	.	9	.	.

ST ANDREWS BAY.—*Continued.*

Kind of Fish.	Date.	Station.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Gurnard.	Aug. 16	I.	1	11½	4	47½	.	.	.	1	.	.
	,, 16	II.	.	.	5	64	.	.	.	1	.	2
	,, 17	III.	.	.	6	89½	.	.	.	2	.	.
	,, 17	IV.	1	14	6	85	.	.	.	1	.	.
	,, 17	V.	1	10½	4	45	.	.	.	.	.	.
			3	36 12·0	25	331 13·2	.	.	.	5	.	2
	Sept. 18	I.	1	12½	4	53	.	.	.	1	.	.
	,, 18	II.	.	.	1	12	.	.	.	.	.	.
	,, 18	III.	1	15	4	55	.	.	.	.	.	.
	,, 18	IV.	.	.	5	70½	.	.	.	.	.	.
	,, 17	V.	.	.	5	66½	.	.	.	.	.	.
			2	27½ 13·7	19	257 13·5	.	.	.	1	.	.
	Oct. 17	I.	.	.	2	27½	.	.	.	.	.	.
	,, 17	II.	.	.	6	81	.	.	.	.	.	.
	,, 17	III.	.	.	3	40½	.	.	.	.	.	.
	,, 16	IV.	.	.	3	37½	.	.	.	.	.	.
	,, 16	V.	1	12	4	51½	.	.	.	.	.	.
			1	12	18	238 1·32	.	.	.	.	.	.
	Dec. 19	I.	.	.	1	15	.	.	.	.	.	.
	,, 18	V.	.	.	1	9	.	.	.	.	.	.
			.	.	2	24 12·0	.	.	.	.	.	.
Turbot.	Aug. 16	I.	1	15½	.	.	.	.	.	.	.	.
	,, 17	IV.	.	.	1	15	.	.	.	.	.	.
			1	15½	1	15	.	.	.	.	.	.
	Oct. 17	II.	1	15	1	16	.	.	.	.	.	.
	,, 17	III.	1	14½	1	16	.	.	.	.	.	.
			2	29½ 14·7	2	32 16·0	.	.	.	.	.	.
	Jan. 22	V.	.	.	1	17	.	.	.	.	.	.

SOUTHESK TRAWLINGS IN MORAY FIRTH.

Kind of Fish.	Date.	Males. Number.	Males. Total length in inches.	Females. Number.	Females. Total length in inches.	Three-fourths Mature. M.	Three-fourths Mature. F.	Nearly Mature. M.	Nearly Mature. F.	Mature. M.	Mature. F.
Plaice.	Jan. 24	6	97¾	4	105	.	.	1	2	4	2
	,, 23	.	.	4	91¼	.	.	.	.	.	4
	,, 23	19	328½	10	225	.	.	5	6	14	5
	,, 23	6	105½	15	349	.	.	.	1	6	13
	,, 22	7	129	13	301	.	.	5	4	2	9
	,, 21	8	130½	8	176½	.	.	.	4	8	4
		46	791¼ 17·2	54	1247¾ 23·0	.	.	11	17	34	37
	Feb. 19	2	29½	5	116	.	.	1	1	1	4
	,, 20	3	54	6	145½	.	.	.	.	3	6
	,, 21	10	163½	13	310½	.	.	.	.	10	13
	,, 22	4	68	3	69	.	.	.	.	4	3
	,, 22	1	16	7	171½	.	.	.	2	1	5
	,, 26	3	42½	2	51	.	.	.	.	3	2
	,, 27	1	13	4	94	.	.	.	.	1	4
		24	386½ 16·1	40	957½ 23·9	.	.	1	3	23	37
Lemon Soles.	Jan. 23	1	13	1	11¼	.	.	.	.	.	.
	Feb. 22	1	8	.	.	.	.	.	.	.	.
Long Rough Dabs.	Jan. 24	.	.	12	98¼	.	.	.	12	.	.
	,, 23	.	.	22	181½	.	.	.	22	.	.
	,, 22	.	.	8	51	.	.	.	8	.	.
	,, 22	1	7	19	151¼	.	.	1	18	.	.
	,, 21	.	.	24	191¾	.	6	.	12	.	.
		1	7 7·0	85	674¼ 7·9	.	6	1	72	.	.
	Feb. 19	.	25½	3	24½	.	.	.	3	.	.
	,, 20	4	12¼	7	59¾	.	.	4	6	.	1
	,, 21	2	18¼	8	52¼	.	.	2	8	.	.
	,, 22	3	18¼	7	57½	.	.	1	4	.	.
	,, 22	2	13¼	5	41	.	.	2	4	.	.
	,, 26	.	.	1	12	.	.	.	.	.	1
	,, 27	.	.	4	41¼	.	.	.	3	.	1
		11	79¼ 7·2	35	288¼ 8·2	.	.	9	28	.	3
Witch Soles.	Jan. 23	2	23½	.	.	.	.	.	.	.	.
	,, 22	1	12½	1	11	.	.	.	.	.	.
	,, 21	.	.	2	28	.	.	.	.	.	.
		3	36 12·0	3	39 13·0	.	.	.	.	.	.
Common Dabs.	Jan. 24	5	38½	11	85½	.	.	1	.	.	.
	,, 23	.	.	5	36½	.	.	.	.	.	.
	,, 23	1	7½	3	24	.	.	1	1	.	.
	,, 23	.	.	7	61	.	.	.	.	.	.
	,, 22	4	27	9	72¼	.	.	2	.	.	.
	,, 21	3	21	6	44	.	.	3	.	.	.
	,, 21	1	5½	4	32¼	.	.	1	.	.	.
		14	99½ 7·0	45	355½ 7·9	.	.	8	1	.	.

Kind of Fish.	Date.	Males.		Females.		Three-fourths Mature.		Nearly Mature.		Mature.	
		Number.	Total length in inches.	Number.	Total length in inches.	M.	F.	M.	F.	M.	F.
Common Dabs.	Feb. 19	1	10½	3	24	.	.	.	.	.	.
	,, 20	2	16½	5	40	.	.	.	.	.	.
	,, 21	4	30	2	15¾	.	.	.	.	.	.
	,, 22	6	68	14	140¾	.	.	.	.	.	.
	,, 22	.	.	5	47	.	.	.	.	.	.
	,, 27	1	6½	6	55	.	.	.	.	.	.
		14	131½	35	322½	.	.	.	.	.	.
			9·3		9·2						
Skate.	Jan. 21	.	.	4	Breadth 104	.	.	.	.	.	.
					2·60						
Cod.	Jan. 23	3	98	2	Length 69	.	.	.	.	.	.
	,, 22	3	100	4	142	.	.	.	.	.	.
	,, 21	.	.	2	66	.	.	.	.	.	.
	,, 21	5	187	3	89	2	.	.	.	.	.
		11	385	11	366	2	.	.	.	.	.
			35·0		33·2						
	Feb. 19	9	315	3	110	.	.	1	1	.	.
	,, 19	2	68	3	101	.	.	.	.	.	.
	,, 20	12	423	5	179	.	.	10	5	.	.
	,, 21	1	30	2	70	.	.	.	2	.	.
	,, 26	2	67	.	.	.	.	.	.	.	.
	,, 27	.	.	3	108	.	.	.	.	.	.
	,, 28	7	249	3	110	.	.	3	.	2	2
		33	1152	19	678	.	.	14	8	2	2
			34·9		35·6						
Haddocks	Jan. 24	2	23½	3	36	1	1	.	.	.	.
	,, 23	2	31½	6	94½	.	.	.	1	.	.
	,, 22	4	51	7	92	.	.	.	.	.	.
	,, 22	11	164½	18	251¼	.	.	2	8	.	.
	,, 21	8	109	13	210	.	1	.	.	.	.
		27	379½	47	683¾	1	2	2	9	.	.
			14·0		14·5						
	Feb. 19	1	13	3	40¼	.	.	1	3	.	.
	,, 19	5	64½	3	40½	.	.	4	1	.	.
	,, 22	2	26	3	33	.	.	.	.	.	.
	,, 26	2	30	4	48	.	.	.	.	.	.
	,, 28	4	52	8	112½	.	.	.	.	.	.
		14	185½	21	274¼	.	.	5	4	.	.
			13·2		13·0						
Whitings.	Jan. 22	3	36	2	30	.	.	.	.	.	.
	,, 21	.	.	1	15½	.	.	.	.	.	.
		3	36	3	45½	.	.	.	.	.	.
			12·0		15·1						
	Feb. 19	10	123¼	7	94½	.	.	.	.	.	.
	,, 21	1	11½	1	19	.	.	.	.	.	.
	,, 22	1	12	1	11	.	.	.	.	.	.
		12	146¾	9	124½	.	.	.	.	.	.
			12·2		13·8						
Gurnard.	Jan. 24	1	9	3	39	.	.	.	.	.	1
	,, 23	.	.	5	56¾	.	.	.	.	.	3
	21	.	.	1	16½	.	.	.	.	.	.
		1	9	9	112¼	.	.	.	.	.	4
			9·0		12·4						

Kind of Fish.	Date.	Males.		Females.		Three-fourths Mature.		Nearly Mature.		Mature.	
		Number.	Total length in inches.	Number.	Total length in inches.	M.	F.	M.	F.	M.	F.
Gurnard.	Feb. 19	1	14½	2	30½	.	.	.	.	.	.
	,, 21	.	.	1	10	.	.	.	.	.	.
	,, 22	.	.	1	13½	.	.	.	.	.	.
	,, 26	.	.	3	41½	.	.	.	.	.	.
	,, 27	.	.	4	42¾	.	.	.	.	.	.
		1	14½ 14·5	11	138¼ 12·5	.	.	.	.	.	.
Flounder.	Feb. 19	1	10	.	.	.	.	.	.	.	.
	,, 21	1	10½	.	.	.	.	.	.	.	.
	,, 22	1	12	.	.	.	.	.	.	.	.
	,, 27	2	21½	.	.	.	.	.	.	.	.
		5	54 10·8	.	.	.	.	.	.	.	.
Sand Fluke.	Jan. 23	1	10	.	.	.	.	.	.	.	.
	,, 22	1	11¾	3	50	.	.	.	.	.	.
		2	21¾ 10·8	3	50 16·6	.	.	.	.	.	.
	Feb. 26	2	26½	.	.	.	.	.	.	.	.
Turbot.	Jan. 23	1	20½	1	24	.	.	.	.	.	.
	,, 22	.	.	1	31	.	.	.	.	.	.
		1	20½ 20·5	2	55 27·5	.	.	.	.	.	.
	Feb. 28	.	.	1	25	.	.	.	.	.	.
Brill.	Jan. 23	1	21	1	20	.	.	.	.	.	.
	Feb. 19	.	.	1	23	.	.	.	.	.	.
Bib.	Feb. 21	1	11½	.	.	.	.	.	.	.	.
Lythe.	Jan. 21	1	32	.	.	.	.	.	.	.	.
	Feb. 19	1	34	.	.	.	.	.	.	.	.
Hake.	Feb. 26	.	.	3	58½	.	.	.	.	.	.
Monk.	Feb. 22	1	24	1	45	.	.	.	.	.	.

III. ON THE FOOD OF FISHES. By W. Ramsay Smith, B.Sc.

I. Introductory.

This paper and the tables accompanying it record one set of the results of the scheme of investigation planned by Dr T. Wemyss Fulton, Secretary to the Scientific Report Committee, and carried out by the naturalists of the Board, especially by Mr Thomas Scott. 'Form C,' on which this Report is founded, deals (1) with the sizes and maturity of the various kinds of fish, and (2) with the contents of the stomachs of the fish examined and measured; and thus it will be seen that the numbers of fish at the various stations and dates here recorded agree very closely with those in the tables of maturity and sizes, any discrepancies being sufficiently accounted for by the fact that when the sex could not be determined, the fish were not included in the latter tables though they were included in the return of the condition of stomachs.

In projecting such a scheme of examination, one could not possibly have foreseen what the character of the results would be; for on retrospection one can glean nothing from former data, wherever recorded, regarding the questions that are raised and the problems that have to be solved from a systematic examination of many hundreds of fish at certain definite stations at different times of the year and under many varying conditions. One is surprised, therefore, to find how extremely interesting such an investigation has already been, and how very apparently useful it is likely to prove if so fully prosecuted as to yield sufficient material for the solution of the very complex and difficult problems regarding the food of fishes; and one is also struck by the great success that has attended a scheme whose outlines of plan and methods of carrying out had necessarily to be of so tentative a nature. The results already obtained, suggest many lines of investigation and must be extremely encouraging to the promoter of the scheme and those that have so laboriously and patiently carried out the detailed investigations. These details are very much more numerous than can possibly appear from an examination of the tables or from the remarks here made upon them; since in many instances not less than half a dozen species of animals have been identified in a single stomach, and so entered on the returns. It is a matter for regret that the space available for such a report does not permit of the list to be published in full; but the facts noted in the remarks will show how complete the list has been, and how valuable it may become for future reference and investigation.

It will be observed that I confine the remarks almost entirely to matters of fact, no theories being started and very few deductions being made. This is necessitated by the amount of materials at one's disposal, only 8 months' record being as yet available, so that one may say there are not yet sufficient statistics for comparison. The most valuable statistics probably are those of flat-fish, since very little has as yet been recorded regarding the food of these fish; and the value of the information depends not merely on the unmber of fish examined, but on the fact that the fish were examined at definite stations and at stated times. In this way some strange and apparently unaccountable facts come to light. For example, a glance at the statistics relating to long rough dabs in the Firth of Forth will show what sort of problems have to be solved by investigation. During the months from June to October sand-stars formed the chief food of these fishes, shrimps being very rarely recorded in these months. In November the numbers of sand-stars begin to fall off, and are equalled by the number of shrimps. In December no sand-stars are recorded, but shrimps are found in 19 stomachs of 21 containing matter that could be distinguished. After December a few sand-stars are recorded, but on till the end of March, as far as the records go, shrimps form by far the largest proportion of the food of long rough dabs. Among the possible explanations or influences, are the following—the state of the fish as regards ripeness, the migration of the fish from other waters, the migration of the food and the relative abundance of the different foods, the state of the tide, the state of the weather, the time of day when the fish were caught, the preference of the fish for one or other kind of food when perhaps both were to be had, the presence of other fish on the same feeding grounds. Some of these explanations may have but little if any bearing on the subject, but it will be seen that the problem is one involving very many possible factors and one not to be solved off hand, and not without a great deal of patient investigation. At least two years' statistics would be required before one could be certain that any probable solutions had been suggested of the problems started by the present investigation, and before definite steps could be taken to improve the food supply of the various kinds of fish at the various stations.

I. FIRTH OF FORTH.

Plaice.

(*Pleuronectes platessa*).

Of 314 stomachs of plaice examined 89 were empty, and the contents of 25 were indistinguishable: 200 stomachs contained matter that could be identified. The following notes refer to these 200:—

Echinoderms were found in 11 stomachs ($5\frac{1}{2}$%). They consisted of (1) sand-stars, at Station IV., in one in February and in three in March; at Station VI., in one in February and in two in June; and at Station VII., in one in March and in one in August: (2) heart-urchin (*Spatangus*), at Station VI., in one in June: (3) *Amphidotus*, at Station VII., in one in October.

Annelids were found in 148 stomachs (74%). The species identified consisted of (1) *Sipunculus*, at Station II., in one in September, and at Station VII., in two in August: (2) *Priapulus*, at Station I., in one in August; at Station II., in one in June and in three in August; at Station III., in two in June, in one in August, and in one in October; at Station IV., in one in June and in two in October; at Station V., in one in June; and at Station VII., in one in August: (3) *Nereis*, at Station V., in one in June and in one in September; and at Station VI., in one in August: (4) sea-mouse (*Aphrodite*), at Station II., in one in February. 132 stomachs contained annelids that could not be identified. The proportion of the stomachs in which annelids were found to the total number of stomachs containing distinguishable matter at the various stations is as follows:—Station I., 18 of 21; II., 18 of 30; III., 22 of 25; IV., 41 of 47; V., 11 of 16; VI., 6 of 29; VII., 5 of 14; VIII., 7 of 8; IX., 2 of 2. Similarly the proportion during the various months at all the Stations is—June, 25 of 35; August, 19 of 34; September, 14 of 23; October, 17 of 29; November, 1 of 1; December, 1 of 1; January, 3 of 3; February, 15 of 23; March, 38 of 49.

Arthropods were found in 13 stomachs ($6\frac{1}{2}$%). The forms reported are

(1) hermit-crabs, at Station II., in one in March, and at Station VII., in one in October: (2) swimming-crabs, at Station I., in one in March, and at Station III., in two, also in March. Undescribed arthropods were found at Stations I., II., and VI. in two, four, and two stomachs respectively, all in August.

Molluscs were found in 56 stomachs (28°/$_\circ$). The bivalve molluscs consisted of (1) *Scrobicularia*, at Station I., in two in August; at Station II., in one in June, in one in August, in two in October, and in six in February; at Station III., in one in June and in two in August; and at Station V., in two in June, in 3 in August, in two in September, and in two in March: (2) *Solen* (sp. generally *ensis*), at Station I., in one in September; at Station II., in one in September, in one in October, and in one in March; at Station IV., in one in August and in one in October; at Station VI., in two in June, in two in February, and in two in March: (3) *Cardium* (sp. *echinatum*), at Station V., in one in August; and at Station VI., in one, also in August: (4) *Pecten*, at Station IV., in one in August: (5) *Mactra* (sp. *subtruncata*), at Station VI., in three in June and in one in February. There were 16 bivalves unidentified; these were found at Stations II., VI., VII., and VIII. in June, September, and October. The only univalve found was *Buccinum*, at Station IV., in one in August.

Ascidians.—At Station VII. Ascidians were found in one in October.

Fish remains were found only at Station VI. They consisted exclusively of sand-eels (*Ammodytes*) and were found in 15 stomachs, the proportions being—June, in 2 of 7; August, in 2 of 4; September, in 2 of 3; October, in 2 of 3; February, in 3 of 6; March, in 4 of 6. The sand-eels were of various sizes, ranging from 2½ to 5 inches in length.

Lemon Soles.

(*Pleuronectes microcephalus*).

Of 227 stomachs examined, 88 were empty and the contents of 37 were indistinguishable: 102 contained matter that could be identified.

Echinoderms.—The only Echinoderm noted was a sand-star (*Ophiura albida*), at Station II. in one in September.

Annelids were found in 71 stomachs (69%). They consisted of (1) *Sipunculus*, at Station I., in one in August; at Station II., in one in June and in one in August; and at Station III., in three in June, in 2 in August, and in one in November: (2) *Priapulus*, at Station IV., in one in June. The proportion of unidentified Annelids to the number of stomachs containing distinguishable matter at the various stations was—I., 10 of 14; II., 7 of 10; III., 8 of 18; IV., 8 of 11; V., 7 of 9; VI., 11 of 11; VII., 3 of 3; VIII., 7 of 9. The proportion during the various months at all the stations was—June, 17 of 27; August, 5 of 14; September, 16 of 19; October, 10 of 12; November, 4 of 4; February, 1 of 1; March, 8 of 8. One fact may be noted, that the stomachs of all the fish examined during March were either empty or contained annelids.

Arthropods were found in 38 stomachs (37%). Among these there were (1) hermit-crabs, at Station I., in 2 in August, in one in October, and in one in February; at Station II., in one in June, in four in August, in two in September, and in four in October; at Station III., in one in June and in four in August; at Station IV., in one in June; at Station V., in three in June; at Station VI., in one in October; and at Station VIII., in one in November: (2) crabs unidentified, at Station

II., in one in June, and at Station VII., in one in August: (3) unidentified Crustacea most abundant in June.

Molluscs were found in only 5 stomachs (4°/₀). They consisted of *Saxicava*, *Patella*, and nudibranchs.

Common Dabs.

(*Pleuronectes limanda*).

Of 303 stomachs examined, 126 were empty and the contents of 27 were indistinguishable: 150 contained matter that could be identified.

Echinoderms were found in 22 stomachs (14%). They consisted entirely of star-fishes of various species, *Ophiura albida*, *Ophiocoma* (species?), and *Ophiothrix rosula* being those identified.

Annelids were found in 26 stomachs (17%). They consisted of (1) *Priapulus*, at Station III., in one in June, and at Station VI., in one in the same month: (2) *Sabella*, at Station V., in one in June: (3) sea-mouse (*Aphrodite*), at Station II., in one in October: (4) lugworm (*Arenicola*), at Station IV., in two in March. The remaining annelids were not identified. *Tomopteris* was found in one at Station V. in December.

Arthropods were found in 79 stomachs (52%). They consisted of (1) *Hyas*, at Station III., in two in August: (2) *Porcellana*, at Station II., in one in October: (3) hermit-crabs (chiefly *Eupagurus lævis* and *Eupagurus bernhardus* in nearly equal numbers). The proportion of the stomachs containing hermit-crabs to those containing distinguishable matter at the various stations is as follows:—Stations I., 11 of 18; II., 9 of 22; III., 13 of 21; IV., 2 of 14; V., 13 of 22; VI., 3 of 18; VII., 0 of 11; VIII., 3 of 14; IX., 3 of 10. The proportion during the various months was—June, 13 of 36; August, 7 of 27; September, 5 of 13; October, 4 of 14; November, 4 of 9; December, 2 of 3; January, 4 of 9; February, 3 of 5; March, 15 of 34. A considerable number of stomachs contained unidentified crustacea.

Molluscs were found in 13 stomachs (8%). They consisted of (1) *Scrobicularia*, found only in June at Stations II., III., V., and VIII.: (2) *Solen*, at Station I., in four in August; at Station II., in one in October; and at Station VI., in one in September: (3) other molluscs, viz., *Pecten operculata* in two, *Philine* in one, *Tritonia* in one, *Buccinum* in one, and a few unidentified lamellibranchs.

Ascidians were found in one at Station III. in October.

Fish were found in 12 stomachs (8%). They were most abundant in January and March, and consisted of sand-eels (at Station VI.) and herrings, and indistinguishable fish remains.

Long Rough Dabs.

(*Hippoglossoides limandoides*).

Of 451 stomachs examined 253 were empty, and the contents of 12 were indistinguishable: 185 contained matter that could be identified.

Echinoderms were found in 56 stomachs (30%). They consisted almost entirely of sand-stars, *Ophiura albida*, *Ophiura texturata*, and *Ophiocoma rosula*.

Annelids were found in 13 stomachs (7%). With the exception of *Sipunculus*, in one at Station IV. in June, they were not identified.

Arthropods were found in 101 stomachs (54°/₀). They consisted of *Portunus*, *Pandalus*, *Hyas*, and in a few instances of *Nephrops*. By far the greater number, however, was constituted by hermit-crabs and shrimps, the shrimps preponderating to a large extent. Hermit-crabs were found at Station I., in one in August and in one in February; at Station II., in one in June and in one in March; at Station III., in one in August; at Station IV., in one in June; at Station V., in two in June, in two in January, and in one in February; at Station VII., in one in September and one in October; at Station VIII., in one in June and one in January; and at Station IX., in one in January. The proportion of stomachs containing shrimps to the number containing distinguishable matter was as follows:—Station I., 25 of 44; II., 0 of 19; III., 5 of 17; IV., 7 of -24; V., 8 of 25; VI., 0 of 7; VII., 3 of 14; VIII., 5 of 25; IX., 8 of 12. The proportions for the various months were—June, 0 of 27; August, 0 of 24; September, 1 of 17; October, 1 of 14; November, 5 of 18; December, 19 of 21; January, 15 of 31; February, 15 of 21; March, 5 of 14.

Molluscs were found in 9 stomachs (4%). They consisted of—(1) *Scrobicularia* (sp. *alba* and *nitida*) found at Station IV. in three in June, and at Station V. in one in the same month, and in August and January: (2) *Solen* (sp. *ensis* and *pellucidus*), found at Station IV. in one in June, and at V. in one in the same month, and at Station VII., in one in November: (3) *Cardium echinatum*, at Station V. in one in June: (4) *Buccinum*, at Station II. in one in January.

Fish were found in 17 stomachs (9%). They consisted of common dabs, gobies, and whitings.

Witch Soles.

(*Pleuronectes cynoglossus*).

Of 58 stomachs examined, 16 were empty and the contents of 2 were indistinguishable: 40 contained matter that could be distinguished.

Echinoderms consisting of sand-stars were found in only one stomach at Station VIII. in March.

Annelids were found in 39 stomachs (97°/₀). They consisted of (1) *Priapulus*, at Station I., in one in June: (2) *Sabella*, at Station V., in one in September; and at Station VIII. in one in November: (3) *Nereis*, at Station VII., in one in October. The other annelids are unidentified. The proportions of stomachs containing these to the number examined at the various stations were as follows:—Stations IV., 3 of 4; V., 16 of 18; VI., 3 of 3; VII., 1 of 2; VIII., 13 of 14. For the various months the proportions were—June, 13 of 14; August, 4 of 4; September, 10 of 11; October, 0 of 1; November, 2 of 3; December, 1 of 2; February, 5 of 5; March, 1 of 1.

Arthropods were found in 4 stomachs (10°/$_0$). They consisted of (1) *Gammarus*, at Station VIII., in one in August: (2) *Crangon*, at Station V., in one in December; at Station VII., in one in December; at Station VIII., in one in November; and at Station IX., in two in March.

Molluscs were found in 5 stomachs (12%). They consisted of (1) *Scrobicularia*, found at Stations IV. and V., in one in June: (2) of undefined molluscs, found at Station VIII. in three in June.

No *Fish remains* were found in any of the stomachs examined.

Flounders.

(*Pleuronectes flesus*).

Only 2 specimens were examined, one at Station VIII., in June and one at Station IV., in August: the stomachs of both were empty.

Gurnards.

(*Trigla gurnardus*).

Of 156 stomachs examined, 42 were empty, and the contents of 10 were indistinguishable: 104 contained matter that could be identified.

Echinoderms were not found in any of the stomachs.

Annelids were found in only 2, and consisted of *Priapulus* at Station I., in one in August, and of an unidentified annelid at Station V., in one in June.

Arthropods were found in 89 stomachs (85%). They consisted of (1) *Crangon* (sp. *allmanni* and *vulgaris* in nearly equal proportions). The proportion of the stomachs containing *Crangon* to those containing distinguishable matter at the various Stations is as follows:—Station I., none of 7; II., 2 of 9; III., 2 of 10; IV., 0 of 6; V., 1 of 4; VI., 4 of 34; VII., 0 of 8; VIII., 8 of 16; IX., 7 of 10. The proportion during the various months at all the Stations is—June, 4 of 39; August, 2 of 23; September, 5 of 22; October, 3 of 9; November, 10 of 11. At Stations VIII. and IX., *Crangon* formed the greatest food supply of gurnards in September (no fish were examined in October) and in November: in the latter month 10 of 11 stomachs examined containing these forms: (2) *Nephrops* (sp. *norvegicus*) at Station III., in one in June; at Station IX., in one in September; and at Station IX., in one in November: (3) *Portunus* (sp. *depurator*, *pusillus*, and *corrugatus*), at Station I., in one in August; at Station II., in two in September; at Station III., in one in June, in two in August, and one in October; at Station IV., in six in August; at Station VI., in one in June and one in August; at Station VII., in two in August and in four in September. *Portunus* was thus most abundantly found in August, viz., in 52% of stomachs examined, the percentages for June, September, and October being 29, 27, and 11 respectively: (3) *Pandalus* (sp. *brevirostris*), at Station V., in one in June and one in August; and at Station VI., in twenty-two in June and in one in September: (4) *Porcellana* (sp. *longicornis*), at Station I., in one in October: (4) unidentified crabs, at Station I., in two in October; at Station III., in one in August; at Station VIII. (hermit crabs), in one in August and in one in September: (5) unidentified amphipods, at Station I., in two in September; at Station VI., in two in June; at Station VIII., in one in June; and at Station IX., in one in September: (6) unidentified schizopods. With the exception of one at Station VI. in September, all the fish, six in number, containing these were found in August at Stations I., III., VI., and VII.

Molluscs were found in 3 stomachs (2%). They consisted of (1) unidentified lamellibranchs, at Station VI., in one in October: (2) *Eolis*, at Station VI., in one in June: (3) cuttle-fish (? *Rossia*), at Station VIII., in one in August.

Fish were found in 20 stomachs (19%). They consisted of whiting, sand-eels, herrings, and lump-suckers.

Cod.

(*Gadus morrhua*).

Of 251 stomachs examined, 37 were empty, and the contents of 3 were indistinguishable: 211 contained matter that could be identified.

Echinoderms.—The only specimens of Echinoderms found were an *Ophiothrix* at Station I., in September, and an *Ophiocoma* (sp. *bellis*) at the same Station in December.

Annelids were found in 24 stomachs (12%). Unidentified annelids were found at Station IV., in one in February, and at Station V., in three in June. All the annelids found in the rest of the stomachs consisted of *Aphrodite.*

Arthropods were found in 170 stomachs (80%). They consisted of (1) *Nephrops* (sp. *norvegicus*), at Station I., in three in August, in one in September, in one in October, in three in December, in one in January, and in two in February [At Station II. none were found]; at Station III., in three in August, in two in December, and in one in February; at Station IV., in one in February; at Station V., in one in August, in one in September, in five in December, in one in January, and in one in February; at Station VI., in one in October; at Station VIII., in two in August, in four in October, in one in December, in three in February, and in two in March; at Station IX., in one in December and in one in March. None were found at Station II. in any of the months, and in the month of November none were found at any of the Stations. (2) *Portunus* (sp. *depurator* and *corrugatus*), at Station I., in three in August, in four in September, in two in October, in two in December, in one in January, and in one in February; at Station II., in one in October; at Station III., in three in August, in one in October, in three in November, in one in December, and in one in February; at Station IV., in five in August, in two in November, in one in December, and in one in January; at Station V., in one in January; and at Station VII., in 2 in August, and in one in October: (3) *Hyas* (sp. *coarctus*), at Station I., in one in August, in one in December, and in one in February; at Station II., in one in October; and at Station VI., in one in August: (4) *Pandalus*, at Station I., in two in December, in four in January and in one in February; at Station IV., in one in August, and in one in February; and at Station V., in two in August, in one in September, and in two in January: (5) *Pinnotheres* (sp. *pisum*), at Station III., in one in August; and at Station IV., in one in December: (6) *Porcellana* (sp. *longicornis*), at Station V., in one in March; and at Station VI., in one in February: (7) *Crangon*, at Station I., in four in December, in four in January, and in one in February; at Station III., in one in October, in one in November, and in one in December; at Station V., in one in December in seven in January, and in two in February; at Station VI., in one in February; at Station VII., in three in November, in two in December, in one in January, and in three in February; at Station VIII., in one in January and in one in February; and at Station IX., in three in December: (8) *Galathea*, at Station IV., in one in January; and at Station V., in one in February: (9) hermit crabs, at Station I., in one in August, in one in September, in one in November, in one in December, and in two in March; at Station II., in one in August, in one in October, and in two in January; at Station III., in one in August, in three in October, in one in November, in two in December, in one in January, in one in February, and in one in March; at Station IV., in one in December, in two in January, in one in February, and in one in March; at Station V., in two in January, in one in February, and in one in March; at Station VI., in one in September; at Station VII., in two in October, in one in November, and in two in March; at Station VIII., in one in September, in one in October, and in two in February: (10) *Pagurus*, at Station VI., in one in February: (11) crabs unidentified, at Station I., in one in October; at Station II., in one in September and in one in January; at Station III., in one in March; at Station V., in one in December and in one in February; at Station VII., in three in March;

and at Station VIII., in one in the same month: (12) crustacea unidentified, at Station V., in ten in June: (13) *Balanus*, at Station VIII., in one in September.

Molluscs were found in 30 stomachs (14%). They consisted of (1) *Pecten* (sp. *opercularia*), at Station III., in two in October. (2) *Solen*, at Station VI., in three in February: (3) unidentified *lamellibranchs*, at Station V., in twelve in June: (4) *Turritella* (sp. *communis*), at Station I., in one in October; and at Station III., in one in August: (5) *Buccinum*, at Station I., in three in September, and in one in December; at Station IV., in one in August and in two in January; at Station V., in one in January; and at Station VIII., in three in March. (In one instance twenty-three opercula were found in a single stomach): (6) *Fusus*, at Station I., in one in January; and at Station V., in one in the same month.

Fish were found in 75 stomachs (35%). They consisted of whiting, herring, haddock, unidentified flat-fish, sand-eel, sprat, *Centronotus gunnellus*, *Cottus*, *Motella*, long rough dab, and goby. Ova (? herring) were found at Station V., in one in February; and at Station VII., in two in March.

Haddocks.

(*Gadus æglefinus*).

Of 302 stomachs examined: 38 were empty, and the contents of 24 were indistinguishable: 240 contained matter that could be identified.

Echinoderms were found in 58 stomachs (24%). They consisted of (1) *Echinocyamus*, at Station VII., in one in October; and at Station IX., in one in December: (2) a holothurian at Station VIII., in one in November: (3) sand-stars (*Ophiura*, sp. *albida*, *Ophiothrix*, and *Ophiocoma*, sp. *bellis* and *filiformis*).

Annelids were found in 64 stomachs (26%). They consisted of (1) *Priapulus* (sp. *caudatus*), at Station I., in one in January; at Station II., in one in January; at Station III., in one in August; and at Station VII., in one in October, and in one in January: (2) *Nereis*, at Station IX., in one in January: (3) *Aphrodite*, at Station II., in one in September, in one in December, and in two in January; at Station III., in one in October; at Station V., in one in February; at Station VII., in one in September, in one in December, in one in January, and in one in March; and at Station IX., in one in February: (4) unidentified annelids in forty-seven stomachs.

Arthropods were found in 120 stomachs (50%). They consisted of (1) *Hyas* (sp. *coarctus*), at Station III., in one in August: (2) *Porcellana*, at Station III., in one in October: (3) *Pandalus* (sp. *brevirostris*), at Station I., in two in December; and at Station III., in one in October: (4) *Portunus*, at Station II., in one in September; at Station III., in three in November; at Station IV., in one in August; at Station VI., in three in August; at Station VII., in one in December; and at Station VIII., in one in November: (5) *Crangon* found from September till February. In September they were found at Station IX. in two, in October at Station VII. in one, in November at Station VII. in four, and Station IX., in one. During the months of December, January, and February the proportions of stomachs containing *Crangon* to those containing distinguishable matter were as follow:—December, 18 of 23, January, 25 of 53, February, 7 of 14. (6) hermit crabs, at Station I., in one in September and in two in October; at Station IV., in one in August; at Station V., in one in December; at Station VII., in one in

November, in one in January, and in one in March; at Station VIII., in one in August and in two in March; and at Station IX., in two in September and in one in January: (7) *Nephrops*, at Station VIII., in one in September; and at Station IX., in one in November. (8) *Amphipods*, at Station I., in one in October; at Station II., in one in January; at Station V., in one in August, in three in January and in one in February; at Station VI., in one in January; at Station VIII., in three in June, in one in October, and in two in January; and at Station IX., in two in December and in one in January: (9) unidentified crustacea in sixteen stomachs.

Molluscs were found in 57 stomachs (23%). They consisted of (1) *Scrobicularia*, at Station I., in two in September; at Station III., in one in January; at Station V., in one in December, in seven in January, in one in February, and in six in March; at Station VIII., in one in September, in one in October, and in two in January; and at Station IX., in one in September, in two in November, and in three in December: (2) *Solen*, at Station I., in one in December; at Station II., in one in January and in one in February; at Station VII., in one in January; at Station VIII., in one in October; and at Station IX., in one in January: (3) unidentified lamellibranchs: (4) *Buccinum*, at Station I., in one in January: (5) *Philine*, at Station VI. in three, at Station VIII. in two, and at Station IX. in three, all in January: (6) *Rossia*, at Station VIII., in one in August: (7) *Octopus*, at Station IX., in one in January.

Fish were found in 25 stomachs (14%). They consisted of herrings, sand-eels, gobies, flukes, and unidentified flat-fish. Ova were found at Station VIII., in one, and at Station IX., in one, both in February.

Whitings.

(*Gadus merlangus*).

Of 282 stomachs examined, 128 were empty, and the contents of 13 were indistinguishable: 141 contained matter that could be identified.

Echinoderms were entirely absent.

Annelids were found in 5 stomachs (3%). They consisted of (1) *Nereis* at Station IV., in one in August: (2) unidentified annelids.

Arthropods were found in 59 stomachs (42%). They consisted of (1) *Portunus* (sp. *corrugatus*), at Station III., in one in October: (2) *Eupagurus*, at Station I., in one in November; at Station VII., in one in November; at Station VIII., in one in March: (3) *Pandalus* (sp. *annulicornis*), at Station I., in one in December and in one in January; at Station III., in two in December and in three in February; at Station IV., in two in January; at Station V., in one in December and in two in March; and at Station VII., in three in November: (4) unidentified amphipods at Station V., in one in August: (5) unidentified decapods at Station I., in one in September; and at Station VII., in one in the same month: (6) unidentified schizopods, at Station VII., in one in October; and at Station IX., in one in the same month: (7) *Crangon*, most abundantly found in December, January, and February. None were found in August. In September specimens of *Crangon* were found in one at Station VII., and in two at Station IX., in October in one at Station IX., in November in one at Station I., and in one at Station VII. The numbers of stomachs containing these forms for the three months of December, January, and February at the several Stations were—Station I., 12; III., 1; IV., 2; V., 2; VII., 2; VIII., 3; IX., 3. In March *Crangon* was found in one at Station VIII.

Molluscs (lamellibranch) were found at Station VI., in one in September.

Fish were found in 87 stomachs (61%). They consisted of whitings, herrings, sand-eels, sprats, haddocks, and flat-fish, and formed with one exception by far the largest part of the food supply, even at the time when *Crangon* and *Pandalus* (the only other important forms) were abundant. The number of stomachs containing these various kinds from November to February are as follow:—November, fish in 11, *Crangon* in 2, *Pandalus* in 3; December, fish in 12, *Crangon* in 14, *Pandalus* in 4; January, fish in 19, *Crangon* in 8, *Pandalus* in 2; February, fish in 12, *Crangon* in 3, *Pandalus* in 3.

Skate.

(*Raia batis*, *R. clavata*, and *R. radiata*).

Of 59 stomachs examined, 45 were empty. The following is a list of the different animals found in the 12 stomachs containing food:—*Echinoderms*: starfish unidentified. *Arthropods*: *Portunus*, *Crangon*, *Pandalus*, *Ampelisca*, *Nephrops*, hermit-crabs, unidentified crustacea. *Fish*: herring, flat-fish.

Cat Fish.

(*Anarrhichas lupus*).

Of 13 stomachs examined, 6 were empty. *Echinoderms* were found in 3 stomachs: they consisted of *Ophiura*, *Ophiothrix* and *Ophiocoma*. *Arthropods* were found in 6 stomachs: they consisted of *Nephrops*, *Pagurus*, *Hyas*, *Crangon*, and *Galathea*. *Molluscs* were found in 2 stomachs: *Buccinum* was the only species represented.

Angler Fish.

(*Lophius piscatorius*).

Of 34 stomachs examined, 19 were empty; the food in the remaining 15 consisted entirely of fish. The different kinds of fish found were sand-eel in three, whiting in one, haddock in two, cod in one (the cod was 15 inches long), skate in one (the skate was 17 inches broad), flat-fish in one, and fish unidentified in one.

II. ST ANDREWS BAY.

Plaice.

(*Pleuronectes platessa*).

Of 239 stomachs examined, 50 were empty, and the contents of 16 were undistinguishable: 173 contained matter that could be identified.

Echinoderms were found in 18 stomachs (10%). They consisted of (1) *Amphidotus*, at Station I., in one in August; and at Station II., in one in September and in one in October: (2) ophiurids in all the others.

Annelids were found in 102 stomachs (58%). They consisted of (1) *Nereis*, at Station I., in one in July; at Station II., in one in March; at Station III., in one in July and in one in March; and at Station IV., in one in March: (2) *Spio* at Station III., in one in August: (3) *Phyllodoce*, at Station II., in one in October and in one in December; and at Station III., in two in October: (4) other annelids, either *Arenicola* or unidentified.

Arthopods were found in 22 stomachs (12%). They consisted of (1) *Crangon* at Station I., in one in July: (2) *Portunus*, at Station I., in one in September: (3) unidentified amphipods, at Station II., in one in October: (4) unidentified decapods, at Station IV., in one in October: (5) *Ampelisca*, found during March in one at Station I., in nine at Station II., in two at Station III., in one at Station IV., and in one at Station V.

Molluscs were found in 96 stomachs (55%). They consisted of (1) *Nucula*, at Station I., in one in July, and in one in August; at Station II., in one in September, in one in October, and in three in March; at Station III., in two in September and in two in March; at Station V., in three in August, in two in September, in four in October, and in four in March: (2) *Mactra*, at Station IV., in one in July: (3) *Solen* (sp. *pellucidus* and *ensis*). The numbers of these during the various months during the period from July to March were—July in 1, August in 17, September in 7, October in 7, December in 1, January in 1, and March in 22. The numbers are fairly equally distributed over all the Stations. (4) *Scrobicularia*, at Station II., in one in August; at Station III., in two in September; at Station IV., in two in September; and at Station V., in one in October: (5) *Venus* (sp. *galina*), at Station III., in one in August: (6) unidentified lamellibranchs, in seven in the month of July.

Common Dabs.

(*Pleuronectes limanda*).

Of 173 stomachs examined, 54 were empty, and the contents of 13 were indistinguishable: 106 contained matter that could be identified.

Echinoderms were found in 44 stomachs (41%). They consisted of—(1) *Amphidotus* (sp. *cordatus*?), at Station I., in one in September, and at Station III., in one in July: *Ophiocoma* (sp. *bellis*), at Station I., in one in August: (3) sand-stars unidentified, in forty-one stomachs.

Annelids were found in 50 stomachs (47%). They consisted of—(1) *Arenicola*, at Station I., in seven in July, and at Station V., in one in March: (2) *Phyllodoce*, at Station II., in one in December: (3) *Nereis*, at Station I., in one in March: (4) unidentified annelids, found in thirty-eight stomachs, fairly equally distributed at all the Stations during the various months.

Arthropods were found in 13 stomachs (12%). They consisted of—(1) *Portunus*, at Station I., in one in December and in two in March; at Station III., in one in September, in one in December, and in one in January; and at Station IV., in one in September: (2) *Crangon*, at Station I., in one in December: (3) *Ampelisca*, at Station II., in one in December: (4) unidentified crabs, at Stations I. and III., in one in October; and at Station V., in one in March: (5) unidentified amphipods, at Station II., in one in September.

Molluscs were found in 6 stomachs (5%). They consisted of (1) *Solen*, at Station I., in four in March; at Station II., in one in September; at Station III., in one in August; and at Station IV., in one in March: (2) unidentified bivalves.

Fish were found in 5 stomachs (4%). They consisted of goby and common dab, and unidentified fish remains.

Long Rough Dabs.

(*Hippoglossoides limandoides*).

Of 47 stomachs examined, 13 were empty. Of the 34 with food, 28 (82%) contained *Echinoderms*, in every instance consisting of ophiurids.

The *Annelids* found at Station I., in one in August were unidentified. The *Arthropods* were all *Crangon.* The *fish remains* found in one were unidentified.

Gurnards.

(*Trigla gurnardus*).

Of 98 stomachs examined, 46 were empty, and the contents of 4 were indistinguishable; 48 contained matter that could be identified.

No *Echinoderms* were found in any of the stomachs.

Annelids unidentified, were found in only one.

Arthropods were found in 35 stomachs (72%). They consisted of (1) *Cuma*, at Station I., in one in July: (2) *Portunus*, at Station II., in one in July; at Station III., in two in July, in two in August, and in two in October; at Station IV., in one in September; and at Station V., in one in August and in one in September: (3) *Crangon*, at Station I., in one in October and in one in December; at Station II., in one in September and three in October; at Station III., in one, and at Station IV., in three in October; and at Station V., in one in September, in four in October, and one in December: (4) crabs at Station I., in one in August, and in one in October; and at Station II., in two in October: (5) unidentified Crustacea, at Station I., in one in July and in two in September; and at Station II., in one in July.

Molluscs were found in 2 stomachs: *Solen*, at Station III., in one in August: and unidentified molluscs, at Station II., in one in July.

Fish were found in 17 stomachs (35%). They consisted of whiting, herring, sand-eel, pipe-fish, flat-fish, and young pogge.

In one stomach a piece of wood was found.

Haddocks.

(*Gadus æglefinus*).

Of 104 stomachs examined, 13 were empty, and the contents of 11 were indistinguishable: 80 contained matter that could be identified.

Echinoderms were found in 21 stomachs (26%). They consisted of (1) *Holothuria*, at Station II., in one in October: (2) *Ophiocoma*, at Station II., in one in August; and at Station III., in one in the same month: (3) *Echinus*, at Station II., in one in January; and at Station V., in one in March: (4) *Ophiura*, in sixteen stomachs.

Annelids were found in 40 stomachs (50%). They consisted of (1) *Arenicola*, at Station I., in five in July, and in one in September: (2) *Nereis*, at Station II., in two in July: (3) *Aphrodite*, at Station II., in one in August; at Station III., in one in the same month; and at Station IV., in one in July: (4) *Polynoe*, at Station V., in two in October: (5) unidentified annelids, in twenty-five stomachs.

Arthropods were found in 34 stomachs (42%). They consisted of (1) *Crangon*, at Station II., in five in January; at Station III., in four in December; at Station IV., in one in January; and at Station V., in one in December, and in one in March: (2) *Portunus*, at Station II., in two in January; at Station III., in one in December, and in one in March; and at Station IV., in one in January: (3) *Cuma*, at Station III., in one in July: (4) Crab, at Station II., in one in October; and at Station III., in one in July: (5) hermit-crab, at Station II., in one in July: (6) unidentified crustacea.

Molluscs were found in 18 stomachs (22%). They consisted of (1) *Solen*, at Stations II., III., and IV., in one in July; and at Station V., in one in July and in one in January: (2) *Montacuta*, at Station III., in one in July; and at Station IV., in one in the same month: (3) *Scrobicularia*, at Station III., in one in August; at Station III., in one in August; at Station IV., in four in August; and at Station V., in one in July: (4) *Nucula*, at Station V., in one in December: (5) lamellibranchs unidentified, at Station III., in one in July, and in one in December; and at Station V., in one in December.

Whitings.

(*Gadus merlangus*).

Of 80 stomachs examined, 38 were empty, and the contents of 8 were indistinguishable: 34 contained matter that could be identified.

No *Echinoderms* were found in any of the stomachs.

Annelids were found in 7 stomachs (20%). They consisted of (1) *Arenicola*, at Station II., in one in July; and at Station V., in four in October: (2) unidentified annelids.

Arthropods were found in 7 stomachs (20%). They consisted of (1) *Crangon*, at Station I., in one in August; and at Station II., in one in September: (2) *Portunus*, at Station V., in one in October: (3) amphipods, at Station II., in one in July; and at Station III., in one in the same month: (4) decapods, at Station II., in one in September: (5) schizopods, at Station IV., in one in September.

Molluscs (cephalopod) were found at Station V., in one in December.

Fish were found in 8 stomachs (16%). They consisted of whiting, herring, sprat, and sand-eel.

* Less Abundant Fish of St Andrews Bay.

Lemon Soles (*Pleuronectes microcephalus*).—Of 12 stomachs examined 4 were empty, and the contents of 4 were indistinguishable; the remaining 4 contained unidentified *Annelids.*

Flounders (*Pleuronectes flesus*).—Of 29 stomachs examined 21 were empty. *Echinoderms* (*Echinus*) was found in one: *Annelids* were found in four: *Arthropods* consisted of *Crangon* in one and hermit crabs in one: *Molluscs* (*Solen*) were found in one: and *Fish* (gobies) were found in one.

Turbot (*Rhombus maximus*).—Of 7 stomachs examined 4 were empty. One contained *Annelids*: one contained a whiting: and the remaining one contained three young herrings about 5 inches long, one about 4½ inches long, and a young dab 2½ inches long.

Skate.—Of *Raia batis* 5 specimens were examined; 3 were empty: the remaining two contained *Crangon.* Of 30 stomachs of *R. clavata* examined 21 were empty, and the contents of 1 were indistinguishable. *Arthropods* consisted of *Portunus* in two, and unidentified crabs in one: Molluscs consisted of *Mytilus* in two, and unidentified bivalves in three: one contained whitings. One *R. maculata* examined contained *Arthropods* (*Portunus*).

Angler Fish (*Lophius piscatorius*).—Of 5 stomachs examined 3 were empty. The remaining two contained fish.

Cod (*Gadus morrhua*).—Of 16 stomachs examined 1 was empty. *Annelids* consisted of *Aphrodite* in one, *Pandalus* in one, and unidentified annelids in one: *Arthropods* consisted of *Portunus* in seven, *Crangon* in eight, and hermit crabs in seven: one contained unidentified bivalves: and seven contained unidentified *fish remains.*

* Not included in the Tables.

III. LONG LINE BAIT EXPERIMENTS.

These were conducted at different parts of the Firth of Forth during the months of September, December, and January, and also to a less extent in August, February, and March. (*Vide* p. 352).

Common Dabs.

(*Pleuronectes limanda*).

Of 119 stomachs examined 63 were empty, and the contents of 3 were indistinguishable: 53 contained matter that could be identified.

Echinoderms were found in 17 stomachs (32%). They consisted of (1) *Ophiura* (sp. *albida*), in thirteen: (2) unidentified starfish in five.

Annelids were found in 12 stomachs (22%). They consisted of (1) *Sipunculus*, in two: (2) *Aphrodite*, in one: (3) unidentified annelids, in nine.

Arthropods were found in 16 stomachs (30%). They consisted of (1) hermit crabs, in seven: *Porcellana*, in one: (3) crabs, in one: (4) *Eupagurus*, in three: (5) spider crab, in one: (6) *Caprella*, in one: (7) *Crangon*, in one.

Molluscs were found in 4 stomachs (7%). They consisted of (1) *Scrobicularia*, in one: (2) unidentified lamellibranchs, in two: (3) *Doris*, in one.

Fish remains were found in 7 stomachs. They could not be identified.

Cod.

(*Gadus morrhua*).

Of 232 stomachs examined, 28 were empty, and the contents of 6 were indistinguishable: 198 contained matter that could be identified.

Echinoderms were found in 4 stomachs (2%). They consisted of (1) *Echinocyamus* (sp. *pusillus*), in one in September, and *Ophiothrix rosula*, in three in August and September.

Annelids were found in 14 stomachs (7%). They consisted of (1) *Polynoe*, in one in August: (2) *Aphrodite* (sp. *aculeata*), in one in September, in two in December, and in two in January: (3) *Phyllodoce*, in one in January: (4) *Sipunculus*, in one in January: (5) unidentified annelids, in eleven stomachs.

Arthropods were found in nearly all the stomachs examined. They consisted of (1) *Portunus* (sp. *pusillus* and *depurator*), in twenty-seven: (2) *Hyas*, in sixteen: (3) *Eupagurus*, in sixteen: (4) *Pandalus* (sp. *annulicornis*), in fifteen: (5) unidentified crabs, in eight: (6) *Brachyurus*, in one: (7) hermit crabs, in thirty-nine, most abundant in January: (8) *Porcellana* (sp. *longicornis*), in eight (in one fish, 20 inches long, 110 specimens of *Porcellana* were found): (9) *Crangon*, in ninty-three, most abundant in December and January, being found in 21 out of 39 stomachs in December, and in 52 of 84 in January: (10) *Arcturus*, in one in September: (11) *Nephrops*, in six: (12) *Balanus* (sp. *crenatus*), in one in September: (13) *Atelecyclus* (sp. *septemdentatus*), in three in September: (14) *Pinnotheres* (sp. *pisum*), in five: (15) *Galathea*, in four: (16) spider crab, in six in January: (17) *Idotea*, in one in January: (18) unidentified schizopods, in one in February: and (19) unidentified crustacea, in three.

Molluscs were found in 17 stomachs (8%). They consisted of (1) *Solen*, in one in December: (2) *Pecten*, in one in December: (3) unidentified lamellibranchs, in three: (4) *Buccinum*, in thirteen, most abundant in December and January.

Fish were found in 27 stomachs (13%); most abundant from December onwards. They consisted of blenny, long rough dabs, whiting, goby, flat-fish, and *Agonus cataphractus*. Ova were found in one in February.

Haddocks.

(*Gadus æglefinus*).

Of 94 stomachs examined, 9 were empty, and the contents of 7 were indistinguishable: 78 contained matter that could be identified.

Echinoderms were found in 43 stomachs (55%). They consisted of (1) unidentified starfish, in eighteen: (2) *Ophiocoma* (sp. *filiformis* and *rosula*, in four: (3) *Echinocyamus* (sp. *pusillus*), in two: (4) *Ophiura* (sp. *albida*), in twelve: (5) *Ophiothrix* (sp. *rosula* and *albida*?), in nine.

Annelids were found in 17 stomachs (21%). They consisted of (1) *Polynoe*, in one: (2) unidentified annelids, in eleven: (3) *Phyllodoce*, in two: (4) *Arenicola*, in one: (5) *Aphrodite* in two: (6) *Priapulus*, in one.

Arthropods were found in 22 stomachs (28%). They consisted of (1) *Ampelisca*, in one: (2) unidentified amphipods, in five: (3) Unidentified crabs, in two: (4) *Crangon*, in seven: (5) *Eupagurus*, in three: (6) unidentified decapods, in one: (7) *Porcellana* (sp. *longicornis*), in one: (8) hermit crabs, in one: (9) unidentified crustacea, in two.

Molluscs were found in 27 stomachs (34%). They consisted of (1) *Solen*, in three: (2) *Scrobicularia*, in five: (3) *Corbula* (sp. *gibba*), in two: (4) unidentified lamellibranchs, in sixteen: (5) *Cylichna*, in one.

Zoophytes were found in one stomach.

Whitings.

(*Gadus merlangus*).

Of 74 stomachs examined, 55 were empty, and the contents of 2 were undistinguishable: 17 contained matter that could be identified.

Arthropods were found in 16 stomachs (94%). They consisted of (1) *Crangon*, in seven: (2) *Portunus*, in one: (3) *Pandalus*, in one: (4) *Eupagurus*, in two: (5) crabs, in three: (6) unidentified decapods, in three.

Fish were found in 3 stomachs (17%). They could not be identified.

*IV. MONTROSE—*July.*

Plaice (*Pleuronectes platessa*).—Of 19 examined, 4 were empty, and the contents of 2 were indistinguishable: two contained *Arenicola*, one contained *Nereis*, ten contained unidentified annelids, seven contained *Nucula tenuis*, and one contained unidentified lamellibranchs.

One *Long Rough Dab* (*Hippoglossoides limandoides*) was examined: it was empty.

Common Dabs (*Pleuronectes limanda*).—Of 25 examined, 8 were empty, and the contents of 9 were indistinguishable. One contained *Ophiura*, six contained unidentified annelids. One contained *Corystes cassivelaunus*.

Of 3 *Thornback Skate* (*Raia clavata*) examined, one was empty; the contents of another were indistinguishable; the third contained *Portunus holsatus*.

One *Monk Fish* (*Lophius piscatorius*) was examined; it was empty.

One *Black Sole* (*Solea vulgaris*) examined contained *Nereis*.

Of 6 *Whitings* (*Gadus merlangus*) examined, 3 were empty, and the contents of 2 were indistinguishable. The remaining one contained herrings.

Haddocks (*Gadus æglefinus*).—Of 12 examined, 1 was empty, and the contents of 2 were indistinguishable. Sand-stars (*Ophiura alba*) were found in one, and unidentified star-fish in five. Molluscs consisted of *Scrobicularia alba* in one, and unidentified lamellibranchs in three. *Telena fabula* was found in one. A sea anemone (*Actinoloba dianthus*) was found in one.

* Not included in the Tables.

Gurnard (*Trigla gurnardus*).—Of 10 examined, 4 were empty, and the contents of 1 were indistinguishable. *Annelids* were found in one, *Mysis* in one, and unidentified crustacea in three.

*V. ABERDEEN BAY—*July.*

Plaice (*Pleuronectes platessa*).—Of 50 stomachs examined, 4 were empty, and the contents of 1 were indistinguishable. *Echinoderms* consisted of *Amphidotus* (sp. *cordatus*) in one. *Annelids* consisted of *Nereis* in two, and unidentified annelids in thirty-six. *Molluscs* consisted of *Solen* in one, *Nucula* in one, *Venus* (sp. *gallina*) in two, *Scrobicularia* in eleven, and unidentified bivalves in six.

Common Dabs (*Pleuronectes limanda*).—Of 48 stomachs examined, 14 were empty, and the contents of 8 were indistinguishable. *Echinoderms* consisted of *Ophiura* in six, and *Ophiocoma* in five. *Annelids* consisted of *Priapulus* (sp. *caudatus*) in one, *Nereis* in two, and unidentified annelids in thirteen. *Arthropods* (*Portunus*) were found in one. *Molluscs* consisted of *Scrobicularia* in one, and unidentified bivalves in one.

Long Rough Dabs (*Hippoglossoides limandoides*).—All the stomachs of these examined, 8 in number, were empty.

Gurnards (*Trigla gurnardus*).—Of 57 stomachs examined, 10 were empty, and the contents of 1 were indistinguishable. Unidentified annelids were found in one. *Arthropods* consisted of *Crangon* in two, *Portunus* in six, and *Mysis* in forty-one. Flat-fish (sp. ?) were found in one, goby in one, and unidentified fish remains in one.

Haddocks (*Gadus æglefinus*).—4 were examined; the contents of 1 were indistinguishable. *Echinoderms* (*Ophiocoma*) were found in two; *Amphidotus cordatus* in one. *Annelids* unidentified were found in one.

Whitings (*Gadus merlangus*).—Of 18 stomachs examined, 13 were empty, and the contents of 2 were indistinguishable. Of the remaining three, one contained *Echinoderms* (*Ophiocoma*), one *Annelids* (*Aphrodite*) and one *Molluscs* (*Loligo*).

One *Thornback Skate* (*Raia clavata*) examined contained *Crangon*, one *Grey Skate* (*Raia batis*) contained *Portunus* (sp. *depurator*), and pogge (*Agonus*), one *Monk-Fish* (*Lophius piscatorius*) contained whitings, and one *Sand-Fluke* (*Arnoglossus megastoma*) contained unidentified fish remains.

*VI. CRUDEN BAY—*July.*

Plaice (*Pleuronectes platessa*).—Of 13 stomachs examined 4 were empty. Unidentified *Annelids* were found in three, *Molluscs* (lamellibranch) in four, and *Fish* (sand-eels) in three.

Common Dabs (*Pleuronectes limanda*).—Of 8 stomachs examined 5 were empty. *Echinoderms* (*Ophiocoma filiformis*) were found in one. *Arthropods* (*Eupagurus bernhardus*) in one: and unidentified lamellibranchs in one.

Cuckoo or Sand Skate (*Raia circularis*).—Of 3 stomachs examined 2 were empty. The remaining one contained *Annelids.*

Cod (*Gadus morrhua*).—Of 2 stomachs examined 1 was empty. The remaining one contained *Fish* (Common dabs).

Haddocks (*Gadus æglefinus*).—Of 7 stomachs examined 1 was empty, and the contents of 1 were indistinguishable. *Echinoderms* (star-fish) were found in four; and *Molluscs* (unidentified lamellibranchs) in one.

Whiting (*Gadus merlangus*).—Two were examined: both were empty.

Gurnard (*Trigla gurnardus*).—Of 12 stomachs examined 1 was empty. *Arthropods* were found in the remaining 11, consisting of *Portunus pusillus* in two; and schizopods (probably *Mysis*) in nine.

* Not included in the Tables.

*VII. FISH EXAMINED AT THE UNIVERSITY LABORATORY.

As a rule, four fish of each kind were examined every week from the end of July to the end of January. These fish were procured from a fishmonger in town, and the locality of their capture could not be determined with any degree of certainty, but was some 20 or 30 miles east of May Island.

Plaice (*Pleuronectes platessa*).—Of 110 stomachs examined, 35 were empty. *Echinoderms*, consisting of star-fish, were found in three. *Arthropods* consisted of 'crabs' in four, spider-crabs in one, and hermit-crabs in one. *Molluscs* consisted of *Mactra* in three, whelk in two, and unidentified molluscs in thirty-seven. *Fish*, unidentified, were found in one. Mucus was found in eight stomachs, white pulp in five, and black pulp in fourteen.

Lemon Soles (*Pleuronectes microcephalus*).—Of 102 stomachs examined, 55 were empty. *Annelids* were found in three. *Molluscs* were found in two, in one an unidentified shell, and in the other, four chitons. Of the remainder of the stomachs six contained white pulp and thirty-eight black pulp.

Common Dabs (*Pleuronectes limanda*).—Of 103 stomachs examined, 33 were empty. *Echinoderms* consisting of sand-stars were found in ten. *Annelids* unidentified were found in four, and *Arenicola* in one. *Arthropods* consisted of crabs in two, and hermit-crabs in four. *Molluscs* were found in four stomachs, consisting of *Scrobicularia* (sp. *nitida*) in one, *Pecten* in one, unidentified lamellibranchs in one, and whelk in one. *Fish remains*, unidentified, were found in four. Of the remaining stomachs, black pulp was found in thirty-four, brown pulp in two, yellow pulp in two, and mucus in two.

Haddocks (*Gadus æglefinus*).—Of 112 stomachs examined, 26 were empty. *Echinoderms* were found in 61 stomachs, consisting of *Spatangus* in one, sand-stars in forty, and unidentified star-fish in twenty. *Annelids*, consisting of *Aphrodite*, were found in two. *Arthropods* consisted of crabs in one, hermit-crabs in one, *Crangon* in one, and unidentified crustacea in two. *Molluscs* consisted of mussels in two, unidentified lamellibranchs in one, and whelks in one. *Fish remains* were found in two, and ova in twelve (all in the months of August and September). *Zoophytes* (sertularians) were found in two.

Whitings (*Gadus merlangus*).—Of 112 stomachs examined, 90 were empty. *Echinoderms* (sand-stars) were found in three. *Annelids* (*Aphrodite*) were found in one. *Arthropods* consisted of *Crangon* in five, and crabs in one. *Molluscs* (*Loligo*) were found in one. *Fish* consisted of whiting in one, flat-fish in one, and unidentified fish in nine.

Gurnards.—Of 97 stomachs examined, 55 were empty. *Arthropods* were found in 29 stomachs, consisting of *Crangon* in twelve, *Parathemisto* (sp. *oblivia*) in one, swimming crabs in ten, and unidentified crustacea in six. *Fish* were found in 13 stomachs, consisting of gurnard in two, sand-eels in one, dabs in one, herrings in one, whitings in one, and unidentified fish in eight.

Witch Soles (*Pleuronectes cynoglossus*).—Of 26 stomachs examined, 10 were empty, 15 contained black pulp. The remaining one contained unidentified *Annelids*.

*VIII. FISH EXAMINED ON BOARD THE "SOUTHESK."

Plaice (*Pleuronectes platessa*).—On January 11th, 23 were examined at Montrose, none of which contained any food. On January 21st, off the

* Not included in the Tables.

Caithness coast, Noss Head, 11 to 12 miles N., 16 were examined, 9 of which were empty; the rest contained only a little mucus. From January 22nd to 24th, in the vicinity of Smith Bank, 84 were examined, all of which were empty or contained only a little mucus. From February 19th to 27th, in the same locality, 27 were examined, and all were empty or contained a very little mucus. On February 26th, off Lossiemouth, 5 were examined, all of which were empty. The chief point of interest in connection with these plaice is the relation of their empty condition to the ripeness of their reproductive organs (see p. 188).

Lemon Soles (*Pleuronectes microcephalus*).—In January, 2 were examined, one was empty, and one contained spider-crabs. In February, 1 was examined: it was empty.

Long Rough Dabs (*Hippoglossoides limandoides*).—In January, of 86 stomachs examined, 75 were empty. *Annelids* were found in one, *Arthropods*, consisting of *Crangon*, in four, goby in one, and unidentified fish in four. One contained ova. In February, of 46 examined, 45 were empty. The remaining one contained *Fish* (goby).

Witch Soles (*Pleuronectes cynoglossus*).—In January, 6 were examined, 2 were empty, the contents of 1 were indistinguishable, one contained *Annelids*, and two contained *Arthropods* (*Crangon*).

Common Dabs (*Pleuronectes limanda*).—In January, of 59 stomachs examined, 42 were empty. *Echinoderms*, consisting of sand-stars, were found in seven stomachs. *Annelids*, unidentified, were found in five. *Arthropods* consisted of *Eupagurus* (sp. *bernhardus*) in one, *Portunus* in one, *Galathea* in one, *Crangon* in one, and *Hyas* in one. *Fish* (sand-eels) were found in two. In February, of 49 stomachs examined, 25 were empty, and the contents were indistinguishable. *Echinoderms*, consisting of sand-stars, were found in three stomachs. *Annelids*, unidentified, were found in two. *Arthropods* (*Eupagurus bernhardus*) were found in two. *Molluscs* consisted of *Pecten* in one, *Buccinum* in one, and unidentified molluscs in one. *Ascidians* were found in one. *Fish* were found in eleven.

Skate.—*Raia batis.* 3 were examined, they all contained *Fish* unidentified, and two of them contained *Crangon.*

Skate.—*Raia clavata.*—1 was examined, it contained *Portunus* and hermit-crabs.

Cod (*Gadus morrhua*).—In January, of 24 examined, 13 were empty. *Arthropods* (hermit-crabs) were found in three, *Molluscs* (*Buccinum*) in one, haddocks in three, and unidentified fish remains in five. In February, of 47 examined, 33 were empty. *Arthropods* (*Crangon*) were found in one, whiting in one, haddocks in one, and unidentified fish remains in twelve.

Haddocks (*Gadus æglefinus*).—In January, of 74 stomachs examined, 27 were empty, and the contents of 9 were indistinguishable. *Echinoderms* (sand-stars) were found in four, and *Amphidotus* in one, *Annelids* were found in ten. *Arthropods* consisted of *Crangon* in thirteen, *Portunus* in five, unidentified crabs in five. *Ampelisca* in one, *Galathea* in two, *Hyas* in one, *Anonyx* in one, and unidentified schizopods in one. *Molluscs* consisted of *Chiton* in one, *Buccinum* in one, *Scrobicularia* in one, and unidentified bivalves in two. *Fish* consisted of goby in one, and unidentified fish in two. An *Ascidian* was found in one, and an anemone in one. In February, of 35 stomachs examined, 14 were empty, and the contents of 2 were indistinguishable. *Echinoderms* (sand-stars) were found in two, unidentified *Annelids* in five. *Arthropods* consisted of *Crangon* in eight, crab in one, *Galathea* in one, *Anonyx* in one, and schizopods in one. *Molluscs* consisted of *Scrobicularia* in one, unidentified bivalves in one, and cephalopods in one. *Fish* consisted of goby in one, and unidentified fish in two.

Whiting (*Gadus merlangus*).—In January, of 6 stomachs examined, 2 were empty; three contained *Arthropods* (*Crangon*), and three contained *Fish*, unidentified. In February, of 21 examined, 9 were empty, and the contents of 2 were indistinguishable. *Arthropods* (*Crangon*) were found in two, and *Fish*, unidentified, in nine.

Gurnard (*Trigla gurnardus*).—In January, of 11 examined, 2 were empty. *Arthropods* (*Crangon*) were found in seven, *Annelids* in one, unidentified *Fish* in two, and sand-eels in one. In February, of 13 examined, 6 were empty. *Arthropods* consisted of *Crangon* in four, and *Pandalus* in two. *Molluscs* (cephalopods) were found in one. *Fish*, unidentified, were found in one, and whitings in one.

Flounders (*Pleuronectes flesus*).—In February, of 5 examined, 2 were empty; one contained *Crangon*, and one contained goby.

Sand Fluke (*Arnoglossus megastoma*).—In January, 2 were examined, 3 of which were empty: three contained unidentified fish remains. In February, two were examined, one was empty, and one contained *Crangon*.

Turbot (*Rhombus maximus*).—In January, 3 were examined; in February, 4. All were empty.

Brill (*Rhombus lævis*).—In January, 2 were examined: both were empty. In February, 1 was examined; it contained unidentified fish remains.

Bib (*Gadus luscus*).—1 was examined: it contained flat-fish.

Lythe (*Gadus pollachius*).—2 were examined: both were empty.

Hake (*Merluccius vulgaris*).—In February, 3 were examined: 1 was empty, the contents of one was indistinguishable, and one contained *Crangon*.

Monk (*Lophius piscatorius*).—2 were examined: both were empty.

*IX. STOMACHS SENT FROM OBAN.

Stomachs of cod and ling sent from Oban during the months from April to July were examined at the University Laboratory.—These fish were caught generally between Hynish and Skerryvore, in water varying from 6 to 40 fathoms in depth.

Cod (*Gadus morrhua*).—28 were examined. *Echinoderms* consisted of *Asterias* (sp. ?) in two, *Ophiothrix* (sp. *rosula*) in eight, and *Echinocyamus* (sp. *pusillus*) in one. *Annelids* (*Aphrodite aculeata*) were found in one. *Arthropods* consisted of *Cancer* (sp. *pagurus*) in five, *Hyas* (sp. *coarctus*) in three, *Nephrops* (sp. *norvegicus*) in one, *Portunus* (sp. *puber*) in one, and *P. depurator* in one, *Galathea* in one, *Eupagurus* (sp. *prideuxi*) in one, and *Porcellana* (sp. *longicornis*) in one. *Molluscs* consisted of *Buccinum* in one, *Loligo* (sp. *vulgaris*) in one, *Trochus* (sp. *ziziphinus*) in one, and *T. tumidus* in one, *Ophiopholis* (sp. *bellis*) in one, and unidentified cuttle-fish in two. Sand-eels were found in one, and unidentified fish in eight.

Ling (*Molva vulgaris*).—19 were examined. *Arthropods* (*Nephrops norvegicus*) were found in one. *Molluscs* consisted of *Octopus* in one, *Eledone* (sp. *cirrosa*) in one, and unidentified cuttle-fish in one. *Fish* consisted of whiting in one, ling in one, haddock in three, sole in four, and unidentified fish in eight.

* Not included in the Tables.

I. Firth of Forth.

Kinds of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing: Echinoderms.	Annelids.	Arthropods.	Molluscs. Bivalves.	Univalves.	Fish.
Plaice.	June 11	II.	10	.	.	.	10	.	2	.	.
	,, 12	III.	10	.	.	.	10	.	1	.	.
	,, 14	IV.	1	.	.	.	1	.	.	.	.
	,, 15	V.	5	.	.	.	5	.	2	.	.
	,, 15	VI.	11	4	.	3	.	.	9	.	2
	,, 19	VIII.	2	.	.	.	2	.	2	.	.
	,, 19	IX.	2	1	.	.	1	.	.	.	.
			41	5	.	3	29	.	16	.	2
	Aug. 1	I.	8	3	.	.	5	2	2	.	.
	,, 1	II.	6	.	.	.	5	4	1	.	.
	,, 1	III.	8	.	1	.	6	.	2	.	.
	,, 2	IV.	5	1	.	.	4	.	1	1	.
	,, 5	V.	5	.	.	.	1	.	4	.	.
	,, 3	VI.	5	.	1	.	1	2	1	.	2
	,, 2	VII.	6	2	.	1	3	.	.	.	.
			43	6	2	1	25	8	11	1	2
	Sept. 10	I.	5	.	.	.	4	.	1	.	.
	,, 7	II.	5	1	2	.	.	.	2	.	.
	,, 7	V.	5	.	1	.	5	.	2	.	.
	,, 7	VI.	5	2	.	.	.	.	.	.	3
	,, 6	VII.	5	2	.	.	2	.	1	.	.
	,, 6	VIII.	5	.	.	.	4	.	1	.	.
	,, 6	IX.	1	.	.	.	1	.	.	.	.
			31	5	3	.	16	.	7	.	3
	Oct. 6	I.	6	.	1	.	5	.	1	.	.
	,, 4	II.	6	1	1	.	.	.	2	.	.
	,, 8	III.	7	1	.	.	6	.	.	.	.
	, 8	IV.	10	2	1	.	6	.	1	.	.
	,, 3	V.	1	.	.	.	1	.	.	.	.
	,, 3	VI.	8	2	3	.	1	.	1	.	2
	,, 2	VII.	8	3	2	1	.	1	.	1	.
	,, 2	VIII.	2	2	.	.	.	.	.	.	.
			48	11	8	1	19	1	5	1	2
	Nov. 8	III.	1	1	.	.	.	.	.	.	.
	,, 30	III.	8	.	8	.	.	.	.	.	.
	,, 1	VIII.	2	1	.	.	1	.	.	.	.
			11	2	8	.	1	.	.	.	.
	Dec. 1	III.	1	1	.	.	.	.	.	.	.
	,, 21	IV.	16	15	.	.	1	.	.	.	.
			17	16	.	.	1	.	.	.	.
	Jan. 3	IV.	13	8	2	.	3	.	.	.	.
	,, 9	VI.	2	2	.	.	.	.	.	.	.
	,, 8	IX.	1	1	.	.	.	.	.	.	.
			16	11	2	.	3	.	.	.	.

Kinds of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing					
									Molluscs.		
						Echinoderms.	Annelids.	Arthropods.	Bivalves.	Univalves.	Fish.
Plaice	Feb. 12	I.	3	3	.	.	.	.	.	.	.
	„ 11	II.	10	.	2	.	6	.	6	.	.
	„ 5	IV.	12	3	.	1	9	.	.	.	3
	„ 11	VI.	15	9	.	1	1	.	3	.	.
	„ 6	VII.	2	2	.	.	.	.	.	.	.
	„ 6	VIII.	1	1	.	.	.	.	.	.	.
			43	18	2	2	16	.	9	.	3
	Mar. 11	I.	7	1	.	.	5	1	.	.	.
	„ 8	II.	9	3	.	.	3	1	2	.	.
	„ 11	III.	3	.	.	.	3	.	.	.	.
	„ 9	IV.	23	1	.	3	20	2	.	.	.
	„ 8	V.	2	.	.	.	.	.	2	.	.
	„ 8	VI.	11	5	.	.	4	.	2	.	4
	„ 8	VII.	6	2	.	1	3	.	.	.	.
	„ 4	IX.	3	3	.	.	.	.	.	.	.
			64	15	.	4	38	4	6	.	4
Total Plaice.			314	89	25	11	148	13	54	2	16
Lemon Soles.	June 12	II.	10	.	5	.	1	3	.	.	.
	„ 12	III.	10	.	2	.	6	1	.	.	.
	„ 14	IV.	7	1	2	.	3	4	.	.	.
	„ 15	V.	8	.	4	.	2	3	.	.	.
	„ 15	VI.	6	.	.	.	6	1	.	.	.
	„ 19	VIII.	9	.	4	.	4	2	.	.	.
			50	1	17	.	22	14	.	.	.
	Aug 1	I.	6	2	.	.	2	2	.	.	.
	„ 1	II.	6	1	.	.	2	4	.	.	.
	„ 1	III.	8	2	.	.	3	4	.	.	.
	„ 2	IV.	6	2	1	.	2	.	.	.	.
	„ 3	VI.	5	1	4	.	.	.	.	.	.
	„ 2	VII.	5	.	4	.	.	1	.	.	.
	„ 2	VIII.	4	1	2	.	1	.	.	.	.
			40	9	11	.	10	11	.	.	.
	Sept. 10	I.	5	.	.	.	5	.	.	.	.
	„ 7	II.	5	1	1	1	1	3	.	.	.
	„ 7	V.	5	.	.	.	5	.	.	.	.
	„ 7	VI.	5	2	.	.	3	.	.	.	.
	„ 6	VII.	5	.	2	.	2	.	.	.	.
			25	3	3	1	16	3	.	.	.
	Oct. 6	I.	6	3	1	.	1	1	.	.	.
	„ 4	II.	7	.	.	.	6	4	.	.	.
	„ 8	III.	8	4	3	.	.	1	.	.	.
	„ 3	V.	2	2	.	.	.	.	.	.	.
	„ 3	VI.	6	1	2	.	.	1	.	.	.
	„ 2	VII.	3	1	.	.	2	.	.	.	.
			32	11	6	.	9	7	.	.	.
	Nov. 8	I.	3	3	.	.	.	.	.	.	.
	„ 8	III.	5	4	.	.	1	.	.	.	.
	„ 30	IV.	6	6	.	.	.	.	.	.	.
	„ 1	VIII.	4	.	.	.	4	1	.	.	.
			18	13	.	.	5	1	.	.	.

Kinds of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing					
						Echinoderms.	Annelids.	Arthropods.	Molluscs.		Fish.
									Bivalves.	Univalves.	
Lemon Soles.	Dec. 1	I.	2	2	.	.	.	.	.	.	.
	,, 1	I.	9	9	.	.	.	.	.	.	.
	,, 20	III.	1	1	.	.	.	.	.	.	.
			12	12	.	.	.	.	.	.	.
	Jan. 10	I.	5	5	.	.	.	.	.	.	.
	,, 7	III.	3	3	.	.	.	.	.	.	.
	,, 8	VII.	1	1	.	.	.	.	.	.	.
			9	9	.	.	.	.	.	.	.
	Feb. 12	I.	6	4	.	.	.	2	.	.	.
	,, 5	IV.	3	3	.	.	.	.	.	.	.
	,, 11	VI.	2	1	.	.	1	.	.	.	.
	,, 6	VII.	1	1	.	.	.	.	.	.	.
	,, 6	VIII.	2	2	.	.	.	.	.	.	.
	,, 6	IX.	2	2	.	.	.	.	.	.	.
			16	13	.	.	1	2	.	.	.
	Mar. 11	I.	9	6	.	.	3	.	.	.	.
	,, 8	II.	3	3	.	.	.	.	.	.	.
	,, 11	III.	6	3	.	.	3	.	.	.	.
	,, 8	V.	2	2	.	.	.	.	.	.	.
	,, 8	VI.	2	1	.	.	1	.	.	.	.
	,, 8	VII.	2	1	.	.	1	.	.	.	.
	,, 4	IX.	1	1	.	.	.	.	.	.	.
			25	17	.	.	8	.	.	.	.
Total Lemon Soles.			227	88	37	1	71	38	.	.	.
Common Dabs.	June 12	II.	10	.	.	2	.	6	1	.	1
	,, 12	III.	7	2	.	.	1	4	1	.	.
	,, 14	IV.	6	.	.	.	2	4	1	.	.
	,, 15	V.	9	1	1	.	.	6	1	.	.
	,, 15	VI.	5	.	1	3	2	.	.	.	.
	,, 19	VIII.	8	2	2	.	2	1	1	.	.
			45	5	4	5	7	21	5	.	1
	Aug. 1	I.	7	1	.	.	.	2	4	.	.
	,, 1	II.	5	4	1	.	.	.	.	.	.
	,, 1	III.	7	1	.	1	.	5	.	.	1
	,, 2	IV.	6	.	.	4	.	.	.	.	.
	,, 5	V.	5	2	.	.	1	2	.	.	.
	,, 3	VI.	3	2	.	.	.	.	.	.	.
	,, 2	VII.	6	2	1	.	1	2	.	.	.
	,, 2	VIII.	5	1	2	.	1	2	.	.	.
			44	13	4	5	3	13	4	.	1
	Sept. 10	I.	3	1	.	.	.	2	.	.	.
	,, 7	II.	5	2	2	.	1	.	.	.	.
	,, 7	V.	5	4	.	.	.	1	.	.	.
	,, 7	VI.	5	.	3	.	1	1	.	.	1
	,, 6	VII.	6	3	1	.	.	1	1	.	.
	,, 6	VIII.	5	.	.	2	2	1	.	.	.
			29	10	6	2	4	6	1	.	1

Kinds of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing: Echinoderms.	Annelids.	Arthropods.	Molluscs. Bivalves.	Univalves.	Fish
Common Dabs.	Oct. 4	II.	6	1	.	5	.	1	1	.	1
	,, 8	III.	7	1	2	1	1	1	.	.	.
	,, 3	V.	5	1	1	.	.	3	.	.	.
	,, 3	VI.	2	.	.	1	.	2	1	.	1
	,, 2	VII.	5	3	2	.	.	.	.	.	.
	,, 2	VIII.	2	2	.	.	.	.	.	.	.
			27	8	5	7	1	7	2	.	2
	Nov. 8	I.	1	1	.	.	.	.	.	.	.
	,, 8	III.	6	5	.	.	.	1	.	.	.
	,, 30	IV.	4	3	.	1	.	.	.	.	.
	,, 7	VII.	5	5	.	.	.	.	.	.	.
	,, 1	VIII.	7	4	.	.	1	2	.	.	.
	,, 1	IX.	12	4	3	.	.	1	.	.	.
			35	22	3	1	1	4	.	.	.
	Dec. 1	I.	5	4	1	.	.	.	.	.	.
	,, 20	I.	3	2	.	.	.	1	.	.	.
	,, 1	III.	2	1	.	.	.	1	.	.	.
	,, 6	V.	9	8	.	.	.	.	.	.	.
	,, 5	IX.	3	3	.	.	.	.	.	.	.
	,, 5	VIII.	6	6	.	.	.	.	.	.	.
			28	24	1	.	.	2	.	.	.
	Jan. 10	I.	2	2	.	.	.	.	.	.	.
	,, 10	II.	4	2	.	.	.	2	.	.	.
	,, 3	IV.	2	.	.	1	.	1	.	.	.
	,, 9	V.	1	1	.	.	.	.	.	.	.
	,, 8	VII.	6	4	1	.	.	.	.	.	1
	,, 8	VIII.	5	2	1	.	1	.	.	.	1
	,, 8	IX.	11	6	1	.	1	2	.	.	1
			31	17	3	1	2	5	.	.	3
	Feb. 12	I.	4	2	1	.	.	1	.	.	.
	,, 5	IV.	6	3	.	.	2	1	.	.	.
	,, 11	V.	2	1	.	.	.	1	.	.	.
	,, 6	VII.	1	1	.	.	.	.	.	.	.
	,, 6	VIII.	2	2	.	.	.	.	.	.	.
	,, 9	IX.	4	4	.	.	.	.	.	.	.
			19	13	1	.	2	3	.	.	.
	Mar. 11	I.	8	.	.	.	2	6	.	.	.
	,, 8	II.	7	3	.	.	1	3	.	.	.
	,, 11	III.	6	2	.	.	.	5	.	.	.
	,, 8	VI.	9	.	.	.	2	2	.	.	3
	,, 8	VII.	9	4	.	1	1	1	1	.	1
	,, 4	IX.	6	5	.	.	.	1	.	.	.
			45	14	.	1	6	18	1	.	4
Total Common Dabs.			303	126	27	22	26	79	13	.	12
Long Rough Dabs.	June 12	II.	7	3	.	4	.	.	.	.	.
	,, 12	III.	4	2	.	1	.	1	.	.	.
	,, 14	IV.	8	1	.	.	4	1	4	.	.
	,, 15	V.	10	1	3	1	.	3	2	.	.
	,, 19	VIII.	13	3	2	3	2	2	.	.	.
			42	10	5	9	6	7	6	.	.

Kinds of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing Echinoderms.	Annelids.	Arthropods.	Molluscs. Bivalves.	Univalves.	Fish.
Long Rough Dabs.	Aug. 1	I.	6	1	.	2	.	3	.	.	.
	,, 1	II.	5	1	.	4	.	.	.	.	.
	,, 1	III.	5	2	.	1	.	1	.	.	..
	,, 2	IV.	2	.	.	2	.	.	.	.	.
	,, 5	V.	5	2	.	2	.	.	.	.	.
	,, 2	VII.	6	2	.	3	.	.	.	.	1
	,, 2	VIII.	5	2	.	2	1	.	.	.	.
			34	**10**	**.**	**16**	**1**	**4**	**.**	**.**	**1**
	Sept. 10	I.	1	.	.	1	.	.	.	.	.
	,, 7	II.	5	2	.	3	.	.	.	.	.
	,, 7	V.	5	4	.	.	.	1	.	.	.
	,, 7	VI.	3	.	.	3	.	.	.	.	.
	,, 6	VII.	6	4	.	2	1	1	.	.	.
	,, 5	VIII.	5	1	.	2	.	1	.	.	1
	,, 6	IX	5	2	.	.	1	1	.	.	1
			30	**13**	**.**	**11**	**2**	**4**	**.**	**.**	**2**
	Oct. 4	II.	7	1	.	5	.	.	.	.	1
	,, 8	III.	6	2	2	.	.	.	.	.	2
	,, 3	V.	5	5	.	.	.	.	.	.	.
	,, 2	VII.	9	4	.	4	.	1	.	.	.
	,, 2	VIII.	6	6	.	.	.	.	.	.	.
	,, 2	IX.	8	7	.	.	.	1	.	.	.
			41	**25**	**2**	**9**	**.**	**2**	**.**	**.**	**3**
	Nov. 8	I.	9	7	.	.	.	2	.	.	.
	,, 8	III.	10	6	1	1	.	.	.	.	2
	,, 30	IV.	12	1	1	4	.	7	.	.	.
	,, 7	VII.	3	2	.	.	.	.	1	.	.
	,, 1	VIII.	10	7	1	.	..	1	.	.	1
			44	**23**	**3**	**5**	**.**	**10**	**1**	**.**	**3**
	Dec. 1	I.	8	8	.	.	.	.	.	.	.
	,, 20	I.	21	12	.	.	.	9	.	.	.
	,, 1	III.	1	1	.	.	.	.	.	.	.
	,, 21	IV.	1	.	.	.	.	1	.	.	.
	,, 6	V.	9	8	.	.	.	1	.	.	.
	,, 5	VII.	3	1	.	.	.	2	.	.	.
	,, 5	VIII.	8	6	1	.	.	2	.	.	.
	,, 5	IX.	14	8	.	.	.	6	.	.	.
			65	**44**	**1**	**.**	**.**	**21**	**.**	**.**	**.**
	Jan. 10	I.	28	18	.	4	1	10	.	1	.
	,, 10	II.	12	11	.	.	.	1	.	.	.
	,, 7	III.	6	3	.	.	.	3	.	.	.
	,, 3	IV.	5	1	.	.	.	3	.	.	1
	,, 9	V.	17	12	.	.	1	4	1	.	.
	,, 8	VII.	7	3	1	1	.	1	.	.	1
	,, 8	VIII.	10	5	.	.	.	4	.	.	1
			85	**53**	**1**	**5**	**2**	**26**	**1**	**1**	**3**
	Feb. 12	I.	21	9	.	.	1	11	.	.	1
	,, 5	III.	2	2	.	.	.	.	.	.	.
	,, 11	V.	25	18	.	.	.	6	.	.	.
	,, 6	VII.	3	3	.	.	.	.	.	.	.
	,, 6	VIII.	3	3	.	.	.	.	.	.	.
	,, 6	IX.	5	3	.	.	.	2	.	.	.
			59	**38**	**.**	**.**	**1**	**19**	**.**	**.**	**1**

Kinds of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing					
									Molluscs.		
						Echinoderms.	Annelids.	Arthropods.	Bivalves.	Univalves.	Fish.
Long Roughs.	Mar. 11	I.	9	4	.	.	.	4	.	.	1
	,, 8	II.	2	1	.	.	.	1	.	.	.
	,, 11	III.	8	4	.	.	.	2	.	.	2
	,, 8	V.	6	4	.	.	1	.	.	.	1
	,, 8	VII.	9	8	.	1	.	.	.	.	.
	,, 4	VIII.	12	11	.	.	.	1	.	.	.
	,, 4	IX.	5	5	.	.	.	.	.	.	.
			51	37	.	1	1	8	.	.	4
Total Long Rough Dabs.			451	253	12	56	13	101	8	1	17
Witch Soles.	June 14	IV.	4	.	.	.	4	.	1	.	.
	,, 15	V.	7	.	.	.	7	.	1	.	.
	,, 19	VIII.	3	.	.	.	3	.	3	.	.
			14	.	.	.	14	.	5	.	.
	Aug. 5	V.	1	.	.	.	1	.	.	.	.
	,, 2	VIII.	6	2	1	.	3	1	.	.	.
			7	2	1	.	4	1	.	.	.
	Sept. 7	V.	5	.	.	.	5	.	.	.	.
	,, 5	VIII.	6	.	.	.	6	.	.	.	.
	,, 6	IX.	1	1	.	.	.	.	.	.	.
			12	1	.	.	11	.	.	.	.
	Oct. 2	VII.	1	.	.	.	1	.	.	.	.
	,, 2	VIII.	5	4	1	.	.	.	.	.	.
			6	4	1	.	1	.	.	.	.
	Nov. 1	VIII.	3	.	.	.	3	1	.	.	.
	,, 1	IX.	2	2	.	.	.	.	.	.	.
			5	2	.	.	3	1	.	.	.
	ec. 5	VII.	1	.	.	.	1	1	.	.	.
	,, 6	V.	1	.	.	.	.	1	.	.	.
			2	.	.	.	1	2	.	.	.
	Jan. 9	V.	2	2	.	.	.	.	.	.	.
	Feb. 11	V.	7	4	.	.	3	.	.	.	.
	,, 6	VIII.	3	1	.	.	2	.	.	.	.
			10	5	.	.	5	.	.	.	.
Total Witch Soles.			58	16	2	.	39	4	5	.	.
Gurnards.	June 12	II.	6	2	1	.	.	1	.	.	1
	,, 12	III.	7	1	.	.	.	4	.	.	5
	,, 15	V.	5	3	.	.	1	1	.	.	.
	,, 15	VI.	28	1	2	.	.	25	.	1	.
	,, 19	VIII.	9	4	2	.	.	1	.	.	1
			55	11	5	.	1	32	.	1	7

Kinds of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing: Echinoderms.	Annelids.	Arthropods.	Molluscs. Bivalves.	Univalves.	Fish.
Gurnards.	Aug. 1	I.	5	2	1	.	1	3	.	.	.
	,, 1	II.	3	3	.	.	.	.	.	.	.
	,, 1	III.	4	1	.	.	.	3	.	.	.
	,, 2	IV.	6	.	.	.	.	6	.	.	2
	,, 5	V.	2	1	.	.	.	1	.	.	.
	,, 3	VI.	5	.	.	.	.	4	.	.	2
	,, 2	VII.	6	3	.	.	.	2	.	.	1
	,, 2	VIII.	5	2	.	.	.	2	.	1	.
			36	12	1	.	1	21	.	1	5
	Sept. 10	I.	5	3	.	.	.	2	.	.	.
	,, 7	II.	5	.	1	.	.	2	.	.	2
	,, 7	V.	5	3	1	.	.	1	.	.	.
	,, 7	VI.	5	2	1	.	.	2	.	.	.
	,, 6	VII.	5	1	.	.	.	4	.	.	1
	,, 6	VIII.	5	.	.	.	.	3	.	.	2
	,, 6	IX.	7	3	.	.	.	4	.	.	1
			37	12	3	.	.	18	.	.	6
	Oct. 6	I.	5	2	.	.	.	3	.	.	.
	,, 4	II.	4	2	.	.	.	1	.	.	1
	,, 8	III.	1	.	.	.	.	1	.	.	.
	,, 3	V.	1	.	1	.	.	.	.	.	.
	,, 3	VI.	2	.	.	.	.	2	1	.	.
	,, 2	VII.	4	3	.	.	.	.	.	.	1
			17	7	1	.	.	7	1	.	2
	Nov. 1	VIII.	5	.	.	.	.	5	.	.	.
	,, 1	IX.	6	.	.	.	.	6	.	.	.
			11	.	.	.	.	11	.	.	.
Total Gurnards.			156	42	10	.	2	89	1	2	20
Cod.	June 15	V.	19	2	2	.	2	10	12	.	.
	,, 15	VI.	2	1	.	.	.	.	.	.	1
			21	3	2	.	2	10	12	.	1
	Aug. 1	I.	6	.	.	.	.	6	.	.	1
	,, 1	II.	4	1	.	.	1	2	.	.	.
	,, 1	III.	8	1	.	.	.	7	.	1	.
	,, 2	IV.	6	.	.	.	.	6	.	1	1
	,, 5	V.	3	.	.	.	.	3	.	.	1
	,, 3	VI.	2	.	.	.	.	1	.	.	.
	,, 2	VII.	5	3	.	.	.	2	.	.	.
	,, 2	VIII.	2	.	.	.	1	2	.	.	1
			36	5	.	.	2	29	.	2	4
	Sept. 10	I.	5	.	.	1	.	5	.	3	1
	,, 7	II.	2	.	1	.	.	1	.	.	.
	,, 7	V.	3	.	.	.	.	3	.	.	1
	,, 7	VI.	1	.	.	.	.	1	.	.	.
	,, 6	VIII.	2	.	.	.	.	2	.	.	1
	,, 6	IX.	1	.	.	.	.	.	.	.	1
			14	.	1	1	.	12	.	3	4

Kinds of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing					
						Echinoderms.	Annelids.	Arthropods.	Molluscs.		Fish.
									Bivalves.	Univalves.	
Cod.	Oct. 6	I.	5	1	.	.	1	4	.	1	1
	,, 4	II.	1	.	.	.	1	1	.	.	.
	,, 8	III.	4	.	.	.	.	4	2	.	1
	,, 3	V.	1	1	.	.	.	.	.	.	.
	,, 3	VI.	1	.	.	.	.	1	.	.	1
	,, 2	VII.	2	.	.	.	1	2	.	.	1
	,, 2	VIII.	7	.	.	.	2	5	.	.	6
			21	2	.	.	5	17	2	1	10
	Nov. 8	I.	2	.	.	.	.	1	.	.	1
	,, 8	III.	5	.	.	.	2	5	.	.	2
	,, 30	IV.	5	3	.	.	.	2	.	.	2
	,, 7	VII.	5	.	.	.	1	4	.	.	2
			17	3	.	.	3	12	.	.	7
	Dec. 1	I.	5	.	.	1	.	5	.	1	.
	,, 20	I.	2	1	.	.	.	1	.	.	.
	,, 1	III.	5	1	.	.	2	5	.	.	.
	,, 21	IV.	1	.	.	.	.	1	.	.	1
	,, 5	VII.	6	1	.	.	2	5	.	.	1
	,, 6	V.	5	.	.	.	.	5	.	.	.
	,, 5	VIII.	1	.	.	.	.	1	.	.	.
	,, 5	IX.	5	1	.	.	.	4	.	.	1
			30	4	.	1	4	27	.	1	3
	Jan. 10	I.	8	.	.	.	.	8	.	1	2
	,, 10	II.	4	1	.	.	.	3	.	.	.
	,, 7	III.	8	6	.	.	.	2	.	.	1
	,, 3	IV.	6	.	.	.	.	1	.	.	5
	,, 9	V.	13	1	.	.	1	8	.	2	3
	,, 8	VII.	3	1	.	.	.	1	.	.	2
	,, 8	VIII.	2	1	.	.	.	1	.	.	.
			44	10	.	.	1	24	.	3	13
	Feb. 12	I.	5	1	.	.	.	4	.	.	3
	,, 11	II.	1	.	.	.	.	.	.	.	1
	,, 5	III.	6	1	.	.	.	3	.	.	2
	,, 5	IV.	7	1	.	.	1	3	.	.	1
	,, 11	V.	2	.	.	.	1	2	.	.	1
	,, 11	VI.	4	1	.	.	1	3	3	.	1
	,, 6	VII.	4	2	.	.	1	.	.	.	1
	,, 6	VIII.	5	.	.	.	1	5	.	.	4
	,, 6	IX.	4	1	.	.	.	1	.	.	3
			38	7	.	.	5	21	3	.	17
	Mar. 11	I.	8	.	.	.	.	2	.	.	8
	,, 11	III.	1	.	.	.	.	1	.	.	.
	,, 9	IV.	1	.	.	.	.	1	.	.	1
	,, 8	V.	1	.	.	.	.	1	.	.	.
	,, 8	VI.	1	.	.	.	.	.	.	.	1
	,, 8	VII.	10	.	.	.	2	8	.	3	4
	,, 4	VIII.	5	2	.	.	.	3	.	.	1
	,, 4	IX.	3	1	.	.	.	2	.	.	1
			30	3	.	.	2	18	.	3	16
Total Cod.			251	37	3	2	24	170	17	13	75
Haddocks.	June 15	VI.	3	.	1	.	1	.	2	.	1
	,, 19	VIII.	5	.	3	.	2	1	.	.	.
			8	.	4	.	3	1	2	.	1

Kind of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing Echinoderms.	Annelids.	Arthropods.	Molluscs. Bivalves.	Univalves.	Fish.
Haddocks.	Aug. 1	II.	6	2	3	1	.	.	.	.	.
	,, 1	III.	12	3	.	1	6	3	1	.	2
	,, 2	IV.	6	.	.	2	.	3	1	.	.
	,, 5	V.	5	3	1	.	.	1	.	.	.
	,, 3	VI.	5	1	.	.	.	3	.	.	1
	,, 2	VII.	6	1	4	1	1	.	.	.	.
	,, 2	VIII.	5	.	.	1	5	4	.	.	.
			45	10	8	6	12	14	2	.	3
	Sept. 10	I.	5	.	.	4	.	1	2	.	.
	,, 7	II.	5	.	1	2	1	2	.	.	.
	,, 7	V.	5	.	.	.	.	.	5	.	.
	,, 7	VI.	5	4	1	.	.	.	.	.	.
	,, 6	VII.	5	.	.	5	1	.	.	.	.
	,, 6	VIII.	5	2	.	.	.	1	1	.	.
	,, 6	IX.	5	.	.	.	1	2	1	2	.
			35	6	2	11	3	6	9	2	.
	Oct. 6	I.	3	.	.	.	1	3	.	.	.
	,, 4	II.	5	2	.	.	.	3	.	.	.
	,, 8	III.	4	.	.	2	1	2	2	.	.
	,, 3	V.	4	.	.	.	.	.	4	.	.
	,, 3	VI.	2	.	2	.	.	.	.	.	.
	,, 2	VII.	5	1	.	1	3	1	.	.	.
	,, 2	VIII.	5	.	2	.	.	1	3	.	1
	,, 2	IX.	5	1	2	.	1	1	.	.	.
			33	4	6	3	6	11	9	.	1
	Nov. 8	III.	2	.	.	1	1	.	.	.	.
	,, 7	VII.	5	.	.	4	.	4	.	.	3
	,, 1	VIII	5	1	.	.	4	1	.	.	1
	,, 1	IX.	5	.	1	.	1	2	2	.	.
			17	1	1	5	6	7	2	.	4
	Dec. 1	I.	5	2	.	.	.	3	.	.	.
	,, 20	I.	5	.	.	2	1	4	2	.	.
	,, 6	V.	5	.	.	.	2	3	1	.	1
	,, 5	VII.	6	.	.	.	2	6	.	.	.
	,, 5	VIII.	5	.	.	.	.	5	.	.	.
	,, 5	IX.	5	1	.	2	.	4	3	.	.
			31	3	.	4	5	25	6	.	1
	Jan. 10	I.	1	.	.	.	1	1	.	1	.
	,, 10	II.	26	3	.	12	6	15	3	.	.
	,, 7	III.	3	.	.	2	1	2	2	.	.
	,, 9	V.	10	.	1	.	1	3	7	.	1
	,, 9	VI.	6	1	.	.	.	3	.	.	4
	,, 8	VII.	10	.	.	4	3	5	1	.	3
	,, 8	VIII.	7	.	.	.	.	4	.	.	.
	,, 8	IX.	10	1	2	.	2	4	1	.	.
			73	5	3	18	14	37	14	1	8
	Feb. 12	I.	4	1	.	.	.	3	.	.	.
	,, 11	II.	2	.	.	.	.	1	1	.	.
	,, 11	V.	5	2	.	.	1	1	1	.	1
	,, 6	VIII.	5	.	.	1	2	1	.	.	3
	,, 6	IX.	5	1	.	.	1	3	2	.	1
			21	4	.	1	4	9	4	.	5

Kind of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing: Echinoderms.	Annelids.	Arthropods.	Molluscs. Bivalves.	Molluscs. Univalves.	Fish.
Haddocks.	Mar. 11	I.	1	.	.	.	1	.	.	.	.
	,, 8	V.	8	.	.	.	.	.	6	.	.
	,, 8	VII.	9	.	.	7	3	3	.	.	.
	,, 4	VIII.	11	1	.	2	4	4	.	.	2
	,, 4	IX.	10	4	.	1	3	3	.	.	.
			39	5	.	10	11	10	6	.	2
Total Haddocks.			302	38	24	58	64	120	54	3	25
Whitings.	June 15	VI.	4	4	.	.	.	.	.	.	.
	Aug. 1	I.	7	5	.	.	.	.	.	.	2
	,, 1	II.	6	5	1	.	.	.	.	.	.
	,, 1	III.	8	3	2	.	.	.	.	.	2
	,, 2	IV.	2	.	.	.	1	.	.	.	1
	,, 5	V.	5	3	1	.	.	1	.	.	.
	,, 3	VI.	5	4	.	.	.	.	.	.	1
	,, 2	VII.	6	6	.	.	.	.	.	.	.
	,, 2	VIII.	5	3	1	.	.	.	.	.	1
			44	29	5	.	1	1	.	.	7
	Sept. 10	I.	5	3	1	.	.	1	.	.	.
	,, 7	II.	5	3	.	.	.	.	.	.	2
	,, 7	V.	5	2	1	.	1	.	.	.	2
	,, 7	VI.	5	3	1	.	1	.	1	.	.
	,, 6	VII.	5	3	.	.	.	2	.	.	.
	,, 6	VIII.	5	4	.	.	.	.	.	.	1
	,, 6	IX.	5	2	.	.	.	2	.	.	1
			35	20	3	.	2	5	1	.	6
	Oct. 6	I.	5	2	.	.	.	.	.	.	3
	,, 4	II.	3	2	.	.	.	.	.	.	1
	,, 8	III.	4	2	.	.	.	1	.	.	1
	,, 3	V.	2	.	.	.	.	.	.	.	2
	,, 2	VII.	5	1	.	.	.	1	.	.	3
	,, 2	VIII.	5	1	1	.	.	.	.	.	3
	,, 2	IX.	5	2	.	.	.	2	.	.	2
			29	10	1	.	.	4	.	.	15
	Nov. 8	I.	5	1	.	.	.	2	.	.	3
	,, 8	III.	5	3	.	.	.	.	.	.	2
	,, 30	IV.	5	3	.	.	.	.	.	.	2
	,, 7	VII.	7	5	.	.	.	5	.	.	3
	,, 1	VIII.	5	3	2	.	.	.	.	.	.
	,, 1	IX.	2	1	.	.	.	.	.	.	1
			29	16	2	.	.	7	.	.	11
	Dec. 1	I.	5	4	.	.	.	.	.	.	1
	,, 20	I.	6	.	.	.	.	6	.	.	.
	,, 1	III.	5	1	.	.	.	3	.	.	3
	,, 6	V.	4	.	.	.	.	3	.	.	1
	,, 5	VII.	5	.	.	.	.	1	.	.	5
	,, 5	VIII.	5	1	.	.	.	3	.	.	1
	,, 5	IX.	6	3	.	.	.	2	.	.	1
			36	9	.	.	.	18	.	.	12

Kind of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing: Echinoderms.	Annelids.	Arthropods.	Molluscs. Bivalves.	Univalves.	Fish.
Whitings.	Jan. 10	I.	9	3	.	.	.	6	.	.	1
	,, 10	II.	5	2	.	.	.	.	.	.	3
	,, 7	III.	8	3	1	.	.	.	.	.	4
	,, 3	IV.	5	1	.	.	.	4	.	.	1
	,, 9	VI.	3	2	.	.	.	.	.	.	1
	,, 8	VII.	8	2	.	.	.	1	.	.	.
	,, 8	VIII.	5	3	1	.	.	.	.	.	1
	,, 8	IX.	4	2	.	.	.	.	.	.	2
			47	18	2	.	.	11	.	.	13
	Feb. 12	I.	6	2	.	.	.	2	.	.	2
	,, 5	III.	6	2	.	.	.	4	.	.	1
	,, 11	V.	4	.	.	.	.	.	.	.	3
	,, 6	VIII.	5	.	.	.	.	.	.	.	5
	,, 6	IX.	5	3	.	.	.	1	.	.	1
			26	7	.	.	.	7	.	.	12
	Mar. 11	I.	2	2	.	.	.	.	.	.	.
	,, 8	V.	7	4	.	.	.	2	.	.	2
	,, 8	VII.	5	1	.	.	1	3	.	.	1
	,, 4	VIII.	8	4	.	.	1	1	.	.	2
	,, 4	IX.	10	4	.	.	.	.	.	.	6
			32	15	.	.	2	6	.	.	11
Total Whitings.			282	128	13	.	5	59	1	.	87
Skate. *R. batis.*	June 19	VIII.	2	.	.	.	.	1	.	.	1
	Aug. 1	I.	2	2	.	.	.	.	.	.	.
	,, 1	III.	2	.	.	.	.	2	.	.	.
	,, 2	VII.	1	1	.	.	.	.	.	.	.
	Sept. 6	VII.	3	3	.	.	.	.	.	.	.
	,, 6	VIII.	2	2	.	.	.	.	.	.	.
	,, 6	IX	1	1	.	.	.	.	.	.	.
	Oct. 2	IX.	2	2	.	.	.	.	.	.	.
	Nov. 8	III.	1	.	.	.	.	1	.	.	.
	Dec. 1	I.	1	1	.	.	.	.	.	.	.
	,, 5	IX.	2	2	.	.	.	.	.	.	.
	Feb. 6	IX.	1	.	.	.	.	.	.	.	1
Total, . .			20	14	.	.	.	4	.	.	2
R. clavata.	Aug. 1	II.	1	.	.	.	.	1	.	.	.
	, 1	III.	3	2	.	.	.	1	.	.	.
	,, 2	IV.	6	6	.	.	.	.	.	.	.
	Sept. 10	I.	1	.	.	.	.	1	.	.	.
	,, 7	II.	2	2	.	.	.	.	.	.	.
	Oct. 6	I.	2	2	.	.	.	.	.	.	.
	,, 8	III.	3	3	.	.	.	.	.	.	.
	,, 3	VI.	1	1	.	.	.	.	.	.	.
	,, 2	VII.	3	2	.	.	.	1	.	.	.
	,, 2	IX.	1	1	.	.	.	.	.	.	.
	Nov. 8	I.	2	2	.	.	.	.	.	.	.
	,, 8	III.	1	1	.	.	.	.	.	.	.
	,, 7	VII.	1	1	.	.	.	.	.	.	.
	,, 1	VIII.	1	1	.	.	.	.	.	.	.
	Dec. 1	I.	2	2	.	.	.	.	.	.	.
	,, 6	V.	2	.	.	.	.	2	.	.	.
	,, 6	VII.	1	1	.	.	.	.	.	.	.
	Jan. 8	IX.	1	1	.	.	.	.	.	.	.
	,, 9	V.	1	.	.	.	.	1	.	.	.
	Feb. 12	I.	2	2	.	.	.	.	.	.	.
	,, 6	VII.	1	1	.	.	.	.	.	.	.
Total, . .			38	31	.	.	.	7	.	.	.
R. radiata.	Jan. 8	VII.	1	.	.	1	.	.	.	.	.
Total Skate, .			59	45	.	1	.	11	.	.	2

Kind of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing					
						Echinoderms.	Annelids.	Arthropods.	Molluscs.		Fish.
									Bivalves.	Univalves.	
Cat-Fish.	June 19	VIII.	1	.	.	.	.	1	.	.	.
	Aug. 3	VI.	1	1	.	.	.	.	.	.	.
	,, 2	VII.	1	.	.	.	.	1	.	.	.
	Nov. 8	III.	1	1	.	.	.	.	.	.	.
	Jan. 10	I.	1	.	.	.	.	1	.	1	.
	Feb. 12	I.	3	1	.	1	.	2	.	1	.
	,, 11	VI.	2	.	.	2	.	1	.	.	.
	,, 6	IX.	2	2	.	.	.	.	.	.	.
	Mar. 11	III.	1	1	.	.	.	.	.	.	.
			13	6	.	3	.	6	.	2	.
Angler Fish.	June 15	VI.	1	.	.	.	.	.	.	.	1
	Aug. 1	II.	3	1	.	.	.	.	.	.	2
	,, 1	III.	5	5	.	.	.	.	.	.	.
	,, 2	IV.	1	1	.	.	.	.	.	.	.
	,, 3	VI.	5	3	.	.	.	.	.	.	2
	,, 2	VIII.	2	.	.	.	.	.	.	.	2
			16	10	.	.	.	.	.	.	6
	Sept. 10	I.	1	.	.	.	.	.	.	.	1
	,, 7	V.	1	.	.	.	.	.	.	.	1
	,, 7	VI.	3	2	.	.	.	.	.	.	1
	,, 6	VII.	4	3	.	.	.	.	.	.	1
	,, 5	VIII.	1	.	.	.	.	.	.	.	1
	,, 6	IX.	1	.	.	.	.	.	.	.	1
			11	5	.	.	.	.	.	.	6
	Oct. 6	I.	1	1	.	.	.	.	.	.	.
	Nov. 8	III.	1	1	.	.	.	.	.	.	.
	,, 1	VIII.	1	1	.	.	.	.	.	.	.
			2	2	.	.	.	.	.	.	.
	Jan. 8	IX.	1	1	.	.	.	.	.	.	.
	Feb. 12	I	2	.	.	.	.	.	.	.	2
			3	1	.	.	.	.	.	.	2
Total Angler Fish,			34	19	.	.	.	.	.	.	15

II. St Andrews Bay.

Plaice.	July 12	I.	13	2	2	.	9	1	1	.	.
	,, 12	II.	9	2	1	.	6	.	.	.	.
	,, 13	III.	10	5	1	.	2	.	3	.	.
	,, 13	IV.	5	2	.	.	2	.	2	.	.
	,, 13	V.	5	.	.	.	.	.	5	.	.
			42	11	4	.	19	1	11	.	.
	Aug. 16	I.	5	.	.	1	3	.	3	.	.
	,, 16	II.	11	2	2	.	2	.	6	.	.
	,, 17	III.	5	.	.	.	1	.	5	.	.
	,, 17	IV.	7	4	.	.	1	.	3	.	.
	,, 17	V.	10	3	1	.	.	.	6	.	.
			38	9	3	1	7	.	23	.	.

Kind of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing					
						Echinoderms.	Annelids.	Arthropods.	Molluscs.		Fish.
									Bivalves.	Univalves.	
Plaice.	Sept. 18	I.	5	1	.	.	2	1	2	.	.
	,, 18	II.	5	1	.	2	1	.	3	.	.
	,, 18	III.	5	.	.	.	4	.	4	.	.
	,, 18	IV.	5	.	.	.	3	.	4	.	.
	,, 17	V.	5	.	2	1	.	.	3	.	.
			25	2	2	3	10	1	16	.	.
	Oct. 17	I.	6	1	.	.	3	.	2	.	.
	,, 17	II.	6	.	.	2	3	1	4	.	.
	,, 17	III.	7	.	2	.	3	.	2	.	.
	,, 16	IV.	6	.	3	1	3	1	.	.	.
	,, 16	V.	7	.	.	3	2	.	6	.	.
			32	1	5	6	14	2	14	.	.
	Dec. 19	II.	1	.	.	.	1	.	.	.	.
	,, 19	III.	3	3	.	.	.	.	.	.	.
	,, 18	IV.	13	4	2	2	5	.	.	.	.
			17	7	2	2	6	.	.	.	.
	Jan. 21	III.	14	7	.	.	7	3	1	.	.
	,, 21	IV.	7	2	.	.	4	1	.	.	.
	,, 22	V.	1	1	.	.	.	.	.	.	.
			22	10	.	.	11	4	1	.	.
	Mar. 19	I.	15	3	.	1	9	1	6	.	.
	,, 18	II.	12	.	.	1	8	9	9	.	.
	,, 19	III.	18	.	.	4	13	2	8	.	.
	,, 18	IV.	13	7	.	.	3	1	3	.	.
	,, 19	V.	5	.	.	.	2	1	5	.	.
			63	10	.	6	35	14	31	.	.
Total Plaice, .	. .	. .	239	50	16	18	102	22	96	.	.
Common Dabs.	July 12	I.	10	1	.	6	8	.	.	.	.
	,, 12	II.	10	4	3	3	.	.	.	.	.
	,, 13	III.	10	2	.	2	4	.	2	.	.
	,, 13	IV.	5	2	.	2	.	.	.	.	1
	,, 13	V.	6	2	2	2	.	.	.	.	.
			41	11	5	15	12	.	2	.	1
	Aug 16	I.	5	.	1	1	3	.	.	.	.
	,, 16	II.	5	4	1	.	.	.	.	.	.
	,, 17	III.	5	2	1	1	.	.	1	.	.
	,, 17	IV.	6	3	3	.	.	.	.	.	.
	,, 17	V.	5	3	1	.	.	.	.	.	1
			26	12	7	2	3	.	1	.	1
	Sept. 18	I.	5	1	.	4	.	.	.	.	.
	,, 18	II.	5	1	.	2	4	1	1	.	.
	,, 18	III.	5	1	.	.	3	1	.	.	.
	,, 18	IV.	5	1	1	.	2	1	1	.	.
			20	4	1	6	9	3	2	.	.

Kind of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing Echinoderms.	Annelids.	Arthropods.	Molluscs. Bivalves.	Univalves.	Fish.
Common Dabs.	Oct. 17	I.	7	1	.	5	2	1	.	.	.
	,, 17	III.	7	.	.	1	6	.	.	.	1
	,, 16	IV.	6	2	.	2	2	.	.	.	.
	,, 16	V.	7	.	.	1	5	.	.	.	1
			27	3	.	9	15	1	.	.	2
	Dec. 19	I.	9	2	.	3	1	2	1	.	.
	,, 19	II.	8	5	.	2	1	.	.	.	.
	,, 19	III.	5	2	.	2	.	1	.	.	.
	,, 18	V.	1	.	.	.	.	.	1	.	.
			23	9	.	7	2	3	2	.	.
	Jan. 21	III.	2	.	.	.	2	1	.	.	.
	,, 22	V	3	2	.	.	1	.	.	.	.
			5	2	.	.	3	1	.	.	.
	Mar. 19	I.	10	2	.	2	3	2	5	.	1
	,, 18	II.	6	5	.	1	.	.	.	.	.
	,, 18	IV.	1	.	.	.	.	.	1	.	.
	,, 19	V.	14	6	.	2	3	3	.	.	.
			31	13	.	5	6	5	6	.	1
Total Common	Dabs, .	. .	173	54	13	44	50	13	13	.	5
Long Rough Dabs.	July 12	I.	1	1	.	.	.	.	.	.	.
	,, 12	II.	1	1	.	.	.	.	.	.	.
	,, 13	III.	1	1	.	.	.	.	.	.	.
	,, 13	V.	4	.	.	4	.	.	.	.	.
			7	3		4	.	.	.	.	.
	Aug. 16	I.	2	.	.	1	1	.	.	.	.
	,, 17	V.	5	1	.	4	.	.	.	.	.
	,, 17	II.	2	1	.	1	.	.	.	.	.
	,, 17	III.	1	.	.	1	.	.	.	.	.
			10	2	.	7	1	.	.	.	.
	Sept. 18	I.	5	2	.	3	.	.	.	.	.
	,, 18	II.	4	1	.	3	.	.	.	.	.
	,, 18	III.	1	.	.	1	.	.	.	.	.
	,, 17	V.	3	.	.	3	.	.	.	.	.
			13	3	.	10	.	.	.	.	.
	Oct. 17	II.	1	.	.	1	.	.	.	.	.
	,, 17	III.	1	.	.	1	.	.	.	.	.
	,, 16	V.	6	1	.	4	.	1	.	.	.
	,, 19	I.	1	.	.	.	.	1	.	.	.
	,, 19	II.	1	.	.	.	.	1	.	.	.
	,, 19	III.	5	4	.	.	.	2	.	.	1
	,, 18	V.	2	.	.	1	.	.	.	.	.
			17	5	.	7	.	5	.	.	1
Total Long Roug	h Dabs,	.	47	13	.	28	1	5	.	.	1

Kind of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing.					
									Molluscs.		
						Echinoderms.	Annelids.	Arthropods.	Bivalves.	Univalves.	Fish.
Gurnards.	July 12	I.	6	3	.	.	.	3	.	.	1
	,, 12	II.	7	5	.	.	.	2	1	.	.
	,, 13	III.	10	7	1	.	.	2	.	.	1
	,, 13	V.	5	3	1	.	.	1	.	.	.
			28	18	2	.	.	8	1	.	2
	Aug. 16	I.	5	3	.	.	.	1	.	.	1
	,, 16	II.	5	4	.	.	.	.	.	.	1
	,, 17	III.	6	2	.	.	.	1	1	.	1
	,, 17	IV.	7	7	.	.	.	.	.	.	.
	,, 17	V.	5	3	.	.	.	1	.	.	1
			28	19	.	.	.	3	1	.	4
	Sept. 18	I.	5	3	.	.	.	2	.	.	.
	,, 18	II.	1	.	.	.	.	1	.	.	.
	,, 18	III.	5	1	1	.	.	.	.	.	3
	,, 18	IV.	5	1	1	.	1	1	.	.	1
	,, 17	V.	5	1	.	.	.	2	.	.	2
			21	6	2	.	1	6	.	.	6
	Oct. 17	I.	2	.	.	.	.	2	.	.	2
	,, 17	II.	6	2	.	.	.	4	.	.	.
	,, 17	III.	3	.	.	.	.	3	.	.	1
	,, 16	IV.	3	.	.	.	.	3	.	.	.
	,, 16	V.	5	1	.	.	.	4	.	.	1
			19	3	.	.	.	16	.	.	4
	Dec. 19	I.	1	.	.	.	.	1	.	.	.
	,, 18	V.	1	.	.	.	.	1	.	.	1
			2	.	.	.	.	2	.	.	1
Total Gurnards,	. .	. .	98	46	4	.	1	35	2	.	17
Haddocks.	July 12	I.	10	1	.	2	8	3	.	.	.
	,, 12	II.	10	1	2	2	7	1	1	.	.
	,, 13	III.	10	2	2	.	2	2	3	.	.
	,, 13	IV.	5	.	2	.	1	.	2	.	.
	,, 13	V.	6	1	1	1	1	1	2	.	.
			41	5	7	5	19	7	8	.	.
	Aug. 16	I.	3	1	1	1	.	.	.	.	.
	,, 17	II.	5	1	.	2	4	1	.	.	.
	,, 16	II.	4	1	.	1	.	.	1	.	.
	,, 17	III.	7	.	2	3	2	.	1	.	.
	,, 17	IV.	5	1	.	.	.	.	4	.	.
			24	4	3	7	6	1	6	.	.
	Sept. 18	I.	2	1	.	.	1	.	.	.	.
	,, 17	V.	5	1	.	.	4	.	.	.	.
			7	2	.	.	5	.	.	.	.
	Oct. 17	II.	1	.	.	1	.	1	.	.	.
	,, 16	V.	4	2	.	1	2	.	.	.	.
			5	2	.	2	2	1	.	.	.
	Dec. 19	III.	10	.	1	2	3	9	1	.	.
	,, 18	V.	2	.	.	1	.	1	2	.	.
			12	.	1	3	3	10	3	.	.

Kind of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing: Echinoderms.	Annelids.	Arthropods.	Molluscs. Bivalves.	Univalves.	Fish.
Haddocks.	Jan. 22	II.	10	.	.	1	3	10	.	.	.
	,, 21	IV.	2	.	.	.	2	2	.	.	.
	,, 22	V.	1	.	.	1	.	1	1	.	.
			13	.	.	2	5	13	1	.	.
	Mar. 19	III.	1	.	.	1	.	1	.	.	.
	,, 19	V.	1	.	.	1	.	1	.	.	.
			2	.	.	2	.	2	.	.	.
Total Haddocks,			104	13	11	21	40	34	18	.	.
Whitings.	July 12	I.	11	8	1	.	.	.	.	.	2
	,, 12	II.	10	3	1	.	1	1	.	.	4
	,, 13	III.	4	2	.	.	1	1	.	.	.
	,, 13	IV.	3	2	.	.	.	.	.	.	1
	,, 13	V.	5	5	.	.	.	.	.	.	.
			33	20	2	.	2	2	.	.	7
	Aug. 16	I.	2	1	.	.	1	1	.	.	.
	,, 17	II.	4	3	.	.	.	.	.	.	1
	,, 16	II.	1	1	.	.	.	.	.	.	.
	,, 17	III.	1	.	.	.	.	.	.	.	1
	,, 17	IV.	1	1	.	.	.	.	.	.	.
			9	6	.	.	1	1	.	.	2
	Sept. 18	I.	1	1	.	.	.	.	.	.	.
	,, 18	II.	2	1	1	.	.	.	.	.	.
	,, 18	III.	3	1	.	.	.	2	.	.	.
	,, 18	IV.	1	.	.	.	.	1	.	.	.
	,, 17	V.	5	3	.	.	.	.	.	.	2
			12	6	1	.	.	3	.	.	2
	Oct. 17	II.	1	.	1	.	.	.	.	.	.
	,, 16	IV.	4	.	3	.	.	.	.	.	1
	,, 16	V.	5	1	.	.	4	1	.	.	.
			10	1	4	.	4	1	.	.	1
	Dec. 19	II.	2	2	.	.	.	.	.	.	.
	,, 19	III.	8	1	.	.	.	.	.	.	7
	,, 19	IV.	3	.	1	.	.	.	.	1	1
	,, 18	V.	2	2	.	.	.	.	.	.	.
			15	5	1	.	.	.	.	1	8
	Jan. 22	II.	1	.	.	.	.	.	.	.	1
Total Whitings,			80	38	8	.	7	17	.	1	21

III. Long Line (Bait) Experiments.

Kind of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing Echinoderms.	Annelids.	Arthropods.	Molluscs. Bivalves.	Univalves.	Fish.
Common Dabs.	Sept. 1		6	2	.	3	.	1	.	.	.
	,, 4		6	2	.	1	2	1	.	.	.
	,, 12		4	1	.	1	.	2	2	.	.
	,, 17		2	1	.	.	1	.	.	.	.
	,, 21		5	1	.	4	.	.	.	.	.
	,, 24		4	2	.	.	1	1	.	.	.
	,, 28		5	3	.	.	1	1	.	.	.
	,, 28		6	2	.	.	1	2	1	.	.
			38	14	.	9	6	8	3	.	.
	Dec. 12		12	10	.	2	.	.	.	.	.
	,, 16		2	1	.	.	.	.	1	.	.
	,, 27		1	.	.	.	.	1	.	.	.
			15	11	.	2	.	1	1	.	.
	Jan. 16		8	3	3	.	1	1	.	.	1
	,, 17		1	1	.	.	.	.	.	.	.
	,, 19		3	1	.	.	1	.	.	.	1
	,, 25		23	12	.	3	2	3	.	.	2
	,, 26		1	1	.	.	.	.	.	.	.
	,, 30		9	6	.	.	1	1	.	.	2
			45	24	3	3	5	5	.	.	6
	Feb. 1		8	6	.	.	1	1	.	.	.
	Mar. 13		3	3	.	.	.	.	.	.	.
	,, 15		2	.	.	1	.	.	.	.	1
	,, 16		8	5	.	2	.	1	.	.	.
			13	8	.	3	.	1	.	.	1
Total Common Dabs,			119	63	3	17	12	16	4	.	7
Cod.	Aug. 30		7	.	.	2	1	7	.	.	.
	Sept. 1		6	2	.	.	2	4	.	.	.
	,, 4		6	.	1	.	.	5	.	.	.
	,, 12		5	1	.	.	.	3	1	.	.
	,, 14		7	.	.	2	.	7	.	.	.
	,, 17		5	.	.	.	.	5	.	.	.
	,, 21		2	.	1	.	.	1	.	.	.
	,, 24		5	1	1	.	.	3	.	.	.
	,, 26		3	.	.	.	.	3	.	.	1
	,, 27		7	1	.	.	1	6	.	.	.
	,, 28		7	2	.	.	.	5	.	.	.
	,, 28		4	1	1.	.	.	2	.	.	.
			57	8	4	2	3	44	1	.	1
	Dec. 12		8	.	.	.	.	6	1	.	.
	,, 26		3	.	.	.	.	3	1	.	1
	,, 25		21	5	1	.	1	15	.	1	1
	,, 27		14	2	.	.	2	12	1	1	2
			46	7	1	.	3	36	3	2	4
	Jan. 15		10	1	.	.	3	9	.	.	3
	,, 16		14	.	.	.	.	14	.	2	3
	,, 17		17	1	1	.	2	15	.	1	.
	,, 19		10	1	.	.	.	9	.	3	3
	,, 25		13	1	.	.	.	12	.	1	.
	,, 26		16	4	.	.	.	12	1	.	.
	,, 30		12	.	.	.	1	11	.	.	4
			92	8	1	.	6	82	1	7	13

Kind of Fish.	Date.	Station.	Number Examined.	Number Empty.	Number Indistinguishable.	Number containing					
									Molluscs.		
						Echinoderms.	Annelids.	Arthropods.	Bivalves.	Univalves.	Fish.
Cod.	Feb. 1		10	3	.	.	.	7	.	2	4
	Mar. 13		10	.	.	.	1	10	.	.	1
	„ 15		10	2	.	.	.	7	.	1	4
			20	2	.	.	1	17	.	1	5
Total Cod,			232	28	6	4	14	186	5	12	27
Haddocks.	Aug. 30		5	.	1	4	2	1	.	.	.
	Sept. 1		7	1	1	4	.	.	.	.	.
	„ 4		6	1	.	4	2	.	1	.	.
	„ 12		4	1	.	2	2	.	.	.	.
	„ 14		6	.	.	6	1	1	.	.	.
	„ 17		5	1	.	1	1	.	1	.	.
	„ 21		12	.	4	8	.	1	3	.	.
	„ 24		5	.	.	1	.	2	4	.	.
	„ 26		9	.	.	2	2	6	6	.	.
	„ 27		6	.	.	.	4	6	3	1	.
	„ 28		5	.	.	4	.	1	4	.	.
	„ 28		6	3	1	.	.	.	2	.	.
			71	7	6	32	12	17	24	1	.
	Dec. 26		16	1	.	6	3	4	2	.	.
	„ 27		1	.	.	1	.	.	.	.	.
			17	1	.	7	3	4	2	.	.
	Jan. 17		1	1	.	.	.	.	.	.	.
Total Haddocks,			94	9	7	43	17	22	26	1	.
Whitings.	Aug. 30		5	5	.	.	.	.	.	.	.
	Sept. 1		5	5	.	.	.	.	.	.	.
	„ 4		7	6	.	.	.	.	.	.	1
	„ 12		5	1	.	.	.	4	.	.	.
	„ 14		3	3	.	.	.	.	.	.	1
	„ 15		5	4	.	.	.	.	.	.	.
	„ 21		5	5	.	.	.	.	.	.	.
	„ 24		5	2	.	.	.	3	.	.	.
	„ 26		7	4	2	.	.	2	.	.	.
	„ 27		7	4	.	.	.	3	.	.	.
	„ 28		2	2	.	.	.	.	.	.	.
	„ 28		5	4	.	.	.	1	.	.	.
			56	40	2	.	.	13	.	.	2
	Dec. 12		3	3	.	.	.	.	.	.	.
	„ 25		6	3	.	.	.	3	.	.	1
	„ 26		1	1	.	.	.	.	.	.	.
			10	7	.	.	.	3	.	.	1
	Jan. 19		6	6	.	.	.	.	.	.	.
	„ 25		2	2	.	.	.	.	.	.	.
			8	8	.	.	.	.	.	.	.
Total Whitings,			74	55	2	.	.	16	.	.	3

IV. ON THE PELAGIC FAUNA OF THE BAY OF ST ANDREWS DURING THE MONTHS OF 1888. By W. C. M'Intosh, M.D., LL.D., F.R.S., Professor in the University of St Andrews.* (Plates III.–IV.)

I. GENERAL REMARKS.

The following remarks on the pelagic fauna can only be considered as preliminary, since a series of observers would require to be apportioned amongst the various groups so as to work them up thoroughly. Moreover, in regard to certain departments, *e.g.*, post-larval fishes, it has not been possible to compare the exact condition of the offshore with the inshore at all seasons of the year, since only a small sailing boat manned by a single fisherman was at my command. So far as the work goes, however, it will form a basis for future observations; and though much greater elaboration would have been possible, the limited time as well as the exigencies of the public service rendered such impossible.

The prevalence of many pelagic forms of animals has often interested the marine observer: thus the numerous medusæ, siphonophores, crustaceans, salpæ, pteropods, and other forms have in foreign waters received much attention, especially as surface-fauna in fine weather. No systematic examination of such animals in British seas, however, has hitherto been made, though isolated observations on particular types are numerous—such types having as a rule occurred as surface-fauna, or have been stranded on the beach.

In 1884, during the expeditions connected with H.M. Trawling Commission, the importance of this subject in connection with the food of post-larval, young, and adult food-fishes was fully brought out. Thus it was shown that, besides the persistent pelagic types, a vast number of sedentary or bottom-forms have pelagic larvæ, which mount to the upper regions of the water, and again descend as they approach the adult condition. The young fishes thus have a double chance, first as the larval forms ascend, and secondly as they descend in the other stages; and it need hardly be pointed out that the smaller fishes would chiefly affect the former, the larger young fishes the latter. The pelagic fauna thus may be grouped into two great divisions, viz., the *Temporarily Pelagic* and the *Permanently Pelagic* fauna, as indeed was done in a lecture on the subject delivered in November 1886.†

In the treatment of the question a different method has been adopted from that of the German observers, especially Dr Hensen,‡ who sunk nets of a special construction, and calculated the amount of water passing through them in a given time, then having counted the various eggs and animals, he (Dr Hensen) apportioned them to the cubic foot of water.

The method followed at St Andrews consisted of the steady use of tow-nets at the surface and bottom, as well as in mid-water, the latter being a large net—24 feet in length, and attached to a triangle of wood or bamboo—10 feet each way.

* I desire to record the very great assistance rendered me during this inquiry by Mr J. Pentland Smith, M.A., a distinguished student in Natural History in the University. Without his aid the limited time at my disposal would greatly have prolonged the investigations. I have also to thank Prof. G. S. Brady for kind assistance with the *Copepoda*, and Dr Merle Norman for help with the same group (*Crustacea*).

† Abstract in *Ann. Nat. Hist.*, Feb. 1887.

‡ Vide *Fünfter Bericht der Kommission z. w. &c., der deutschen Meere*, Berlin, 1887.

The mid-water net was of service in regard to the post-larval fishes, since no other known form of net has been so successful in capturing these active forms. Lately, moreover, a net of a different kind has been of great use in examining the bottom-fauna, viz., one constructed after the manner of a small trawl. Thus the trawl-heads are of very light iron, the beam a slender bar of elm, 8 feet 6 inches long; the net (18 feet long) is in the form of a trawl-net, but composed of cheese-cloth, with a terminal region 3 feet in length of ordinary (fine) cotton cloth. The mouth of the net is kept about 9 inches from the ground by being drawn 'taut' between the trawl-heads, and has an oblique aperture of 3 feet from beam to foot-rope. This is a most fatal net for larval fishes and the swarms of invertebrates that haunt the bottom-water in early spring, and should be used only for a short time. The mathematical apportionment of the animals comprising the pelagic fauna therefore falls short of the German method, but for all practical purposes connected with the fisheries the plan here adopted is fairly satisfactory. It gives at a glance the vast resources to be found in the sea for the nourishment of the food-fishes,—resources ranging over the vegetable as well as the animal kingdom, and comprehending under the latter representatives of every class from the fishes downward. The importance of the pelagic fauna in supplying food for fishes cannot be overestimated, for though the adults of many of the food-fishes might obtain nourishment from the bottom-fauna alone, it is certain that their post-larval and young stages could not. Moreover, the remarkable adaptation whereby the most minute post-larval forms, such as the very young cod, find in the pelagic forms those that are suited for their wants is a striking feature. Again, the terminal portion of the intestine in the larval herrings captured in March shows a deep greenish coloration, which may be connected with chlorophyll. Moreover, even so minute a form as an Infusorian is occasionally in the larger fishes swallowed in masses as food.

There is no more interesting point in the inquiry than the gradual advent in the early part of the year of the larval fishes, and their great abundance in the spring months, such as March, April, and May. Then, while the larval stages of a few still appear in the warmer months, viz., June, July, and August, the predominance of post-larval types of food-fishes is the main feature. These become rarer in the pelagic fauna as winter approaches, and finally almost disappear from the area in question.

In the same way the larval stages of mussels and other shell-fishes of importance make their appearance at a stated period, continue in great profusion for some time, and then gradually diminish and disappear. In the case of the mussel the advent of the larval forms in swarms in the bay is in touch with the ripe condition of the adult forms in the Eden some time previously, the long-continued presence of certain of these larvæ being connected with the later maturation of the reproductive elements in the littoral and often stunted examples so abundant in many parts of the bay—especially amongst the rocks.

Besides the special interest of the inquiry in connection with the Fisheries, the bearing of many of the facts, *e.g.*, the appearance and disappearance of the multitudes of Medusæ and Hydromedusæ, are of a novel kind, since even the most recent and most authoritative investigators on the subject, such as Prof. Haeckel, do not give information on this question. Little indeed has been done in this respect since the days of Ed. Forbes, with the exception of the notes lately made at the Naples Zoological Station.

The pelagic fauna round the British shores seems to have many features in common, the presence of *Noctiluca* and other southern types on the one hand, and *Arachnactis* as a northern type on the other, amongst many forms common to both areas, being perhaps two of the most noteworthy contrasts.

Though not strictly belonging to any special group or to any special season, the pelagic mud carried about by the bottom-water plays a most important part in feeding the sedentary mollusks, molluscoids, Cirripedes, and other fixed types. One has only to examine the stomachs of Ascidians and of edible mollusks, such as oysters and mussels, to observe the large number of Infusoria, Diatoms, and other Algæ, sponge-spicules, and organic matter of various kinds, which must thus be swept by currents in their neighbourhood amongst a plentiful supply of sand and mud.

In the first place, the tables showing the various forms found in the several nets will be given, each haul being indicated. Considerable blanks occasionally occur, but in almost every instance such is due to storms, since it would have been rash for a single man to venture out with a small open sailing boat unless in safe weather. No opportunity of utilising the services of a trained and hardy seaman, however, was lost. Special remarks on the floating eggs of fishes, and on the larval and post-larval fishes then follow, and lastly remarks on the occurrence and disappearance of some of the most interesting invertebrate members of the pelagic fauna will be appended.

The number of hauls of the mid-water net during the period covered by this report was upwards of 110, while the surface- and bottom-nets were employed 91 and 70 times respectively.

JANUARY.

The diatoms and lower algoids were less prominent than in spring and summer, but a considerable number were present along with a few Rhizosoleniæ.

The Infusoria of this month were represented both in the surface- and bottom-nets by *Ceratium tripos*, but they only occurred abundantly in the bottom-nets.

Amongst the Cœlenterates were fine examples of *Tima Bairdii*, Johnst., fully 2 inches across, a species procured half a century ago at St Andrews by Ed. Forbes on the west sands after a storm; and it is recorded from Shetland and the Firth of Forth by the same accomplished zoologist, as well as from Berwick Bay by its discoverer. This and other specimens were colourless, the peduncle alone showing a whitish tip, and a faint brownish tinge appearing at the base of the tentacles. The reproductive elements were well developed, so that it seems to breed early. The hydroid stock of *Tima* is somewhat uncertain, but Haeckel gives (for the genus) *Lafoea* and *Campanaria*. The former is common enough in our seas. It is interesting, however, that no very small examples of *Tima* have yet been seen. Another noteworthy form was *Stomobrachium octocostatum*, which, like the former, occurred in the mid-water net.

Another interesting Medusa was *Circe rosea*, Forbes, which often occurred in great numbers, not only within the bay but beyond it; for instance, in the region of the Bell Rock, outside the limits. *Circe* occurred both in the surface- and bottom-nets as well as in the mid-water. This species formed one of the features of the winter months.

Examples of both large and small *Pleurobrachiæ* were common in January in the mid-water net, but they rarely appeared in the surface-nets. This form, on the whole, was the most abundant Cœlenterate.

Beroë, in both adult and young conditions, occasionally was captured during the month, but it was by no means common. The largest examples were 3½ inches in long diameter.

Sagittæ of various sizes were prevalent during this month, and some were large—with developing reproductive organs. It was during January many years ago, that the west sands, for a mile or more, were strewn with fine living examples, which sparkled in the setting sun along the beach like needles of glass. These were formerly considered somewhat rare, but they are really amongst the most abundant marine animals. In the surface-net a few occurred about ½ an inch in length; while in the bottom-net many from ¼ inch to ½ inch were procured. In the mid-water net they often occurred in swarms, and some reached about an inch in length. A curious parasitic trematode larva occupied the alimentary canal near the anus.

Tomopteris also, though not numerous, occurred on many occasions; indeed, its absence was rarer than its presence.

The capture of such annelids as *Scalibregma inflatum* probably indicates that the mid-water net touched the ground, as in their adult state these are not pelagic.

Amongst the sessile-eyed Crustacea fine specimens of *Amathilla sabini*, Leach, appeared several times in the mid-water net, both in the adult (female with pale brownish ova) and young state.

Idotea linearis also occurred, probably in connection with floating weeds or other pelagic organisms.

The higher Crustacea were represented by *Mysis flexuosa* and young shrimps (*Crangon vulgaris*). The females of the shore-crabs at present carry ova, so that their zoëæ only appear later.

Diastylis Rathkii in the adult condition occasionally appeared, while the young were common in the bottom-nets.

Of the other crustaceans, the copepods occurred in considerable numbers in the mid-water and bottom-nets; indeed, *Acartia longiremis* and *Calanus finmarchicus* were seldom absent from the latter, and occasionally *Pseudocalanus elongatus*.

Dead valves of ostracods were not uncommon, if the net closely approached the bottom.

Parathemisto oblivia, again, appeared to attain its maximum during this month, great numbers being captured in the mid-water net, and also occasionally in the surface- and bottom-nets. Both large and small forms abounded, the adult males having spermatozoa, and moreover some had parasitic ascaroid worms.

The Thysanopods also were occasionally plentiful.

Amongst the pelagic mollusks *Spirialis* alone was prominent in the larval and young conditions. Dead valves of young *Mytili* were present in the contents of many of the bottom-nets.

February.

Spores of many Algæ occurred in the various nets, but especially in the mid-water and bottom, along with numerous Diatoms and occasionally with Rhizosoleniæ.

Many Infusoria appeared in the bottom-nets, and *Ceratium tripos* and *C. fusca* were also present occasionally in limited numbers.

The Cœlenterates in February were a few examples of a *Thaumantias* in the mid-water nets; vast numbers of *Circe* in the same net, as well as smaller numbers in the surface- and bottom-nets, an occasional *Beroë* of large size and many Pleurobrachiæ — large (⅞ inch), and small ($\frac{1}{8}$ inch), the former especially being very fine. Moreover, free ova of this species (*Pleurobrachia*) were not uncommon. The reproductive organs of *Circe* showed numerous clear cells in the large specimens. This species thus seemed to be generally distributed throughout the water, occurring in surface, mid-water, and bottom-nets. Moreover, many young specimens were present. Only a single small example of *Tima Bairdii* appeared in the mid-water net, while in the bottom-net minute Ephyræ of *Aurelia aurita* occurred sparingly.

The southern inshore waters at this season, as at Sheerness-on-Sea, presented, in addition to *Pleurobrachia* and *Tima Bairdii*, swarms of *Noctiluca.*

The annelids in the mid-water net were represented by *Autolytus prolifer* with the ventral sac for ova, and by the males with the bifid palpi, the sexual forms of *Nereilepas*, and by *Tomopetris*, which occurred both in the mid-water, bottom, and surface-nets.

A larval *Nerine* (with long bristles) was once seen. Bristles of *Sabellaria spinosissima* and *Harmothoë* were also common in the bottom-nets.

Sagittæ were extremely abundant, especially in the mid-water net, and in almost mature condition. Moreover, several showed a larval trematode in front of the caudal septum. The larger specimens in the mid-water net measured $1\frac{1}{8}$ inch, and the same size was seen in both surface- and bottom-nets.

The surface-net during February was characterised by the presence of a few examples of *Parathemisto oblivia*, the ubiquitous *Atylus Swammerdamii*, *Mysis flexuosa*, and an occasional *Idotea linearis.* The Copepoda, were represented by many specimens of *Acartia longiremis* and *Pseudocalanus elongatus*, as well as by smaller numbers of *Calanus finmarchicus.*

In the mid-water net, again, Copepoda, such as *Pseudocalanus elongatus*, were captured in considerable numbers, and so occasionally with *Acartia longiremis*; *Calanus finmarchicus* was less abundant, while *Parathemisto* occurred almost daily, sometimes in swarms, and now or then *Amathilla sabini* and *Eurydice pulchra.* The males of *Parathemisto* still showed spermatozoa. An occasional *Idotea linearis* was also procured. Other forms present in the mid-water and bottom tow-nets were *Mysis flexuosa* (small and large), *M. vulgaris*, and *Atylus Swammerdamii.* Moreover, considerable numbers of *Boreophausia Raschii* appeared in the mid-water nets about the middle of the month. This species is in dense swarms near the mouth of the Forth.

The bottom-nets presented numerous examples of *Parathemisto oblivia*, besides *Pseudocalanus elongatus*, and *Calanus finmarchicus* in considerable numbers; while *Mysis flexuosa* occurred occasionally. *Thysanoessa* once appeared in this net.

During February no molluscoids were noted in the various nets, but such may have been accidental, for in all probability *Cyphonautes* and the Appendicularians may yet be procured. Young examples of *Spirialis* again were the only molluscan forms observed in the bottom-nets.

No pelagic ova were obtained in the bay this month, but a post-larval fish, apparently connected with the gadoids, was procured in the mid-water net off the Tents Moor on the 20th. It had not previously come under notice. It is distinguished by eyes (Plate III. figs. 5, 6 and 7) resembling those of a gadoid, and it is considerably larger than a goby at the stage of the entire larval dorsal and ventral fin. Its length was about $\frac{3}{8}$ of an inch (9–10 mm.). The eyes are large and silvery; the notochord is quite straight, and only embryonic rays occur in the tail, though inferiorly a thickening is present from the development of hypural elements.

The pectoral fins are large, and a marginal (embryonic) fin occurs along the ventral edge of the abdomen. The latter is translucent, and presents an opacity in front (liver), beneath which lies a small yellowish oil-globule, so that the ovum likewise possesses this feature. The vent is prominent and open. Black pigment-corpuscles are grouped along the roof of the abdomen in the usual position, while a single one lay over the liver. A row of these also runs along the base of the dorsal marginal fin from the head to the tail, and a similar series exists along the ventral border from the vent to the tail. Over the faintly yellowish mid-brain are five isolated black specks, followed by an interval, after which the dorsal row commences. When viewed laterally, it is difficult to keep the head in position, from the great size of the eyes, the inferior border of which abuts close on the maxillary margin. The otocysts are large, and lie close behind the eyes.

Another and somewhat younger example (Plate III. fig. 5), subsequently procured, shows the peculiar character of the cerebral pigment somewhat better (fig. 7), though the yolk was not yet completely absorbed.

It is difficult at present to give the relationships of this form, but the great size of the eye, the shortness of the snout in front of it, the upward slope of the mandible, and the pigment distinguish it from any form hitherto seen.

During this month the pelagic ova of the long rough dab should be abundant, as the adults are now ripe.

Moreover, at the end of the month a female bib was found with perfectly ripe ova, so that in all probability these will occasionally be procured in the bay about this time. The breeding season of this species, therefore, would seem to be much earlier than that of the poor cod, which does not spawn at St Andrews, as a rule, till June or July. The egg-capsule is finely punctured as in the plaice, and the micropyle resembles that of the haddock.

March.

Pelagic plant life in March consisted of many diatoms, spores of Algæ, and often of *Rhizosoleniæ*. Every cast of the net, especially at the bottom and surface, teemed with these structures towards the end of the month.

The only Infusorian recognised was *Ceratium tripos*, though many of of the more minute forms were also present.

The Cœlenterates occurred chiefly in the mid-water net, and included *Circe* and *Pleurobrachia*, the former appearing often in very great numbers, and indeed forming a feature in the collections of the period, both in the mid-water and bottom nets. Both large and small examples were present, but the majority were full grown. *Pleurobrachia* was almost as abundant, but the majority of the examples were small, though occasionally some reached $\frac{3}{4}$ inch. Minute forms abounded in the trawl-like bottom-net towards the end of the month. Cœlenterate life was much more abundant; thus swarms of Ephyræ of *Aurelia* and probably of *Cyanea* also were present; indeed, in former years they appeared to have been pumped with the water into the laboratory, since every vessel contained them in March 1887. Minute specimens of *Thaumantias lucifera*, *Oceania* (*Tiara*) *octona*, and *Lizzia octopunctata*, and other forms occurred in the same net, which also captured many young examples of *Lesueuria* scarcely visible to the naked eye. A single example of *Bougainvillia britannica* (*Margelis ramosa*, A. Agassiz) was also obtained by the mid-water net. Thus a wealth of medusoid life is found close to the bottom at this season, and such is the most likely area in which to find *Ephyræ* and Medusa-buds.

The Annelids were represented by *Autolytus prolifer* in considerable numbers, the majority being captured by the trawl-like bottom tow-net. Many had the ovigerous pouch. A larval form with curiously reticulated surface, and which has a very wide distribution, since Mr Shrubsole finds the same form at Sheerness-on-Sea, appears to be an early larval stage of *Nerine*, as shown by Claparède and Mecznikow. A few older stages of the larval form of *Nerine* also occurred in the same net.

Sagittæ were numerous, both small and large, the latter reaching fully an inch. This form abounded in the mid-water and bottom-nets, and also occasionally reached the surface. It has been found in the stomachs of several food-fishes, and is probably eaten by most, so that its importance in this respect is considerable.

The surface-net during March showed that *Halitemora longicornis* abounded, while *Calanus finmarchicus*, *Centropages hamatus*, and *Pseudocalanus elongatus* occurred in small numbers. Many *Nauplii* and a few zoeæ also appeared in this net towards the end of the month.

In the mid-water net the Copepods consisted of *Calanus finmarchicus*, often in considerable numbers, and of *Acartia longiremis.* The other crustaceans were represented by the ubiquitous *Parathemisto oblivia*, by a few examples of *Crangon vulgaris*, *Mysis flexuosa*, *M. vulgaris*, *M. Griffithsiæ*, *Atylus Swammerdamii*, *Eurydice pulchra*, *Idotea linearis*, and zoeæ. In former years the zoeæ of *Lithodes maia* issued about the middle of the month.

The bottom tow-net gave many Nauplii and zoeæ of *Crangon*, *Carcinus*, and others, both abounding towards the end of the month. *Parathemisto oblivia* in numbers, and a few examples of *Hyperia medusarum* and *Thysanoessa* also were captured. Amongst the Copepods were *Calanus finmarchicus* in considerable numbers, *Pseudocalanus elongatus* in myriads, and *Halitemora longicornis* occasionally.

The Molluscoida were scantily represented in the pelagic fauna, only a few examples of *Cyphonautes*, besides the Appendicularians having come under observation. The latter during the earlier part of the month were chiefly small specimens, and obtained sparingly. Towards the end of March they were much more numerous and larger, and the 'houses' also were common.

The only pelagic mollusks were young examples of *Spirialis.*

The pelagic ova of this month included a considerable number of plaice, the embryos from a comparatively early period being distinguished by pale yellow pigment-corpuscles. These eggs were not obtained in great numbers, as might have been imagined from the vast multitudes of plaice in the Bay, but mostly in twos and threes—showing that they are sparsely scattered throughout the water. At most only a very few mature plaice (none of which have been under observation) occur in the Bay, which probably has to depend upon its main supply of eggs, post-larval and young fishes on the offing, *e.g.*, near the Bell Rock in the deep water near which large and mature plaice are plentiful. The eggs of the plaice are large (·068 of an inch) and very buoyant. The structure of the egg-capsule conforms to that generally observed, being minutely dotted with a close series of rows or punctures, which in some views seem elevated, in others depressed, and the surface is peculiarly rough as if minutely corrugated. This condition sometimes gives a sheen to the egg in certain lights, as if silvered or frosted.

If a ripe plaice be examined, the large size of the ovaries is marked, those in a fish of 23 inches being about 11 inches in length, the greatest transverse diameter being $4\frac{1}{2}$ inches, and the thickness about an inch. A comparatively large proportion of the ova attains maturity at the same time, apparently from $\frac{1}{5}$ to $\frac{1}{3}$ of the total bulk being translucent in some examples. The enormous number of these large eggs thus sent into the water from a shoal of ripe plaice within a limited period must make a noteworthy addition to the pelagic fauna.

An egg with which I had long been familiar in March and April was also found in the Bay this month, viz., a comparatively large egg measuring ·0675 inch, and having a capacious perivitelline space, within which is the isolated yolk measuring ·041 inch. During the trawling expeditions it was a common form at the surface on the rich grounds off the Forth. Mr Cunningham, too, found it in the same region a year later, and figures it in his paper.* It is also frequently brought to the laboratory from the Bell Rock grounds by the fishermen of St Andrews.† Mr Cunningham, unfortunately, could not hatch the egg. At St Andrews the early embryo lies on the yolk in the midst of the large perivitelline space (Plate III. fig. 1); but by-and-by the tail elongates, the yolk becomes somewhat smaller, and the embryo stretches across the entire area (Plate III. fig. 2), as well as tends to the upper arch in floating. Before hatching, minute yellowish chromatophores are dotted along each side of the embryo. When extruded the yolk-sac is large, and the tail long. The embryo (Plate III. fig. 3) floats helplessly with its large yolk-sac uppermost, though it twists and wriggles with great vigour at intervals. The head is slightly yellowish by transmitted light, and the round chromatophores along the sides have a deeper yellowish tint. They extend nearly to the tip of the notochord. A tinge of the same hue also occurs in the eyes, which are otherwise devoid of pigment. The heart is broadly tubular, and pulsates very feebly. The tail bends dorsally (*i.e.*, downwards) as the animal floats. The relationships of this form are still obscure.

The pelagic forms in the Bay also included a large egg (about $\frac{1}{14}$ inch) with a pale oil-globule, the relationships of which are also at present uncertain.

In contrast with the condition in the Bay, the use of the surface tow-net by the fishing boat 'Rose,'‡ south-east of the Bell Rock, towards the end of the month, gave a much greater number of pelagic ova. Thus there were a considerable number of the eggs with the large perivitelline space, the diameter of the egg being ·063 and the yolk ·042 inches (see Plate III. fig. 1); other eggs were ·044 inch, and a third series, also with perivitelline space, ·0675 inch and the yolk ·041; while the ova of the haddock, cod, rockling, and others were plentiful.

Amongst the larval fishes characteristic of the Bay during this month were young plaice, which were both captured in the mid-water net and hatched from ova obtained by the same means. A detailed description has long been prepared,§ so that it need only be stated here that the larval plaice about a day old measures 7 mm., if the ova have been recently captured before hatching. This length is much greater than that given by Mr Cunningham,‖ viz., 4·1 mm., but there is this important difference that his ova were fertilised artificially, and removed from the ovum when almost ready to hatch. The larval plaice is a large form, and is easily seen in the vessels. Moreover, the yellow pigment of those observed at St Andrews (for three or four seasons) was not in the form of

* *Trans. Roy. Soc. Edin.*, vol. xxxiii. pt. 1, p. 105, pl. vii. fig. 2.

† Amongst these James Gourlay and A. H. Cunningham deserve special notice.

‡ A. H. Cunningham, skipper.

§ *Researches on the Food-Fishes*, M'Intosh and Prince (now being published by the Royal Soc. Edin.).

‖ *Op. cit.*, p. 99.

'three rows down each side,'* but the chromatophores were generally distributed over the sides, though perhaps they were a little denser in a lateral view along the dorsal and ventral borders.

During the latter days of the month also a few larval cod in their speckled condition, along with a few larvæ of the haddock, were captured in the mid-water net, and the larvæ from some of the eggs of the rockling escaped as soon as the contents of the mid-water and bottom-nets reached the laboratory.

In March likewise vast numbers of Clupeoids, apparently herrings, occur in the nets, especially in the trawl-like bottom tow-net. Some of them still had the yolk sac. Moreover, the intestine in many had a bright greenish coloration from chlorophyll. Comparatively few larval herrings were obtained in the mid-water net, but myriads thronged the lower part of the water towards the end of the month. They had probably only recently escaped from the eggs, though the absence of the yolk-sac in many, and the presence of well-marked embyronic fin-rays, showed that they were some days old. These active little fishes are so translucent as nearly to be invisible, except for the silvery eyes with a slightly greenish lustre. So far as known, the ova of the herring have not been found on the open sandy reach (opposite the estuary of the Eden), where the densest masses of these young herrings occurred. They are, however, abundant enough off the Forth and east of Fife. The appearance of the young herrings would not seem to be much later than those in the south, for Mr Cunningham records them in Plymouth Sound in February and March. Chromatophores run along the ventral edge from the vent to the liver, and a few specks occur over the united segmental ducts at the rectum.

These young fishes alone would enrich a Bay as regards fish-food, and yet myriads of *Nauplii*, zoeæ of crabs and shrimps, and various other forms swarm round them. Such inquiries, indeed, extend our views in connection with the resources in the ocean for the nourishment of fishes at all seasons of the year.

Numerous young sprats, from $1\frac{3}{8}$ inch to $1\frac{3}{4}$ inch, were occasionally captured in the mid-water net.

A larval form, which in the laboratory was associated with the sand-eel, more, however, as a convenience in description than from any absolute certainty of its relationship, was abundant in the Bay towards the end of the month. It is easily distinguished from the larval Clupeoid by the position of the vent, which is almost median.

Another larval fish (Plate III. fig. 8, and Plate IV. figs. 2, 3 and 4), which is readily distinguished from the Clupeoids by the presence of a large oil-globule in the posterior region of the abdomen, is not uncommon in March, occurring year after year about the beginning of the month. In those hitherto seen here, the yolk has been absorbed, but a large globule of oil remains thereafter, though it also speedily diminishes by absorption. The rapid disappearance of the yolk is a feature of interest. Though in general aspect it is Clupeoid, the anus is nearly median, thus boldly contrasting with the condition in the latter. Its exact relationships have yet to be worked out.

The larval fish figured in Plate IV. fig. 1 presents another type, and differs from anything hitherto met with. The body is less elongate than in the Clupeoids, and the vent is median. The intestine, moreover, presents a peculiarly distinct incurvation in the rectal region. Remains of the yolk with a considerable oil-globule exist towards the anterior

* Cunningham, *Op cit.*

part of the abdomen. No dorsal pigment is present, but a line of black chromatophores occurs along the ventral edge.

Besides the larval food-fishes, numerous larvæ of the sea-scorpion (*Cottus scorpius*) appeared in the mid-water net, and their vitality is so great that they will live for many days in a small vessel of unchanged sea-water. The piebald larval armed bull-heads (*Agonus cataphractus*) were frequently obtained, and their yellow touches are boldly relieved by the almost translucent body; moreover, their action in swimming is more undulatory than in the swift food-fishes. The larval stages of Montagu's sucker were also common, and the young (larval) gunnels occasionally were swept into the mid-water net near the rocks.

April.

Diatoms, spores of Algæ, *Rhizosoleniœ*, and other forms of plant-life were abundant in April. Moreover, during this month the peculiar gelatinous algoid masses, which will be more particularly described under May, appeared in the Bay. Their great profusion had a close relation with the abundance of various pelagic animals.

During April the pelagic Cœlenterates began to be more prominent in the mid-water net. Thus *Thaumantias* and *Lizzia*, with buds, and many examples of *Circe*, were captured. The latter seems to attain a large size this month; indeed, no larger forms have been seen, and the reproductive organs are well developed. Moreover, an occasional example of *Sarsia tubulosa* appeared towards the end of the month, and a few of them attained $\frac{1}{2}$ an inch in long diameter. The gonozoids of *Clytia Johnstoni* were characteristically plentiful at this period, issuing from the stock in swarms. Moreover, the old polypites and cups were thrown off, and new ones reproduced. *Pleurobrachia* was as abundant as usual, but the specimens were chiefly small. Moreover, the young of *Beroë*, about $\frac{3}{16}$ inch, and of *Lesueuria*, $\frac{3}{8}$ inch, occasionally appeared.

Amongst the annelids the various forms of *Autolytus prolifer* were captured, the females bearing ova. The epitocous forms of *Nereis* likewise appeared, and *Tomopteris* was frequent.

Sagittæ on the whole were less conspicuous than in the previous month, but some were $\frac{5}{8}$ inch long. A few were mature at the beginning of the month, but these were in the minority. This corresponds with the condition of the Neapolitan forms.*

In the surface-net *Centropages hamatus* abounded towards the end of the month, and also *Evadne Nordmanni.*

Nauplii of various forms were also very common, including those of Cirripedes; while the cypris-stage of the latter with the black specks was frequent in the mid-water net.

From the beginning of the month zoeæ appeared in great numbers in the mid-water as well as in the surface-net, and were as characteristic of the open sea as of inshore waters, occurring all along the eastern shores from the north of Scotland to the south. In the mid-water net were also *Parathemisto*, *Eurydice pulchra*, *Idotea linearis*, and *I. tricuspidata*, *Diastylis Rathkii*, *Mysis vulgaris*, *M. flexuosa*, and *Crangon vulgaris*, the last six, however, probably being specially related to work close inshore.

Moreover, Schizopods occurred in vast numbers about the 23rd (in 1886), and were stranded on the west sands for some days as a belt left by the retiring water. Some supposed that a quantity of chaff had been

* *Mittheilung a.d. Zoolog. Stat. z. Neapel*, 8 Bd. iii. and iv. Heft, p. 401.

thrown into the sea, and had thus been left by the tide. The pools at both east and west rocks were in some cases semi-solid with them. Their enormous numbers must have exercised a considerable influence on the food of the fishes in the Bay and near it; and the stomachs of those examined—*e.g.*, sprats, fifteen-spined stiklebacks, armed bull-heads, and whiting—were distended with them. They consisted of *Nyctiphanes* and *Thysanoessa.*

A few Appendicularians made their appearance at the end of the month, but they probably were in the Bay sooner, since young forms were procured in February. They at any rate were not in the profusion so characteristic of April 1887, when the huge mid-water net frequently filled like a balloon with them and their 'houses,' and this—day after day, so that the patience of the boatman was nigh exhausted by the heavy work thus entailed. It was a relief to him when they diminished. There can be little doubt that, like other Ascidians, they are eaten by fishes of all kinds, and thus their great numbers make them important elements in the food of that group. They have long been known to occur in abundance in Scottish waters; for Edward Forbes, in 1845, found that the cloudy patches of red colouring matter in the sea off the north of Scotland consisted almost entirely of them. They were also frequently met with in the work for the Trawling Commission under Lord Dalhousie. Their prodigious numbers, however, were only clearly estimated at St Andrews. The forms which occurred in the Bay were almost colourless, and thus differed from Forbes's examples and many of those procured in the expeditions just named.

They fed freely, apparently on the peculiar gelatinous algoid structure in 1887, and the vessels in which they were kept were littered with small brownish, cylindrical fœcal masses, which apparently represented algoid structure altered by digestion. During the months (April and May) in 1887 in which they were under observation, their size considerably increased. Their disappearance in May was as sudden as their advent in such enormous numbers in April. As a rule, the Appendicularians have their reproductive organs fully developed during this month.

In April 1887 one of the most remarkable features of the pelagic fauna for some weeks was the occurrence, almost daily for a week or two, of *Clione borealis*, Pallas, a pteropod (mollusk) hitherto considered one of the rarest of British marine animals. Indeed, Dr Gwyn Jeffreys, long the authority on the group, and who had searched the British seas more thoroughly than any other in recent times, could only observe in regard to its occurrence, that Dr Leach, during a tour in the Orkneys (? Hebrides) in 1811, says he found several mutilated specimens on the rocks, and succeeded in capturing one alive on the coast of Mull. Like others of the group, it forms part of the food of the whale, and it need hardly be said is a prize for any food-fish. The species is one of the most beautiful as well as the most graceful in motion amongst the pelagic animals of our shores. None occurred in the Bay in 1888.

Amongst the pelagic ova were those of plaice, cod, haddock, whiting, dab, rockling, and flounder, those of the gurnard appearing at the end of the month, though in former years occasionally at the beginning. Others not yet clearly differentiated were also procured. The comparative scarcity of ova in the upper waters of the Bay is in marked contrast with the rich grounds in the Moray Firth, Smith Bank, and the region south-east of the Isle of May. It may be truly said that the pelagic ova are an index of the kind and number of the adult fishes in the neighbourhood. At the end of the month pelagic ova of the ling are found at a distance from land, but none have been recognised in the Bay. In glancing with a lens at collections of ova made with the surface-net at the beginning of the month just outside the Bay (near the Bell Rock), the sizes and conditions of the several ova are diagnostic. Thus the large ovum, with the wide perivitelline space, is characterised by its translucency, and the isolated yolk is readily seen in the early stage, just as the embryo with the diminished yolk in the same large space is conspicuous in the later stages. The embryo floats yolk uppermost at the high arch of the egg, leaving the wide perivitelline chamber beneath it. Though the latter space is thus peculiarly large, it is interesting that no real difference exists between this egg and the others beside it. For instance, the young cod and its yolk almost fill the egg-capsule, the yolk in the floating egg being uppermost, while the body of the embryo stretches along each side of the lower pole, its curvature being determined by the limited size of its envelope. On the other hand, the embryo in the large egg is comparatively free, and bends only a little over its own yolk, following, in short, the same relative curvature that is seen in the more tightly enveloped cod. The yellow pigment of the embryo, the minutely streaked capsule, and the comparatively large size of the egg indicate that of the plaice. The size of the egg of the haddock distinguishes it from that of the cod, and the characteristic bands of pigment in the embryo of the latter (in the egg) render the distinction easy at that stage. The small size and bright yellow pigment in the embryo differentiate the egg of the dab; while the egg of the rockling (probably 3-bearded) is still less, and has a single large clear oil globule at its summit. The transparency of the egg of the sprat and the reticulations of the yolk are also diagnostic.

Post-larval gadoids from $\frac{1}{4}$ to $\frac{1}{2}$ an inch, appeared at the end of the month in the mid-water net, and some were procured during the month south-east of the Isle of May. Larval sand-eels about $\frac{3}{4}$ of an inch, and various Clupeoids from $1\frac{1}{4}$ to 2 inches long, were likewise obtained.

On the fine fishing grounds south-east of the Isle of May early post-larval sand-eels were in great numbers near the surface, and were captured in the tow-nets amongst the pelagic ova. The distribution of this form is very wide, and though it is probable the ova are demersal, the pelagic habits in the post-larval and young, and even of those of considerable size, tend to spread the species throughout the neighbouring ocean.

In stormy cold weather at the beginning of April, and with a high east wind and rain, the bottom-net on one occasion was prolific in ova, such as those of the dab, cod, haddock and rockling, whereas the surface-net gave only one or two. Towards the end of the month the ova of the sprat abounded in the bottom-net.

Post-larval flounders, $\frac{7}{16}$ to $\frac{9}{16}$ inch long, were not uncommon; while a dab, $1\frac{1}{16}$ inch, gave a later stage in development, as also did a goby, $1\frac{5}{8}$ inch long.

In the same net (mid-water) larval sand-eels, Montagu's sucker, and post-larval armed bull-heads (*Agonus*) occurred; young lump-suckers about $\frac{1}{4}$ inch, and young *Cotti* $\frac{3}{16}$ inch long, also were captured.

Though larval and post-larval armed bull-heads were not uncommon in the nets, all the adults had not spawned, for in the beginning of the month various females with nearly ripe eggs were found. Again, though post-larval wolf-fishes (*Anarrhichas lupus*) must abound near the mouth of the Bay, it is remarkable that none have ever occurred within it, more especially as a mass of ova was found within the limits of the Bay in January 1886. The post-larval wolf-fishes are active swimmers.

In the trawl-like bottom-net young herrings were likewise procured in great numbers at the beginning of the month, some of them having the yolk-sac still present. The greater part of the Bay seemed to abound with them, and yet comparatively little indication of their presence in such numbers was given by any other net than that just indicated. These little fishes form the prey of many invertebrate forms, even so small a medusoid as *Lizzia* boldly seizing on the head of a sickly specimen and tenaciously clinging to it; and it is not uncommon to find one inside the manubrium of *Circe.* Higher types, such as young fishes, feed on them greedily; indeed, their minute size, activity, and transparency alone protect them. The greenish silvery sheen of their eyes, however, must often prove disastrous in the case of the larger fishes, which almost universally pursue them. A very great amount of valuable fish-food is thus provided by the superabundance of these larval Clupeoids.

May.

An algoid structure of some interest appears in the Bay in April, during this month, and the next, viz., great numbers of small gelatinous bodies, ovoid, dumb-bell shaped, or somewhat cylindrical in outline (Plate III. figs. 1 to 4). Their long diameter varies from 1 to 2 mm., and thus they are much smaller than examples of the Radiolarians, *e.g.*, *Collozoum inerme.* When removed from the mid-water net they float somewhat heavily near the bottom of the glass vessels, though it is probable that their range in the open sea varies in depth according to circumstances. Moreover, in June, they specially abounded in the estuary of the Eden, and this distribution perhaps may give a clue to their origin. They presented a hyaline gelatinous matrix (Plate V. fig. 1*a*), in which were studded small greenish-yellow cells containing nuclei, and many of which, from their constricted aspect, appeared to be in a state of division. Occasionally somewhat large, round nucleated cells occurred amongst the others. In many, again, minute fusiform spicular bodies, or acicular bodies like spicules (Plate V. fig. 2), were sparsely scattered throughout the protoplasm, after the manner of certain Radiolarians, *e.g.*, the *Sphærozoum neapolitanum*, as figured by Brandt. After preservation in spirit, the latter (spicules) became finely granular, and were rendered invisible by mounting in calcium chloride.

The vast abundance of these algoid structures in the Bay could not but have an important influence on the fauna, and this was especially seen in regard to the Appendicularians, and perhaps in *Tomopteris* and other forms.

Rhizosolenia formed a conspicuous feature of the water during May, and it not only occurred in, but beyond the limits, penetrating, moreover, all the harbours and creeks connected with it—so as to give occasionally a greenish tint to the water—on the surface of which the dull greenish sparkling structures were visible to the naked eye. The vast abundance of this algoid form sometimes interfered with the working of the nets, the pores of which were plugged, thus retaining the water and masses of Appendicularians and their houses, so that the boat was anchored or the sail-ropes broken. The distribution of *Rhizosolenia* varied; thus on the 10th May, it was chiefly at the upper region, within two fathoms of the surface, while the lower parts were occupied by Appendicularians; while on other occasions it occurred towards the bottom or throughout the entire depth.

The fishermen at this time considered the water extremely muddy, probably from disturbance of the bottom by the easterly wind, and did not appear to connect the profusion of *Rhizosoleniæ* with the obscurity. They also imagined that under these circumstances the fishes did not see the bait, while others were of opinion that they had left the Bay. The latter, however, can hardly be correct, since many delicate young gadoids and other forms are plentiful. The abundance of this algoid causes the lines to feel sticky, and still more the nets, while its peculiar odour (which some of the men say resembles 'herring water') is diagnostic. Mr Pearcey, of the 'Challenger' Expedition, states that the herring-nets are injured by the abundance of this algoid substance, and that the herrings avoid the water where it is in great profusion.* Further observation is probably necessary before coming to the latter conclusion, but there can be no doubt about the disagreeable odour and tendency to injure the nets.

While the upper regions of the water in the Bay were teeming with *Rhizosoleniæ*, the lower were crowded with Appendicularians, and the stomachs of these were distended by chlorophyll-granules, the same appearing in the fœcal pellets both in the intestine and when discharged. No fragments of skeleton referable to Rhizosoleniæ were visible, and the greenish colour of the chlorophyll was somewhat brighter than in that form, but it may have been altered by digestion. The vast swarms of Appendicularians at any rate fed on such material, and were most abundant during its presence in the Bay.

Besides the foregoing, Diatoms of many species occurred in great abundance—along with spores of Algæ.

In May the pelagic Cœlenterates, especially the Hydromedusæ, became much more prominent than in the earlier months of the year. *Beroë* appeared in the surface-net on one occasion; while *Sarsia tubulosa*, half an inch in polar diameter (smaller at the commencement of the month), occurred in the mid-water net almost daily. *Sarsia* (*Codonium*) *pulchella*, with the greenish tinge at the oral extremity, was also procured. As *Syncoryne* (the fixed form) is not common in the Bay of St Andrews, these medusoids probably came from the estuary of the Forth and neighbourhood, yet they were often in great numbers, penetrating all the nooks of the Bay, and passing far up the estuary of the Eden.

Various species of *Thaumantias* also made their appearance this month, such as the large and beautiful *Thaumantias pilosella*,† *T. melanops*, *T. lucifera*, and *T. globosa*,‡ but they on the whole occurred sparingly on each occasion. It is no wonder that the medusoids of this type are so abundant in St Andrews Bay, since *Obelia*, *Clytia*, and the Campanularians in general are so common. They are occasionally thrown on the beach in multitudes. Forbes describes *Thaumantias pilosella* only from Shetland and the south of England, though it is abundant all along the eastern shores. The same may be said of *T. melanops*, with the exception that Forbes mentions its occurrence only in Shetland. *T. lucifera* seems to have been met with more generally on the British shores; while the occurrence of *T. globosa* is limited by the author mentioned to Shetland. It is likewise very common on the eastern shores. *Lizzia octopunctata* occurred sparingly, but it is more abundant in early spring and summer, and is generally distributed over the eastern waters of Scotland. The size of the two first-mentioned species of *Thaumantias* somewhat increased as the month advanced, the smaller examples being most abundant in April and at the beginning of May.

Besides the foregoing, a small form procured in the mid-water net of the 26th differed from anything known. It had numerous brick-red and comparatively large marginal ocelli.

Bougainvillia britannica § in small numbers appeared once. The

* *Proc. Roy. Phys. Soc. Edin.*, 1885, p. 400.
† *Laodice cruciata*, Agass.
‡ *Phialidium variabile*, Haeckel.
§ *Margelis ramosa*, Agass.

polyparies of this form are frequently found off St Andrews Bay and in the neighbourhood of the Forth.

The gonozoid of *Syncoryne eximia* or of *Stauridium productum* was another form which occasionally was captured this month in the mid-water net. In all probability it pertains to the former.

Lastly, *Lizzia octopunctata* occurred only once.

The true Medusæ were represented by a considerable number of young *Aureliæ* and *Cyaneæ*, ranging from about $\frac{1}{8}$ to $\frac{1}{2}$ an inch. The smallest had not long been freed from the strobila-stage, and retained the characters of the ephyra-stage. As the month advanced they increased in size, and the contrast was still greater when placed side by side with minute forms procured in March. Young *Aureliæ* and *Cyaneæ* are often beached on the west sands at the end of May.

The Ctenophores were abundant. At the beginning of the month many small *Pleurobrachiæ* appeared, their size varying from somewhat less than $\frac{1}{8}$ to $\frac{1}{2}$ an inch in their longest diameter.

Beroë occurred occasionally and of moderate size, and sometimes injured the post-larval fishes after capture in the mid-water net.

The most interesting Ctenophore of the season, however, was *Lesueuria vitrea* of Milne Edwards, which was first captured on the 19th of May, and thereafter almost daily in the mid-water net till September. Moreover, they occurred in great numbers, and for a considerable time were the most conspicuous feature in the pelagic fauna. Yet this form is quite new to British waters. It was discovered and described in 1841 by the late Prof. Milne Edwards, his specimens having been procured in the Bay of Nice. It is recognised by its great translucency, powerful locomotive flappers, and characteristic shape. It is further characterised by its extreme delicacy; indeed, it is the most fragile of a fragile group, and it is difficult to preserve—in any degree of perfection—even small examples. They varied in size from the period indicated onward; that is, both large and small forms were present throughout, the maximum of $3\frac{1}{2}$ inches or rather more, being reached in August. Mature ova appeared in some towards the end of June and in July. Certain examples in the latter month and in August showed a much larger development of the two principal lobes at the sides of the mouth. No Cœlenterate is more brilliantly phosphorescent or luminous, the light being intense and faintly bluish.

Since its discovery by Milne Edwards, Verany has again found it at Nice, and Sars and Spagnolini at Naples. That so conspicuous a form should have escaped notice in the other seas of Europe is peculiar, for it can hardly be supposed that for the first time it has passed into the German Ocean and the North Sea. It was easily distinguished from Beroë, at St Andrews by its more active motion, yet Alexander Agassiz considered it more sluggish than *Bolina.*

While *Lesueuria* is thus an interesting addition to the British fauna, it also concerns us more especially in the present inquiries in relation to the food of fishes directly or indirectly. The immense abundance of the species provides during June and July a vast quantity of minute ova ($\frac{1}{62}$ inch), which form food not only for early larval fishes, but for many of the lower groups, these again being directly the prey of post-larval fishes.

The pelagic Echinoderms of this month appear to be few in number, the most noteworthy being the ova of Holothurians, which float readily, and thus they generally occur in the surface-net. They issue from the adults in long strings, but these soon break up, so that the ova by-and-by float singly on the surface of the water. The young of the littoral starfishes, such as *Asterias* and *Cribrella*, do not come under the head of the pelagic forms, since they are reptant. The plutei of the sand- and brittle-stars, as well as those of the Echinoids and Spatangoids, had not yet appeared in the superincumbent water.

The pelagic annelids captured in the mid-water net were the sexual form of *Nereilepas*, the ovigerous *Autolytus prolifer*, and *Tomopteris* about $\frac{3}{4}$ inch long. Some of these occurred in the surface-net. Towards the end of the month larval Terebellids and Spionidæ were procured in the bottom-net.

In the surface-net Sagittæ appeared occasionally, but they were small ($\frac{1}{4}$ to $\frac{1}{2}$ inch). In the mid-water net they were more abundant, and the range in size greater, viz., from $\frac{1}{4}$ to 1 inch.

The surface-net showed many Copepods, though as a rule they were less numerous than in former years; for instance, in 1884. They included such forms as *Calanus finmarchicus*, *Halitemora longicornis*, and *Centropages hamatus*. *Halitemora finmarchicus*, so abundant in the open sea off St Abb's Head, was absent.

Moreover, the *Nauplii* of these and other crustaceans were numerous, though less abundant than in 1884, when *Evadne Nordmanni* (one of the *Cladocera*) also occurred at the surface. The greater abundance of *Nauplii* in the surface-fauna of St Andrews Bay was one of the contrasts between it and Aberdeen Bay in 1884. Towards the end of May many of the *Nauplii* of the Cirripedes had settled as *Cypris*-larvæ in the Eden and other parts on shells and submarine bodies.

Amongst sessile-eyed crustaceans captured in the mid-water net were the ubiquitous *Atylus Swammerdamii*, which occurs in hundreds clinging to sea-weeds off the west rocks; *Atylus bispinosus*, *Gammarus marina* (♀ with ova); *Amphithoë littorina* (♀ with ova); *Parathemisto oblivia*, small female bearing ova (28th May); *Proto pedata*, *Idotea tricuspidata* (surface-net occasionally); *Eurydice pulchra*, and *Diastylis Rathkii* (adult). Instead of the foregoing, *Ampeliscus* occurred in May in Aberdeen Bay. These sessile-eyed forms are for the most part to be considered as accidental members of the pelagic fauna, though they must take some share in the nourishment of the larger forms of both young and old food-fishes.

Many zoeæ of *C. mœnas*, *Hyas*, and other forms, and a minute *Crangon* appeared in the mid-water nets, while towards the end of the month some in the Megalops-stage were also present.

Swept down by the stream into the harbour and thence carried into the mid-water net in the Bay, were several exuviæ of larval insects, just as in former years insects themselves occasionally made their appearance from this stream, the Eden, and others.

Moreover, in the harbour itself many of the young flounders caught in the tow-nets at the mouth of the mill-lade, show young examples of *Anceus Edwardii* parasitic at the margin of the muscle-plates, and the tenacity with which they adhere, or fix themselves afresh when dislodged, is remarkable. A deep pit is left on removal, and after boring into the surface of the little flounder it thrusts out a tongue-like process apparently for suction.

The Appendicularians occurred generally throughout the month, both in the surface- and in the mid-water nets. They especially affected the lower parts of the water in great swarms. The larger forms indeed were captured by the mid-water net, the smaller by the surface-net. The longest were about $\frac{3}{8}$ of an inch in length on the 10th May. It sometimes happened that while Rhizosoleniæ occupied the surface and upper regions of the water, the Appendicularians held the lower regions.

The most conspicuous eggs in the Bay during May, in the mid-water net, were those of the gurnard, which especially abounded towards the end of the month, though they were also numerous at other times. The eggs of the sole were also not uncommon.

The ova of the dab are also frequently found in the beginning of May, as well as throughout the previous month, and Captain Burn forwarded many ripe ova of the lemon dab from the Moray Frith at the former period.

Other ova, measuring ·051, ·067, and ·07, were also procured. In the bottom-net especially the ova of the sprat were very common.

A few of Motella (·039) likewise occasionally occurred, and a larva from an egg on the 16th May was reared to Brook's fig. 9, pl. ix.* on 27th May.

The post-larval food-fishes become a marked feature of the pelagic fauna in May, and hitherto they have to a great extent been procured in the mid-water net. Almost daily the young gadoids made their appearance—ranging in size from $\frac{1}{4}$ to $\frac{7}{8}$ of an inch, the smallest with the embryonic fin-rays for the most part, though the permanent were indicated (Plate IV. figs. 5, 6). On looking over an orderly series of these, eight in number ranging from a little over $\frac{1}{4}$ inch to $\frac{3}{4}$ inch, each seems to run into the other, and to show the features of a single form. Some, from their deeper greenish hue on the 11th and 16th, were supposed to resemble *Gadus virens* (the green cod or saithe), but there was nothing reliable in the diagnosis. Many of the larger and even some of the smaller forms had parasitic young *Caligi* (*Chalimi*). The foregoing gadoids gradually merged into unmistakable young cod, $\frac{7}{16}$ and $1\frac{5}{16}$ inch long (31st May), in which all the characters of the species could be recognised. At the beginning of May the average size of any given series in the mid-water net was smaller than towards the end of the month. On the whole, the sizes of the gadoids observed during the month would countenance the view that they were produced from ova of the season. Considerable latitude is evidently necessary in regard to the spawning-period, some being earlier than others, and in each individual the process, as elsewhere explained, is one of some duration.

Pleuronectids were represented in the mid-water net by the young flounders and plaice, ranging from $\frac{3}{8}$ to $\frac{5}{8}$ of an inch. These were of a considerably advanced stage. The most elongated ($\frac{7}{16}$ long and $\frac{1}{8}$ broad) of these appeared to be plaice, though at present uncertainty exists on this point. The shorter and firmer forms probably pertain to the common flounder and dab, though the young of the long rough dab appear to be somewhat similar.

Young Clupeoids, $\frac{3}{8}$ inch to $\frac{1}{4}$ inch, appeared several times, but in former years they were much more common. They may have kept the lower parts of the water, and thus avoided capture, since they were probably plentiful somewhere within the limits, unless we are to suppose that the swarms of larvæ, so characteristic of the previous month, had altogether vanished from the Bay.

Post-larval sand-eels about $\frac{3}{4}$ of an inch were not uncommon.

During May, besides the food-fishes, the Bay abounds with larval and post-larval examples of *Cotti*, *Cyclopteri*, *Agoni*, Montagu's sucker, and other forms, though, with the exception of the two last, these do not frequently occur in the mid-water or other net. In all probability, the *Cotti* and *Cyclopteri* (as observation shows), are only occasionally pelagic in the sense of leaving the neighbourhood of the rocks, borne on floating sea-weeds or otherwise. There is nothing in the life-history of either, however, at variance with a pelagic stage in their early youth. The voracity of the young *Cyclopteri* makes them undesirable associates of the delicate young food-fishes, and the same may be said of the *Cotti*.

* *Journ. Linn. Soc. Zool.*, xviii.

In the latter, the pectoral fins attain great size before the ventrals are functional; and the broad band of pigment slanting over the abdomen is characteristic. The notochord is still straight at $\frac{1}{4}$ inch. The marked coloration of the young *Agoni*, even in spirit, and the shape of the head and body, are sufficiently diagnostic.

June.

The ground-fauna of the Bay in the beginning of June differed in many respects from the pelagic, though the close relationship existing between the two makes the record interesting. Thus, on the 7th June, the naturalist's trawl (small mesh), captured the following forms on the same ground (Steeple-line), as that over which the mid-water and other nets have so often been used :—

10 examples of *Agonus cataphractus* of various sizes.
23 examples of *Gobius minutus* of various sizes.
Numerous small dabs and plaice.
3 Clupeoids.
5 young gurnards, $3\frac{1}{2}$ to 5 inches.

Of post-larval fishes—

2 gadoids, 27 and 33 mm.
11 flounders, 4·5 to 9 mm.
3 examples of *Agonus cataphractus.*
Autolytus prolifer and *Eulalia viridis* amongst the annelids.

The Crustacea included—

1 *Corystes cassivelaunus.*
1 *Portunus holsatus.*
1 *Crangon vulgaris.*
Many examples of *Mysis flexuosa.*
7 *Idotea linearis.*
1 *Atylus Swammerdamii.*
A few examples of *Allorchestes Nilssonii.*
A few examples of *Cuma trispinosa.*
Diastylis Rathkii.
Four sand-stars and a hydroid zoophyte completed the list.

Next day the same trawl was used about a mile N.E. of Kinkell Ness with the following result :—

7 grey gurnards, small.
Many examples of *Gobius minutus.*
1 whiting, unsaleable.
7 examples of *Agonus cataphractus.*
6 saleable plaice ; 3 unsaleable (small).
3 saleable dabs ; 13 unsaleable (small).
1 Clupeoid, 48·5 mm.

Post-larval fishes—

5 flounders, 6, 7, 7·3, 11, and 13 mm.
1 *Agonus cataphractus*, 11 mm.

Other Forms.

Several Polyzoa.
2 *Autolyti.*
Numerous examples of *Portunus holsatus.*
1 *Corystes cassivelaunus.*
1 *Crangon vulgaris.*
Very many examples of *Mysis flexuosa* (young).
Very many examples of *Diastylis Rathkii.*
A few examples of *Nicea Lubbockiana.*
A few examples of *Atylus Swammerdamii.*
A few sand-stars.
1 *Amphidotus.*
2 examples of *Pleurobrachia.*
Various hydroid zoophytes.

At the beginning of June *Rhizosoleniæ* were very abundant, but they gradually diminished as the month progressed. A few were generally present in the various nets, but their numbers were insignificant in contrast with the previous month.

The peculiar gelatinous algoid was procured on various occasions, in considerable abundance, and extended some miles up the Eden.

Diatoms were abundant, some of them growing on the valves of the *Cypris*-stage of Cirripedes. Various spores of Algæ also were plentiful.

Amongst the Infusoria were *Tintinnus denticulatus* and *Ceratium fusus*, *C. divergens*, *C. tripos*, and *Peridinium.* All were found in the bottom tow-nets.

A feature of considerable interest this year was the comparative scarcity of Cœlenterates in the surface-net in June. No entry indeed is recorded, and this agreed with the observations made from the shore as well as at sea. It is rare that so few Medusæ and Hydromedusæ are seen, a fact perhaps in connection with the low temperature so characteristic of the month. Only on one occasion were a few examples of *Cyanea*, 6 to 7 in. in diameter, thrown on the west sands by the tide. In former years not only did they abound in the Bay (and towards the surface) in June, but far out at sea they were captured by the surface-net in great profusion. It would appear, therefore, that warm, sunny weather is connected with the presence of these and other marine forms at the surface. Our waters differed from the southern, as at Sheerness-on-Sea, during this month, chiefly in the absence of *Noctiluca*, which were plentiful in the latter near the surface.

While the surface-waters were thus comparatively barren of Cœlenterates, the mid-water net, on the other hand, demonstrated their great abundance in the deeper regions. In no group was this more marked than in the Hydromedusæ, which were seldom absent from any haul.

Thus *Thaumantias pilosella* occurred in swarms almost every day, and considerably larger as a rule than during the previous month, though not quite mature. The same may be said of *Thaumantias melanops*, except that one (about $\frac{5}{16}$ inch) had fully developed ova on the 13th June. A few examples of a form referable to *T. pileata* were obtained at the beginning of the month. *T. hemisphærica* of Gronovius, so long known to marine zoologists, was perhaps the most conspicuous of the group both in regard to size and numbers; and it is often stranded on the west sands in great profusion, and nearly an inch in diameter. Moreover, it had an additional interest, since it is very frequently selected by the larval *Peachiæ* for attachment by the widely open mouth and tentacles. The young anemomes (Plate V. fig. 5) are thus carried about by the Medusæ without effort on their own part, so that they have almost all the advantages which the *Arachnactis*-stage gives the larval *Edwardsia.* Though the latter genus is well represented in St Andrews Bay or near it, only a single example of the *Arachnactis-stage* was procured. This consisted of a minute pelagic form about $\frac{1}{8}$ in. long from the mid-water net of the 11th June—amongst Hydromedusæ and other Cœlenterates, and as this larval type is rare, a few remarks may be made on it. In lateral view it somewhat resembles a cushion-star, and is more or less translucent, a faint tinge of yellowish existing at the tips of the tentacles. Of the latter there are four conspicuously larger than the rest, three a little shorter, and two tentacle-buds opposite the median one. The oral region shows two prominent papillæ; and the mesenteries, though apparently not quite complete, are well marked.

Food-fishes of various kinds are extremely fond of anemones, and rare forms have frequently been procured from the stomachs of cod. Moreover, the Pleuronectids are especially fond of *Edwardsiæ,* in some cases nothing else having been found in their stomachs. The pelagic young anemones, thus borne by the jelly-fishes just mentioned, are placed within easy reach of the active young gadoids and Pleuronectids, both of which probably diminish the numbers at this stage as well as a subsequent one, when they are settling on the sand.

Thaumantias hemisphærica reached full maturity this month. It appears to be common almost everywhere round the British shores. *T. inconspicua,* Forbes, formerly procured in the Hebrides, occurred in considerable numbers several times about the middle of the month. All examined, however, were immature, and none exceeded $\frac{1}{4}$ of an inch. *T. lucifera,* Forbes, again, a somewhat minute species (under $\frac{1}{4}$ inch), appeared in great numbers at the beginning and end of the month. It seems to be generally distributed round the coast. Once or twice a form referable to *Phialidium variabile* (= *T. globosa,* Forbes), was present with the others in the mid-water net. None were quite mature. They ranged from $\frac{1}{4}$ inch downward. The variability of a species with regard to maturity was well observed in *T. maculata,* Forbes, procured by its discoverer only sparingly in the Zetlandic seas, which was very numerous, and very ripe on the 23d, while those obtained on the 25th were not so far advanced in this respect. Numerous specimens of the small *T. octona,* Forbes, occurred about the middle of the month. This form, according to Forbes, is a western one, having been procured both at Oban and Tarbet, Loch Fyne. The specimens were immature. Many examples allied to the pinkish *T. gibbosa,* Forbes, were captured on the 13th and 18th. It was first procured in the Hebrides. A large immature form, which was found at the beginning and end of the month, seemed to differ from any of the foregoing.

Bougainvillia britannica appeared in the mid-water net almost daily throughout the month. They varied in size, but none were quite ripe. The same may be said of *Sarsia tubulosa,* many being small, and all immature. One or two specimens of *Lizzia octopunctata* were observed during the first half of the month. It is not an abundant form in the Bay, and generally small ($\frac{1}{12}$ to $\frac{1}{8}$ inch). Once only *Oceania episcopalis,* about $\frac{1}{4}$ of an inch in diameter, was captured in the mid-water net on the 18th June.

Several others not yet satisfactorily identified, and a fragmentary example of *Stauridium,* complete the series.

The importance of the foregoing forms in regard to the present inquiry rests mainly on the vast number of ova which they produce, and also the resulting free-swimming Planulæ, both of which largely increase the food-materials for larval and early post-larval fishes, as well as the inveterbrates on which they and the somewhat older stages feed.

It is possible that certain of the forms mentioned above may pertain to the same hydroid stock (representing perhaps younger and older stages, or mere variations); but as our knowledge of the group, though largely added to by the labours of Prof. Haeckel, is still in need of improvement, it has been thought better to follow the descriptions of Forbes. It is also noteworthy that the gonozoids of *Corymorpha*, which abounds off the Budda Rock, have not yet been obtained.

The true Medusæ were represented by a single example of a young *Cyanea*, $\frac{5}{8}$ inch across the disk. It is remarkable that so few forms of this group were secured. During ordinary seasons large examples are abundant in June.

The Ctenophores were numerous. The ubiquitous *Pleurobrachiæ* continued throughout the month, and both large and small examples were obtained. On the whole, the number of the large forms showed an increase on the previous month, but this of course may have been as much due to an immigration from the offing as to growth. The larger forms were mature. One or two examples of *Beroë*, of moderate dimensions, appeared only once, so that this species was comparatively scarce. The most noteworthy example of the group was *Lesueuria vitrea*, M. Edwards, which occurred in numbers almost every day; and as the month progressed a slight increase in size was apparent. Both young and adult forms were common, the former ranging from $\frac{7}{16}$ inch or less upwards. All the Ctenophores were captured in the mid-water net, showing that they had frequented the deeper regions of the water.

The Plutei of brittle and other stars and of *Echinus* were procured in the bottom tow-net, and in the mid-water net on the 23d, but they probably occurred even earlier.

The surface-net captured a few specimens of *Evadne Nordmanni* (Cladocera), a few Copepods, such as *Halitemora longicornis*, *Centropages hamatus*, and *Acartia longiremis*, along with a young *Gammarus*. Moreover, the Megalops-stage of *Hyas* also appeared towards the end of the month, and a considerable number of zoeæ, probably of *Carcinus* and *Hyas*, while a very young hermit crab ($\frac{3}{16}$ inch long) occurred in the same net. So firmly had it grasped a pelagic young *Hyas* that separation could not be affected without the loss of both great claws.

In the mid-water net were many *Caligi*, both ♂ and ♀, some bearing the parasitic *Udonella caligorum*, and with reproductive organs fully devoloped. The *Cypris*-stage of Cirripides also occurred.

Amongst the higher crustaceans a few examples of the Megalops-stage of *Carcinus*, and many long-spined zoeæ (*Porcellana*) were procured. Young examples of *Pandalus annulicornis*, *Hippolyte securifrons* $\frac{1}{4}$ inch each, and *Montagua alderi* were also noted. The exuviæ of Cirripedes were also not uncommon.

Zoeæ and the Megalops-stages are often more abundant at the surface in June along the eastern shores than they were this year.

In the bottom tow-net, again, Copepods were far more numerous than in either surface or mid-water nets, though the species did not vary, stragglers from the dense ranks near the bottom having probably sought the upper parts of the water. The species were *Halitemora longicornis*, *Acartia longiremis*, and *Centropages hamatus*, as well as *Caligi* on one occasion. Swarms of *Evadne Nordmanni* frequented this part of the water. The enormous numbers of this species must have an important influence upon fish-food. The reproductive powers are remarkable. Many examples of the *Cypris*-stage of Cirripedes are also present.

Numerous *Nauplii* likewise occurred, and examples of the *Megalops*-stage of the higher crustaceans, as well as a young stage of *Hippolyte securifrons* $\frac{3}{16}$ inch long.

In the mid-water net the only annelid observed was *Tomopteris onisciformis*, which once appeared in considerable numbers, and fully an inch in length. Numerous ova occurred in the perivisceral diverticula of the feet.

[At this time the ground trawl gave *Eulalia viridis* and *Autolytus prolifer* in a budding condition.]

Sagittæ were occasionally obtained in the mid-water net, but they were comparatively few and small, only the larger forms reaching to 15 mm. or $\frac{5}{8}$ of an inch. This, therefore, was in marked contrast with the condition during the winter months, when the Bay teemed with large and active Sagittæ.

The larval annelids included *Nerine*, *Leucodore*, and the young of *Spio* in great numbers. The abundance of the larval annelids in the pelagic condition makes a notable addition to the food of the post-larval fishes. Many of these pelagic annelids are readily visible to the naked eye.

The vast numbers of Appendicularians characteristic of the preceding month gradually disappeared, and only a few small examples (Plate IV. fig. 9) now and then were secured in the mid-water and bottom-nets. The sudden appearance and almost as sudden disappearance of these forms is an interesting problem, and from the regularity of their advent in spring other causes than the effects of currents are probably involved.

Cyphonautes was rather plentiful this month, especially towards its close, and always in the bottom tow-net.

Pelagic young mussels appeared in the bottom tow-nets about the latter third of the month, and perhaps even sooner, but in comparatively small numbers, and they were first procured in the bottom-net off the Eden whence they probably radiated throughout the Bay. Their size varied from ·0055 to ·014 inch. Nearer the end of the month the measurements of three average forms were as follows:—$\frac{1}{130}$, $\frac{1}{120}$, and $\frac{1}{83}$ of an inch. The young mussels in the Bay kept to the lower regions of the water.

Spirialis, both in the adult and young condition, abounded in the bottom-nets, the larval forms being very numerous. Other minute univalves were abundant.

The very young flounders (9 to 12 mm.) procured in the mid-water net on the 1st, had the embryonic tail and the projecting abdomen, showing that they were in the early post-larval stage. The eyes were lateral, the left just a little in advance of the right. The length of the least was about 7·5 mm. A very early post-larval form only 6·2 mm., with two others (9 and 10 mm.) was got on the 13th. In the latter a median line of black pigment occurs on the ventral surface, from the branchiostegal region backward, and it remains in spirit. The frequency of this black ventral pigment in early post-larval forms is noteworthy.

The young gadoids still remained conspicuous features of the pelagic fauna during June, and they ranged from 7 mm. with an entire marginal fin to 24 mm. They fed on *Nauplii* and Copepods. Some of the smaller of these were of a shorter and stouter formation, with a shorter snout and heavier head, and the permanent rays of the fins seemed to be far advanced for their size. Their jaws appeared to be less lanky than those of the cod, but whether they are mere varieties, or represent the haddock, is unknown. Young cod ($1\frac{1}{16}$ inch), with more or less tessellated pigment on the sides, occurred in the mid-water net on the 15th; while, as mentioned subsequently, somewhat older forms were captured in the ground-trawl.

In the surface-net of 11th June a most minute ovum, ·027 of an inch, with a single oil-globule ·005 of an inch, occurred. It is less than that of the rockling. In the bottom-net of the 26th, again, an ovum, with a somewhat advanced embryo of *Motella*, appeared.

The ova of the gurnard were common at various stages—some multicelled, and others with pigment in the embryo. The eggs of the sole were also not infrequent in June.

In former years the poor cod (*Gadus minutus*) had been found quite ripe during this month, and thus is much later than the bib. Specimens 7 inches long are often mature.

The ripe pelagic ova of the Skulpin have also been obtained. From the appearance of the ovaries of *Labrax lupus* (sea-perch), this species would also seem to reach maturity in June.

The young Pleuronectids procured in the ground-trawl formed a contrast to the pelagic forms—the smallest being 6·5, and the largest 15 mm.* The first mentioned was probably a flounder, with the left eye appearing over the ridge. The others had the eyes further round, in various degrees. Nothing in the appearance of any of these gave a clue to specific separation. The smallest was considerably less than the pelagic form, for instance, got on 1st June, and which measured about 11 mm. The latter perhaps thus pertained to the plaice, the former to the common flounder.

[In the ground-trawl at this time young cod 27 mm. and 33 mm. were obtained, and Clupeoids 1⅞ inch. The former had thus reached the bottom.]

In the mid-water net the newly-hatched larva of *Cyclopterus lumpus* (5 mm.) occasionally occurred; and also about the middle of the month two others, respectively 6 and 9 mm. The breeding season of the species thus extends over a considerable area. A young *Cottus scorpius*, ⅜ inch long, likewise was captured in the same net in the middle of the month. The notochord was slightly bent up posteriorly.

Young gobies marked with ochreous pigment and ranging from 3 to 8 mm. were common in the bottom-net.

July.

During this month also the various nets were used in the estuary of the Eden in connection with the food of the mussels and other points. The increase of Diatoms, Rhizosoleniæ, spores of Algæ, and vegetable débris of various kinds was marked. Moreover, the peculiar gelatinous algoid occurred in profusion. It would seem indeed that this estuary supplied the Bay with much of its microscopic plant-life. Compared with 1884, the latter in the Bay was less abundant towards the surface. Rhizosoleniæ and other Algæ abounded off St Abb's Head in July 1884; and similar observations in the 'Garland,' south-east of the Isle of May and near St Abb's in subsequent years, showed a like condition. Pointed needles allied to those of Rhizosoleniæ were common in certain deep-sea deposits, so that the distribution of this group is very general.

The Infusoria were in vast profusion at the surface during warm days in July, so as to form a thick coating to the tow-nets. Amongst the most abundant forms were *Ceratium tripos*, *C. furca*, *C. divergens*, *C. fusus*, *Tintinnus denticulatus*, and *Amphidinium operculatum*. The species of Peridinium, again, were most plentiful in the bottom tow-nets this season, though also appearing in the surface-nets. Masses are said to occur in the intestines of sardines.

Many of the same forms were found in open sea off St Abb's Head at the end of the month. Moreover, *Ceratium longicorne* occurred as a

* These and many other young Pleuronectids, however, await the skilled investigations of Dr Traquair, who intends to study them this summer at St Andrews.

long chain, apparently from budding, after the manner of the species described by Dr Murray in the 'Challenger' Report.

The Cœlenterates continued in great profusion throughout the entire month, at first solely occurring in the mid-water, and then subsequently in the bottom-nets and at the surface. Moreover, they presented a considerable increase in size, though small forms generally appeared with the larger. The most conspicuous Hydromedusæ perhaps were *Thaumantias melanops*, *T. hemisphærica*, and an undetermined form of *Thaumantias* (Plate V. figs. 6–9). *T. melanops* was frequently $\frac{3}{4}$ of an inch in diameter, and mature. While occurring almost daily in the mid-water net, it also towards the end of the month was found in the bottom-nets, though the specimens in these were small and immature. As in June, *T. hemisphærica* was in great profusion in the mid-water net, and occasionally appeared in the bottom-net; and since the latter feature did not occur previously, it may be presumed that it was not entirely due to the capture of the medusoids on the way up. Larval anemones (*Peachia*), now considerably larger, still abounded on this species and on the foregoing (*T. melanops*), and they occupied diverse positions—now on the outer surface or margin of the disk (Plate V. fig. 5), now on the reproductive organs, and again on the inner surface of the disk, or perched on the manubrium. *T. hemisphærica* was likewise often in the fully ripe condition, and some of the larger reached about $\frac{3}{4}$ of an inch. An undetermined form (Plate V. figs. 6–9), possibly associated with *T. pilosella*, often appeared in as great numbers, sometimes with the male organ fully developed, but none were observed with ripe ovaries. They occasionally reached $1\frac{3}{8}$ inch in diameter, and thus were notable from their size. *T. maculata* at the commencement of the month was procured almost ripe, and fully $\frac{1}{2}$ an inch in diameter, and a week or two later others of the same size fully ripe were captured. The variability in regard to maturity was therefore as marked as in June—a condition probably due to the growth or immigration of a new series. Other representatives of this group were numerous minute medusa-buds, some probably pertaining to *Obelia*, and which along with gonozoids of *Stauridium*, and apparently *Podocoryne carnea*, were generally procured in the bottom-nets. They had perhaps only recently gained freedom, and along with the various planulæ frequented the lower regions of the water. Medusa-buds are very common during July, not only in St Andrews Bay, but everywhere round the coast. In certain parts the water is rendered luminous by the minute medusa-buds of *Obelia* alone. These frequently occur near the surface as well as throughout the water. *Sarsia tubulosa*, as in the previous month, was small and immature at the commencement of July, but attained a larger size as the month advanced—comparatively few, however, were obtained at any given time. Moreover, while *Bougainvillia britannica* was very abundant in June, appearing almost daily in the tow-nets, it occurred very sparingly this month, a single large immature specimen being captured on the 12th.

Aurelia aurita amongst the true Medusæ was comparatively rare, a condition so unusual in ordinary seasons. A young example, $\frac{1}{2}$ an inch across, was found in the mid-water net about the beginning of the month, and a few larger in the same net on the 19th.

In every haul of the mid-water and bottom-nets in July *Pleurobrachia* occurred, both large and small examples at the beginning of the month being present in the mid-water net, while in the bottom net the smaller forms, larvæ and eggs, were most abundant. At the same period large forms ($\frac{3}{4}$ inch in long diameter) seemed to have shed their ova. Towards the middle of the month, larval forms and ova were frequent in the mid-water net, and by-and-by in the surface-net, their diameter varying from 1 to 1–5 m.m. and upwards.

Lesueuria was not quite so frequent as in June, but occasionally in great numbers, both large and small examples being present. Fragments of the ctenophoral rows abounded in the vessels, and their peculiar broad nail-shape made them conspicuous structures in the spirit-preparations. Many had ova measuring ·016 to ·0083 inch. The long diameter of the large examples was a little over 2 inches. All was procured in the mid-water net.

Beroë occurred in much greater numbers than the previous month, both large and small forms being common. They were captured only in the mid-water net till the last day of the month, when they appeared in the surface-net, showing that they likewise followed an upward course as the season advanced. *Beroë* was common in 1885. The luminosity of this form is disliked by the fishermen on the herring-ground, as they fancy it discloses the net to the herring. There can be little doubt that when they are stuck on the nets the luminosity will be elicited, and the herrings may turn aside. The luminosity of *Thaumantias* may also be an inconvenience in this respect. Nothing elicits the luminosity better than rubbing, and stranding them on a net while the current presses them against it is a close approach to this stimulus. The species usually reaches the surface this month all round the eastern shores, both of Scotland and England, and is often in immense abundance. The great wealth of food for various marine animals, and ultimately for fishes, which the ova of this species alone are capable of producing, is remarkable. Moreover, the parasitic *Hyperia* is another element to be considered in fish-food, as several occasionally cling to each Beroë.

A peculiar minute siphonophore-like young Medusa was obtained towards the end of the month (21st) in the surface-net, but its relationships are not yet determined.

Ophiothrix fragilis now in many cases had bulbous masses between the bases of the feet, the distension being caused by brownish-red ova. This species, therefore, was one which sent many of the larvæ upwards. From the first day of the month to the last, many *Plutei* in various stages of development thronged the water. They chiefly occurred in the bottom- and surface-nets, though there is no reason why they should have been altogether absent from the mid-water net, if the mesh had been fine enough. While in the earlier part of the month the *Plutei* were not abundant in the bottom tow-nets, they swarmed in the surface-nets towards the end of the month, and were somewhat larger. At the latter period also many of those in the bottom-nets showed the young star-fishes (post-larval) in the *Plutei.* Moreover, a considerable number of free young star-fishes (Ophiurids) were captured in the same nets. Besides the various forms of *Plutei* (Ophiuroid and Echinoid) there were many examples of the Bipinnaria-stage and a few Auricularians.

It cannot be doubted that in those larval Echinoderms a vast amount of nutritious food is at the service of the pelagic fishes of all kinds, especially in their younger stages.

A considerable increase in the number of the pelagic larval Annelids occurred this month. In every instance they were present in greater or less numbers in the bottom-nets, while as the month progressed they likewise became frequent in the surface-nets. The most abundant forms were the *Spio*, *Polydora*, and *Nerine* larvæ, both in the pear-shaped condition with the great groups of lateral bristles and in the somewhat older and more elongated form. The tubicular type in the transparent tube was also common, and this appears to be a Terebellid, probably the larval form of *Nicolea*, though certainty on this point has not yet been reached. Minute post-larval forms of *Polynoë* were frequent in the bottom-nets, and these pertained to several species.

It is rare to find minute young Polynoidæ between tide-marks where the adults are common, and their abundance in the bottom-nets at a distance from shore explains the reason. They are truly pelagic in their earlier phases.

Besides the foregoing, minute post-larval forms connected with *Aricia*, *Pholoë*, *Capitella*, and others were also procured. The wealth of annelidan life was noteworthy.

Sagittæ were less conspicuous this month, but they occasionally occurred in the mid-water net. Yet they were not far removed, as in 1887 they were almost in masses in the mid-water net, on board the 'Garland,' on the wolf-fish grounds (the Crail 'Hairst' of the fishermen) to the east of Crail. The masses consisted chiefly of Sagittæ, with medusoids, *Hyperia medusarum*, and Copepods.

As in the previous month, crustacean life swarmed in the Bay from the surface to the bottom. A decided difference, however, was apparent—during fully the first half of the month—between the bottom and the surface-nets, since the former were far richer in small crustaceans and annelids, while the latter showed them only sparingly.

In the surface-net *Nauplii* were found more or less throughout the period, though they were more numerous towards the end of the month. Amongst the Copepods were a few examples of *Centropages hamatus*, *Acartia longiremis*, *Halitemora longicornis*, *Oithona spinifrons*, and *Harpacticus chelifer*. Once only *Acartia* appeared in large numbers. *Evadne Nordmanni* was much more plentiful than in June, and in full reproductive activity. The Ostracoda were few, but the Cypris-stages of Cirripedes were more numerous. Other forms were zoeæ, young Hyperiæ, and exuviæ of Cirripedes.

In the mid-water net, about the beginning of the latter third of the month, large specimens of *Calanus finmarchicus* were procured outside the Bay (near the mouth of the Forth), and also within it, showing that most of the examples previously obtained in the Bay this year had been immature. *Caligus rapax* was also common, many with the parasitic *Udonella caligorum*. The zoeæ were not numerous at this period in the mid-water net, either within or without the Bay. Other forms were *Ampelisca Gaimardi* (a female with ova), *Hyperia medusarum*, some with ova, and many free larvæ, *Parathemisto abyssorum* and exuviæ of Cirripedes. Larvæ of the Norway lobster were also common.

In the bottom-net *Nauplii* were extremely abundant throughout the entire month, and the following Copepods were frequent, viz., *Acartia longiremis*, *Halitemora longicornis*, *Longipedia coronata*, *Oithona spinifrons*, and *Centropages hamatus*, some in great numbers. Many Ostracoda were also present, and swarms of *Evadne Nordmanni*, with its brood-pouches in full activity. Besides these, a few zoeæ, *Hippolyte* $\frac{1}{16}$ inch long, and occasionally specimens of *Diastylis Rathkii*, were likewise captured.

If the crustacean life was thus abundant in the Bay in July, it certainly was no less plentiful in the proximity, as shown by the various nets during the trawling expeditions in 1884 and on board the 'Garland'* especially in 1887, where the mid-water net had its bag rendered semi-solid by means of *Boreophausia Raschii* over the rough ground to the east of Crail. The pinkish oil in these and similar crustaceans would

* Courteously placed at my disposal by the Board.

certainly be sufficient to colour the muscles of marine fishes which feed on them, if coloured they could be by such food.

Throughout the month Appendicularıæ were seldom absent from the mid-water and bottom-nets, but they did not appear in the surface-nets till after the middle. As a rule they were small, and few in number, the only exception being the last day of the month, when many (also small) occurred in the bottom-net. July is therefore not a period when the Appendicularians are in full development. On the other hand, the larvæ of the sedentary Ascidians are very abundant in July.

In almost every bottom-net *Cyphonautes* (like *compressus*) occurred—more sparingly in the earlier part, more plentifully towards the end of the month. Some appeared to be larger than formerly, the diameter from apex to base being ·024 inch, and the base being ·029 inch across.

None were captured in the mid-water net, but this probably was due to the mesh of the cheese-cloth permitting them to escape. In the surface-net, again, they only appeared on the last day of the month.

The *Cyphonautes* here referred to has been described by Prof. Allman, who obtained it in considerable abundance in the Moray Firth in 1872. Johannes Müller connected it with *Mitraria*, Semper thought it a larval-mollusk, while Schneider has the credit of tracing its development into *Membranipora*. Very little change ensues in this type as it comes before the marine zoologist in the tow-nets throughout the summer and autumn and even as late as December. The transformation, therefore, probably ensues to a great extent on the ground.

A noteworthy feature was the appearance of *Actinotrocha* on the 5th July in the bottom tow-net, and subsequently many were obtained at different stages (Plate VI. figs. 1–6).

Some were kept in the laboratory until the transformation into *Phoronis* took place, and no marine form is more remarkable both for beauty and life-history. The hooded larval form with an aperture at either end (Plate VI. fig. 1) only shows a series of finely-coloured tentacles, then an inpushing appears at one side (fig. 3), developing into a long coiled tube. The animal still swims gaily about, developing rudiments of new tentacles at the bases of the old (fig. 2). Then it becomes sober, sinks to the bottom, and all at once the long internal tube begins to unroll like the turning of a finger of a glove inside out (fig. 4); the once short body now becomes elongated, and the mouth and vent, instead of being at opposite poles, are now brought near each other, while the stomach and alimentary canal slip into the long tube (figs. 7 and 8). The hood and the central nervous system in it are swallowed by the animal, and hence the puzzling nature of that part of the nervous system which remains.

Phoronis has not hitherto been observed in the Bay, though it is a well known inhabitant of the Firth of Forth—since the observations of Dr Strethill Wright, and the capture of *Actinotrocha* by Dr Cobbold. It is quite possible, however, that it may also frequent certain parts of the Bay. *Phoronis* is a common borer in limestone, and it may also affect other calcareous structures, such as shells, and likewise ordinary rocks.

Young mussels and *Spirialis* have now reached the surface, and often occur in large numbers—along with Copepods, *Evadne*, *Plutei*, *Nauplii*, larval Hyperiæ, *Cyphonautes*, and minute ova of various kinds. In these collections also fragments of the ctenophoral rows of *Pleurobrachia* and *Lesueuria*, shaped like a flattened nail (*i.e.* 'with a head'), are very abundant. Comparing this year, however, with some previous ones, as, for instance, 1884, the number of pelagic mollusks was not so great, especially in the upper parts of the water.

In the surface-net the pelagic bivalves, chiefly mussels, were comparatively few at the commencement of the month, but towards the end they were more abundant. The measurements of the young mussels ranged from ·0125 to ·015 of an inch. A few specimens of the larval stages of *Spirialis* also occurred as a rule, and larval univalves, probably including *Natica.* During this month also the pelagic mussels are met with far out at sea.

The mid-water net captured very few mollusks this month; the specimens, apparently young mussels, which were procured on the 20th and 23rd, ranging from ·009 to ·0155 inch. As none were observed last month in this net, they must either have passed through the meshes or were now only rising from the bottom.

The bottom-nets, on the other hand, in almost every instance showed the young mussels in multitudes; indeed, this could hardly have been otherwise in view of the wonderful profusion of animal life they brought to the surface. During the latter half of the month they occurred in myriads. In size they varied from ·011 to ·023, and on the 31st some appeared to be elongating a little. In company with these were young examples of *Spirialis,* which—somewhat few in number in each net in the earlier part of July—became much more abundant towards the end of the month. Some of these were in the earlier stage, others more advanced, but most were young examples. Other larval bivalves of unknown relationships (but probably of well-known forms) were also present, and several univalves, some of which most resembled the young of *Natica.*

In July the ova of *Modiolaria marmorata* and *Astarte sulcata* are fairly developed, and some probably spawn at this period.

The pelagic ova of July were comparatively few in species, consisting towards the beginning of the month of a few eggs of the gurnard. One of the most interesting ova of the whole series, however, also occurred at this time, viz., that of the sole, a few of which were captured about the same period in the mid-water net. They measured ·045 of an inch. The capsule is thick and tough, as well as minutely punctured. The oil-globules are of a yellowish white appearance by reflected light, and form a more or less complete ring of groups of minute globules. Moreover, the border of the yolk is vesicular. During development the groups of oil-globules change their position, and lie along the ventral surface of the embryo. The observations of Raffaele on the Neapolitan pelagic eggs demonstrate the connection of this ovum with the sole. During the Trawling Expeditions in 1884, the ripe eggs of the sole had been removed from the female fish on the 1st August, but no note was made of their difference from the ova of the other Pleuronectids. Mr Cunningham observes that the sole spawns in winter and spring, and from the appearance of the ovaries of specimens examined in November he considers this correct for the southern waters (Plymouth). It would appear to be different in our neighbourhood.

In the open sea pelagic ova measuring ·034 were procured off the Firth of Forth, which probably belonged to *Motella;* while smaller forms (·022 inch), off St Abbs, are still undetermined. Both of these were captured near the surface.

In the beginning of the month various small flounders, ranging from 6·5 mm. to 12·5 and 18 mm., were procured in the trawl, showing that they were even then seeking downwards. The smallest had the eyes lateral, though the left was slightly advanced, and pigment on both sides of the body, but the fin-rays were well developed for its size. The others had pigment on the right side, and the left (or under surface) white.

A very young Pleuronectid (flounder or dab) also occurred in the surface-net. Its large yolk-sac and general appearance showed that it was little more than a day old.

The surface tow-net gave a pelagic brill measuring 20 mm., and the hand-net at the margin of the water at the estuary of the Eden captured several semi-pelagic young turbot.

In contrast with the condition in the Bay, the use of the mid-water net on board the 'Garland,' in the open and deep water south-east of the Isle of May, showed that towards the end of the month many forms which have been associated with the long rough dab occurred; yet the youngest of these could not have been hatched so early as February and early March, the period when the ripe eggs of the species are common. All swam on edge. In the most advanced the left eye was slightly carried forward, and a little elevated towards the dorsal margin. On the same date (21st July 1887) many forms associated with the 'witch' abounded in the deep water on this ground. In these the eye seems to go much more slowly round than in the common flounder, for in those measuring 15·5 mm. in spirit, the left eye was just visible when the body was viewed from the right, and the fish evidently swam on edge, the pigment on both sides being nearly alike.

The ground-trawl gave the post-larval fishes entered elsewhere (Pleuronectids), but the diminution of those in the mid-water net was pronounced.

The young of the round food-fishes again had rather to be sought amongst the Pier and Castle rocks, and at the bottom of the water, than in mid-water; indeed, in 1886 and 1887, the younger stages abounded there on the 1st June. Young cod, moreover, are occasionally seen at this time off the rocks 5 to 6 inches long, and they appear to be the young of the previous season.

In the mid-water net, on the rich fishing ground south-east of the Isle of May, at 30 fathoms, many young whiting (and one young cod) were caught on 21st July 1877, ranging from about 2 to $2\frac{3}{4}$ inches, and some in shallower water in the same neighbourhood (off St Abb's).

Many whiting were obtained similarly next day, along with a young Montagu's sucker. Whiting seem to be remarkably abundant in the offing at a later period (and smaller) than the cod. At a given length, say 7 mm., these supposed young whitings are deeper and apparently older fishes than in the case of the cod.

In the Bay young whiting, 15 and 19 mm. respectively, were procured in the mid-water net of the 20th July.

The other fishes obtained in the mid-water net consisted of a considerable number of young *Cotti* (sea-scorpions), ranging from 7 to 13 mm. These are easily distinguished from the young food-fishes of the same size, by their shorter snout, smaller mouth and smaller eye, as well as by the deeper greenish pigment, with a trace of yellow on the head and abdomen. Moreover, the latter is much more densely spotted with blackish pigment. From the greater tenacity of life in this species (sea-scorpion), the body does not so soon assume the whitish opacity so characteristic of the gadoids. The specimen, indeed, may be motionless, yet the heart pulsates.

When about 9 mm. in length in each case, the young gadoid is distinguished by having only embryonic rays in the continuous marginal fin, while *Cottus* has a considerable number of rudimentary true rays, both dorsally and ventrally. Still greater differences occur in the tail. Thus in the gadoid the elements are more or less equally developed dorsally and ventrally, and the tapering notochord extends considerably beyond them. The tail, indeed, has a peculiarly symmetrical or feathered appearance. On the other hand, the sea-scorpion (*Cottus*) has a tail less finely tapered, and the rays and other elements are developed only on the inferior division of the tail, the whole dorsal half having only embryonic rays.

Throughout the month young gobies were very common in the mid-water net, as well as occasionally in the trawl. They are sometimes apt to be confounded with young gadoids, though the distinctions are evident enough when the two forms are laid side by side. In length they ranged from 4 to 12 mm.

A single example of a larval *Cyclopterus lumpus*, 5 mm. long, was also observed on the 25th July. It could only have been a few days old.

August.

During the month of August Diatoms, Rhizosoleniæ, spores of Algæ, and other minute vegetable structures were as plentiful as in July, and occasionally they formed a greenish-brown scum at the margin of the tide on the West Sands.

The bottom-net presented a considerable abundance of Infusoria, though the prominent species were not numerous, and there was no special feature in regard to their occurrence during the month, except that they appeared to be more abundant in the Bay than beyond it, *e.g.*, near the Bell Rock and south-east of the Island of May. The species observed were *Ceratium tripos*, *C. fusus*, *C. fusca*, and *C. divergens.* The first mentioned was often very abundant, some of the others being few. *Tintinnus denticulatus* was common, and *T. lagenula* (?) appeared once.

In the surface-net similar forms were met with, viz., *C. tripos*, *C. fusus*, *C. fusca*, and *C. divergens*, along with *Tintinnus denticulatus* towards the end of August. Moreover, Radiolarians occasionally appeared in this net in the Bay. *Ceratium* likewise occurred at the surface in the open sea near the Bell Rock.

The Cœlenterates continued in considerable profusion in August, and if we may judge from their abundance in all three nets (bottom, mid-water, and surface), their distribution throughout the water was on the whole more general. Yet, notwithstanding the number of species which fell under observation, it is noteworthy that no trace of the genus *Steenstrupia* appeared, yet *Corymorpha* abounds in certain parts of the Bay.

Amongst the Hydromedusæ in the bottom-net were *Thaumantias inconspicua*, *T. melanops*, *T. hemisphærica* (small), and *T. globularis*, all of which occurred in the beginning of the month, comparatively few, and these chiefly *T. hemisphærica*, being captured towards the end of the month. Small Medusa-buds, including those of *Obelia*, were common throughout the period. Other forms were *Oceania turrita*, *Stomobrachium octocostatum*, and an undetermined *Thaumantias* (Plate V. fig. 6). On contrasting the surface-fauna of the Bay with that in the vicinity, for instance, in the neighbourhood of the Bell Rock, the greater abundance of *Lizzia octopunctata* and *L. blondina* in the latter area is interesting. Minute Medusa-buds are common to both areas, as also were *Thaumantias inconspicua*, *T. hemisphærica*, and *T. melanops.* *Lizzia octopunctata* is an active and voracious form, and engulfs the bodies of *Appendicularice*, the tail projecting outward as a singular appendage to the Medusa. At this time the open water beyond the Bay had many smaller examples of *Bougainvillia britannica.* The Ctenophores in the surface-nets in the Bay included Beroë, which only occurred plentifully the first week, and then disappeared. *Pleurobrachiœ* were numerous, but small, the majority ranging from $\frac{1}{8}$ to $\frac{1}{2}$ inch. Many ova of Cœlenterates and planulæ were also present. It is noteworthy that no *Lesueuriæ* were obtained in this net.

The Hydromedusæ in the mid-water net were still very numerous, and, moreover, the species varied considerably. All did not occur in great numbers on every occasion, probably because the currents carried them diversely. *Thaumantias melanops*, *T. hemisphærica* (mature), *T. inconspicua*, *Phialidium variabile* in the varieties *globosa*, *convexa*, and *sarnica*, *T. pilosella* (nearly ripe), *T. quadrata* (immature), and the undetermined form (Plate V. fig. 6), previously procured. Larval Peachiæ still frequented *T. hemisphærica* in considerable numbers, both in and beyond the Bay; but, on the whole, they were most numerous within its limits. *Oceania globulosa* was present, and another species with only one yellow tubercle between each pair of tentacles instead of three, with pinkish ocelli and ovaries—yellow by transmitted light; mature. It came otherwise near *Tiara* (*Oceania*) *octona*. A third had no tubercles between the tentacles, which were in four groups, five in each, and with two additional. The ocelli and ovaries agreed with the former. They may have been varieties of *Tiara* (*O.*) *octona*. The latter was also procured in a ripe condition, and in considerable numbers; indeed, it was the most frequent representative of the genus. *Bougainvillia britannica* seemed to be rare, though towards the end of the month it was mature. *Stomobrachium octocostatum* appeared once in small numbers, and a single example of *Tima Bairdii* occurred within the Bay, and another near the Bell Rock. Both were comparatively small.

Beyond the Bay in the neighbourhood of the Bell Rock and 15 miles south of it, a similar Cœlenterate fauna was found in the mid-water net with the addition of fine examples of *Oceania turrita*.

The Ctenophores in the mid-water net were somewhat uniformly numerous throughout August. Many examples of *Beroë*, ranging from $\frac{1}{4}$ to 4 inches, and often in full maturity, were captured. They were absent from few hauls. *Lesueuria* occurred sparingly towards the commencement of the month in this net, the diminution in number being in marked contrast with the condition in July. The gradual increase in the size of *Lesueuria* as the season advanced is noteworthy. Young examples about $\frac{3}{8}$ of an inch occur in April, so that the breeding season would be correctly indicated by the condition of the specimens just mentioned. Young *Lesueuriæ* appear to have no 'lappets.' The older forms ranged from $\frac{1}{2}$ to $3\frac{1}{2}$ inches in their long diameter. Swarms of *Pleurobrachiæ* appeared in almost every net; but, as a rule, they were small, varying from 4 mm. to $\frac{1}{2}$ an inch, or a little more. In some hauls all were very small, a feature in marked contrast with their condition in December. The very young *Pleurobrachiæ* were characterised by their peculiar trumpet-shaped and prominent mouths.

The surface-net was less rich than either of the foregoing, but certain forms occurred in great abundance, showing that a transfer of the rich fauna of the lower regions of the water had taken place. *Thaumantias*, (Phialidium) *variabile*, var. *inconspicua* and *globosa*, *T. octona*, *T. hemisphærica* in full maturity, though like the others by no means in great numbers. Numerous ova of the latter species were also in the low nets. Some small Medusa-buds of unknown relationships occurred in most of the hauls. Others resembled minute Oceaniæ with eight tentacles, though occasionally one was bifid, thus increasing the number. *Lizzia octopunctata* was captured on the 7th, but it is more frequent beyond the limits of the Bay—towards the Bell Rock.

The Ctenophores in this net were represented by a few examples of *Beroë* at the commencement of the month, and by many small examples of *Pleurobrachia*. The very young forms presented the trumpet-like projection of the mouth. Most of the Pleurobrachiæ ranged from $\frac{1}{8}$ to $\frac{1}{2}$ an inch. The free ova of this species had the embyros well advanced, while many of the smallest had only recently escaped.

The surface-net beyond the Bay showed for the most part the same forms, with the addition of a few larval *Peachiæ* on *Thaumantias.*

From the beginning to the end of the month *Plutei* of diverse kinds and at various stages thronged the bottom-net; moreover, many post-larval Echini, Spatangoids, sand-stars, and brittle-stars were also captured in the same net. Similar features occurred in the open water beyond the Bay. They were seldom obtained in the mid-water net, except a few post-larval forms in the latter region. In the surface-net, on the other hand, they were more abundant than in either of the foregoing. Besides various *Plutei* at all stages, there were the Auricularia-stage, Mitraria-larvæ, post-larval Echini and brittle-stars. Some of the long-spined larvæ were $\frac{6}{8}$ and $\frac{7}{8}$ in. across. The abundance of young Echinoderms in the surface and bottom-nets was a marked feature. They form in their older stages a favourite food of many fishes, but whether the long spines prove protective to the larvæ in their pelagic condition is yet an open question.

The larval annelids still held a conspicuous place in the pelagic fauna of August, and the forms which were recognised in the bottom-net were for the most part the same, viz., larvæ of *Nerine*, *Spio*, and *Polydora.* Young Terebellids often occurred in the transparent tubes, which are narrow at one end, dilated at the other, like the tube of *Pectinaria.* Larval and post-larval forms of *Polynoë*, some of them reaching $\frac{1}{8}$ of an inch in length, were also frequent. The younger long-bristled larvæ of *Polydora* were especially common. Young *Capitellæ* were likewise frequently met with. *Tomopteris* appeared comparatively seldom. The use of the bottom-net off the Bell Rock and south-east of the Island of May showed that the same types abounded in this region.

The mid-water net captured *Tomopteris* more frequently than the bottom-net, along with an occasional *Nereis*—probably from touching the bottom or from pelagic sea-weeds or débris. The larval forms of *Nerine*, *Polynoë* and the Terebellid in the tube were also obtained. The mid-water net was less productive of annelids this month than the bottom and the surface-nets.

In the surface-net larvæ of *Nereis* appeared at the beginning of the month and on the 20th. The various *Nerine*-larvæ were also frequent throughout the period, along with the forms above mentioned. The very young (not larval) stages of *Magelona papillicornis*, Fritz Müller, was captured in this net towards the end of the month. *Tomopteris* was procured only once. The chief feature of note in the nets near the Bell Rock was the occurrence of a very young example of *Polynoë pellucida.*

The profusion of the larval and young annelids in the bottom- and surface-nets is a feature of interest in connection with the food of post-larval fishes. The larval annelids, indeed, attained their maximum this year in August in these nets.

In the bottom-net there was no diminution of the Copepoda and other minute crustaceans as contrasted with July; indeed they seemed even more plentiful. *Acartia longiremis* was abundant throughout the entire month, often in myriads, and *Halitemora longicornis* was nearly as frequent. *Centropages typicus* was often obtained, and the same may be said of *Longipedia coronata.* *Pseudocalanus elongatus* was perhaps a little less frequently met with than *Oithona spinifrons,* the latter on one occasion being numerous, and the females bearing ova about the middle of the month. *Calanus finmarchicus* did not appear in this net in the Bay in August, but in the open ground near the Bell Rock, as well as 15 miles south-east of the Island of May, and again close to the western shore of the island it was common. *Nauplii* were abundant in the Bay all August along with *Evadne Nordmanni* and *Ostracoda.* Zoeæ, apparently those of *Portunus holsatus*, were in great numbers on the 17th, and *Diastylis Rathkii*, *Cuma bispinosa* (young), and *Hyperia medusarum* were also noted.

In the open water, south of the Bell Rock (trawling ground), besides *Calanus finmarchicus* there were *Acartia longiremis*, *Centropages hamatus*, *C. typicus*, *Halitemora longicornis*, the two latter in great numbers, and *Pseudocalanus elongatus*, so that there was no great difference in the forms in the bottom-net. Zoeæ and the Megalops-stages were still, however, more numerous; and there were many young examples of *Pandalus annulicornis*, *Hippolyte*, and *Nephrops*, besides *Evadne Nordmanni* and *Ostracoda.* Young *Pandali* were also plentiful west of the Island of May.

Copepods were less numerous in the mid-water net in the Bay, the forms observed in limited numbers being *Halitemora longicornis*, *Centropages typicus*, and *Pseudocalanus elongatus;* and *Caligus rapax.* The young of *Nephrops*, *Crangon*, *Pandalus*, *Hippolyte*, *Pagurus*, and *Galathea* also appeared in this net, along with *Mysis chamæleon*, *M. vulgaris*, *M. flexuosa*, *Crangon vulgaris*, *Liljeborgia zetlandica* (female with ova and nearly fully developed embryos), *Dulichia porrecta*, *Hyperia medusarum* (swallowed by *Pleurobrachia*), zoeæ of Norway lobster, and Megalops-stage of crabs, and young crabs ·6 of a mm.

In the open water this net presented a larger number of zoeæ, and the *Megalops*-stages, besides the young of *Nephrops*, many young *Pandali*, *Caligi*, male and female, the latter bearing ova and occasionally also the parasitic, *Udonella caligorum*, *Centropages hamatus*, *Anomalocera Patersonii*, the latter species being only found in this region, and the *Cypris*-stage of Cirripedes. A very young example of *Hyas coarctatus*, a female *Crangon vulgaris* bearing ova, and *Pandulus annulicornis* in the same condition also occurred. To the west of the Island of May ($\frac{1}{4}$ mile) were a few Copepods, young Amphipods, *Crangon vulgaris*, *Mysis flexuosa*, *M. vulgaris*, and *Boreophausia Raschii.* A few young crabs about $\frac{1}{8}$ inch were likewise obtained.

The surface-nets in the Bay during August exhibited a somewhat greater abundance of crustacean life than in July. Copepods, such as *Acartia longiremis*, *Centropages hamatus*, *C. typicus*, *Longipedia coronata*, *Halitemora longicornis*, and *Oithona spinifrons*, in greater or less numbers, and occasionally a *Cyclopina; Evadne Nordmanni*, *Ostracoda*, and *Nauplii* were common. The long-spined zoeæ of *Porcellana* and the Megalops-stage of *Portunus* and others were frequent, and also a few of unknown relationships. A young *Anceus* also occurred at the end of the month, and it is interesting that this form is not unfrequently found attached like a parasite to the young flounders in the harbour. Exuviæ of Cirripedes were also common.

As a contrast with the inner waters, those south-east of the Bell Rock presented in the surface-nets *Acartia longiremis*, *Centropages typicus*, *C. hamatus*, *Halitemora longicornis*, and *Pseudocalanus elongatus*, with swarms of *Calanus finmarchicus*, which was not found in the previous surface-area. *Evadne*, zoeæ in numbers, and a few examples in the *Megalops*-stage were also obtained.

One of the most marked features of the water in the neighbourhood of the Bay, as near the Isle of May, was the great abundance of the larval and post-larval stages of the Norway lobster. Mingled in the nets with the long trailing tentacles of *Cyanea*, they formed an inextricable rope or chain.

As in the case of the Echinoderms the bottom- and surface-nets captured most Molluscoids in August.

Young Appendicularians (Pl. VI. fig. 9) were frequent in the bottom- and surface-nets, especially the former. On the whole, they were small when contrasted with those procured in May. *Cyphonautes* were also equally plentiful in both nets, some of the largest forms occurring in the surface-net. *Actinotrocha* in various stages was common, and in some the tube was evolved, it may be after immersion in spirit, as no further change had taken place in the condition of the larva. This form was most frequent in the bottom-nets, though from the beginning of the month onward it was occasionally present in the surface-nets. Beyond the Bay a similar fauna existed. Appendicularians, *Cyphonautes*, and *Actinotrocha* being present in both nets. The first mentioned likewise occurred in the mid-water net in both regions. The largest specimen (10 mm.) was captured in this net near the Bell Rock.

The bottom and surface nets still teemed with young mussels. In every haul of the bottom-net they were more or less abundant, their diameter ranging from ·011 to ·017 inch, while about the middle of the month one or two (it may be accidental forms) were about 1 mm., and ovoid in outline. Such, however, were exceptions, and might have been swept from sea-weeds or other bodies by the net. The majority averaged ·012 to 0·13 inch. Young examples of *Spirialis retroversus* were common in this net, but they were smaller than those procured in the same net in the open water south-east of the Bell Rock, on board the 'Garland.' Swarms of larval univalves, apparently the young of *Natica catena* and others were now present in this net, indeed they formed a feature of the month. If some should prove to be *Natica catena*, then the breeding season of this species extends over a considerable period, since the ribbons of sand containing the ova are obtained from March onward.

In the surface-net also the young mussels occurred plentifully throughout August, their size for the most part agreeing with those found near the bottom, viz., from ·010 to ·017 inch, the average in each series (*i.e.*, for the day) varying from ·011 to ·14, though sometimes it reached on the one hand ·010 inch, and on the other ·017 inch. Such would indicate that the pelagic mussels attain, as a rule, an average size, and then change their mode of life. After preservation in spirit they resemble to the naked eye grains of sand, and are easily separated from the more buoyant animals by the readiness with which they fall to the bottom of the vessel. Besides the pelagic mussels were other minute bivalves, probably the post-larval conditions of the common mollusks of the Bay, such as *Mactra*, *Venus*, and other forms, though their precise nature is at present uncertain. Numerous post-larval forms of *Natica* were likewise present in this net, and the young of *Spirialis* occasionally. The surface-nets in the open water near the Bell Rock and south-east of the Island of May presented similar forms, *Spirialis*, perhaps, being more abundant. The post-larval mussels measured, as in the Bay, ·011 to ·014 inch.

No post-larval fishes were captured in the surface-net in the Bay in August, though in the open water beyond it (near the Bell Rock) pelagic *Motellæ*, 3, 5, and 6 mm., were obtained. The great black ventral fins were conspicuous. In the same net also were several Pleuronectids.

The mid-water net during this month showed a great diminution of the post-larval round food-fishes so characteristic of the previous period; indeed, gobies and Pleuronectids were most conspicuous in the Bay. From the beginning of the month gobies from 3 to 10 mm. were frequent, and towards the end others varying from 5 to 12 mm. appeared. Two very young gurnards 5 and 6 mm. were captured at the end of August.

The only other forms were a young *Callionymus* 5 mm. long, and numerous sprats about 2¾ inches long.

All the Pleuronectids had the eyes lateral, and ranged from 7 to 11·5 mm., the smallest with permanent rays appearing in the tail. One example of the form associated with the 'witch' in former papers was obtained at the end of August, so that this species is occasionally carried by the currents shorewards. The notochord was still straight, though the development of hypural elements and permanent rays had occurred inferiorly. Two young turbot about 13 mm. long were also observed. Turbot have apparently small larvæ (as found in 1884), for on 30th August 1887 even the largest post-larval forms south-east of Island of May were small, the right side of these is more pigmented than the left, and the right eye is advanced a little on its way to the left side.

The use of the mid-water net on the area near the Bell Rock gave young whiting from 16 to 29 mm.; gurnards from 8 to 10 mm., with permanent rays in the tail; 'witches' from 6 to 10 mm.; and a plaice (?) 11 mm. long, which had evidently been on edge for some time, the pigment being best marked on each side ventrally. The left eye had slightly advanced. There were, in addition, larval examples of *Cyclopterus* 6 mm., Montagu's sucker 6 mm., and *Cottus* 7 mm.

The bottom-net in the Bay gave only gobies about 3 mm., with permanent rays in the tail. On the Bell Rock ground, however, the net was more productive, the fishes being a Pleuronectid 6·5 mm., *Callionymus* 4 mm., the larval tail being elongated and tapering, while hypural elements appeared beneath; and two unknown forms (perhaps blennies), 5 and 6·5 mm., in which the ventral border of the abdomen somewhat resembled the condition in *Agonus*, though the arrangement of black pigment, the prominence of the angle of the jaw, the form of the tail, and other points differed. Two other larval fishes occurred, one of which had not previously been seen.

September.

Diatoms and other algoid forms were as abundant as in August.

In the bottom-nets throughout this month *Ceratium tripos* occurred in almost every instance, while the following only appeared occasionally, viz., *C. fusus*, *C. divergens*, and *C. furca*, the latter in small numbers and rarely. *Tintinnus denticulatus* was found on several occasions. The only species that could be called abundant was *C. tripos*.

In the surface-nets, on the other hand, there was a decided increase in all the foregoing forms except *C. fusus*. *Ceratium tripos* was especially large and numerous, the least abundant form being *C. divergens*.

The mid-water net was most productive in regard to this group, the surface-net next, while the bottom-net had comparatively few species, and these both small and scantily represented.

In the mid-water net *Thaumantias pilosella* amongst the Hydromedusæ was both large and mature, especially at the beginning of the month; and in this species, as in allied forms, it is probable that after the discharge of the reproductive elements the Hydromedusæ perish. They certainly disappear from the areas they formerly frequented in myriads. Some examples of this species were fully an inch and an eighth across. *T. hemisphærica* was also very abundant at the commencement of September, and its numbers were not much diminished at the close. It was in full maturity throughout. The unknown *Thaumantias* (Plate V. fig. 6); also occurred once. *Tiara (Oceania) octona* frequently appeared, and often of good size; some were ripe, but the majority were unripe, and many small. *O. globulosa* was present only once. *Bougainvillia britannica* was captured throughout the month, but in small numbers, and of variable size. Many were ripe. *Bougainvillia nigritella* was procured once or twice in a ripe condition. *Stomobrachium octocostatum*, more or less ripe, appeared sparingly once or twice and of good size. Another gonozoid, 2·5 mm. in diameter, presented a somewhat globular umbrella with 24 large purplish tentacular bulbs, from which proceeded as many slightly pinkish tentacles. Sub-umbrella reaching nearly to the tip of the umbrella. Peduncle with four lips produced into branched filiform processes. The four double ovaries were filled with large orange-red ova, apparently ripe. *Tima bairdi* frequently occurred in this net, both small and fairly grown examples (about $1\frac{1}{2}$ inch). All were immature. Moreover, an example about five-eighths of an inch across was in the condition formerly noted in the abnormal specimens of a *Thaumantias* in 1886,* for it had no peduncle and consequently no mouth, the four radiating canals terminating in a small circular median spot, which, however, showed no aperture.

Beroë was somewhat plentiful throughout the month in this net, but few large examples were observed, the average of the large forms obtained being from 1 to $1\frac{1}{2}$ inches. They seemed to swim in mid-water, or at least to avoid the surface and bottom, for none entered either surface- or bottom-nets. *Pleurobrachia* was very abundant, often in myriads. Almost all the examples were small, ranging from $\frac{1}{8}$ to $\frac{1}{2}$ an inch. Such collections were in striking contrast, in regard to size, with those obtained at other seasons, *e.g.*, in mid-winter, the great size and beauty of the species at that season being noteworthy.

Hydromedusæ were rare in the surface-net in September, a few ripe examples of *Thaumantias hemisphærica* and a few unknown gonozoids being the only representatives.

A few *Pleurobrachiæ* were generally obtained—chiefly small examples from $\frac{1}{8}$ to $\frac{1}{4}$ inch. Moreover, many ova of this species, some with embryos far advanced, and a few other ova were captured at the surface.

In the bottom-net only a few specimens of *Thaumantias hemisphærica* were seen during September, along with a few minute Medusa-buds. Larval *Pleurobrachiæ* and young forms from $\frac{1}{8}$ to $\frac{1}{2}$ an inch were also obtained. Ova of the same species in various stages of development were also not uncommon.

The larval Echinoderms were somewhat less numerous than in August, but they still occurred in almost every haul of the surface- and bottom-net, accompanied by a few young brittle-stars. One of the Plutei procured in the beginning of the month presented unusually broad lobes or processes. Though in diminished numbers, therefore, the larval star-fishes still formed an important factor in the nourishment of the young food-fishes.

In the surface-net small Appendicularians were captured from the beginning to the end of September, and sometimes they were numerous. Their size corresponded with those procured in the mid-water and bottom nets, and were in contrast with the large examples which abounded in spring. Some of the Appendicularians were minute. On the whole, they appeared most frequently in the surface-net, the bottom-net being next, and, lastly, only three times in the mid-water net. *Cyphonautes*, as in August, was characteristic of the surface- and bottom-nets, and was most numerous in the latter. None were obtained in the mid-water nets. It was absent on few occasions, and thus has a wide range in time during the year just as its geographical range is extensive. The examples seemed to increase little beyond a certain limit. *Actinotrocha* occurred once in the mid-water net,

* Report Brit. Assoc., 1886, p. 710.

but was more frequent in the surface- and bottom-nets. In confinement many specimens passed through their metamorphosis (Plate VI. figs. 1–8) at the commencement of the month, but the young *Phoronis* (after transformation) was rare in the nets, being only present on one occasion in the bottom-net. One *Actinotrocha*, deprived of the larval tentacles and with the adult tentacles as mere buds or papillæ, was obtained on the 22d. After transformation they probably lie on the bottom or soon burrow in mud or other medium for protection.

The bottom-nets, especially, abounded in the larval and post-larval annelids during September, their profusion indeed being remarkable. Most conspicuous in the series were the larval, post-larval, and young forms of *Nerine* which were seldom absent from the bottom-nets, and often in considerable numbers. These were most active members of the bottom fauna (pelagic), and occurred in various stages, from the shorter rounded forms with the enormous bristles to the more elongated types with a pair of short tentacles. No form is more abundant amongst the sand along the beach than *Nerine foliosa*, Sars, while other members of the group are also very common, viz., *Scolecolepis vulgaris*, Johnst., and *Spio seticornis*, Fabr. Their numbers will account for the profusion of their larvæ which thus thronged the lower regions of the water for a long period. Another very abundant larval and post-larval form was *Polydora ciliata*, Johnst., which so frequently perforates the rocks along the beach, and shells—both living and dead—in the deeper parts. Some of the older forms were about 2·5 mm. in length, and showed the great bristles on each side of the fifth body-segment.

Amongst other forms noticed were a young *Aphrodita* 5 mm. long, trochospheres of *Polynoë* with post-larval and young forms, a young example of *Polynoë longisetis* about 1 mm. long, with bristles and scales, and a young specimen of *Pholoë minuta* with four pairs of legs on each side—furnished with the characteristic bristles. *Autolytus prolifer* made its first appearance in the tow-nets on the 17th, carrying ova on the ventral surface. A young *Nephthys*, with six pairs of feet, a caudal cirrus of two segments articulated like the glandular hair of a plant, and a young *Cirratulus* about 3 mm. long, larval Terebellæ, Ariciidæ, various trochospheres of Chœtopods, and a young Turbellarian, of a light greenish colour by transmitted light, also were present. The wealth of annelid-life, indeed, was noteworthy, and many forms not entered here may yet be found on a more prolonged survey of the collections.

The mid-water net presented a contrast to the foregoing, for larval forms of *Nerine* were only procured occasionally, and a young example about $\frac{1}{4}$ of an inch in length. On the other hand, *Tomopteris* about $\frac{3}{4}$ inch long was obtained on several occasions, but sparingly. Sagittæ also occurred frequently in this net, but in small numbers, except on the 5th: they ranged from 12 to 16 mm. in length.

Larval annelids were much more frequent in the surface-nets than in the latter, though they fell far short of the bottom-nets in this respect. The majority belonged to the *Nerine*-group, including *Polydora*, larval forms of *Polynoë* only occurring occasionally. Once only did a fragment of *Tomopteris* appear. A few examples of larval forms of Nerine were obtained in every cast of the net. Some Sagittæ about 18 mm. long were present on the 18th.

The Crustacea in the bottom-nets were apparently as numerous and varied as in August, their profusion being of moment in connection with the abundance of post-larval food-fishes, such as whiting, gurnards, Pleuronectids, and others. Amongst the Copepods were myriads of *Halitemora longicornis* and *Acartia longiremis*, the females of the latter bearing ova in many cases. *Calanus finmarchicus* appeared in limited numbers, whereas none were observed the previous month. *Centropages typicus*, *Pseudocalanus elongatus*, and *Longipedia coronata* were common. *Oithona spinifrons* occurred more sparingly. *Evadne nordmanni* (amongst the Cladocera), was less frequent than in the previous month, but the reproductive activity of the examples was not diminished. A few examples of the *Cypris*-stage of Cirripedes occurred in most hauls of the net. Other forms obtained were exuviæ of *Balani*, *Atylus Swammerdamii* (frequently), *Podocerus capillatus*, *Diastylis Rathkii*, *Cuma* with ova, a few examples of *Mysis flexuosa*, chiefly young. *Nauplii* occurred throughout the entire period, and were often numerous. Zoeæ of various kinds, including the long-spined zoeæ of *Porcellana*, and larval Norway lobsters occasionally appeared, but they were comparatively few.

The crustacean contents of the surface-net most nearly resembled those of the bottom-net, showing that these two regions of the water were most affected by this group. *Halitemora longicornis* and *Acartia longiremis* (some of the females still bearing ova), were as numerous as in the former net, and *Calanus finmarchicus* was also abundant. *Longipedia coronata* occurred occasionally in considerable numbers, while *Centropages hamatus* and *Oithona spinifrons* were less common. *Nauplii* were very plentiful in this net, but *Evadne*, though appearing almost daily, was in limited numbers, some, however, presenting young in the brood-pouch. A few larval cirripedes (*Cypris*-stage), were generally obtained. Zoeæ of *Portunus* and other forms, the long-spined zoeæ of *Porcellana*, with some crabs in the *Megalops*-stage, were also captured, along with a few young crabs from $\frac{1}{16}$ to $\frac{1}{8}$ inch, the larger size of these generally being a feature of the month. Some seemed to pertain to *Corystes*. *Atylus Swammerdamii* and *Podocerus capillatus* were also obtained.

The mid-water net gave a larger number of the smaller forms than in August.* Thus *Halitemora longicornis* and *Acartia longiremis* were numerous, while a few examples of *Pseudocalanus elongatus* were also met with. Zoeæ of *Portunus* and other forms occurred on most occasions, the long-spined larvæ of *Porcellana* being frequent. Young crabs from $\frac{1}{16}$ to $\frac{1}{8}$ inch were also abundant, the earlier forms presenting the large eyes of the *Megalops*-stage. *Atylus swammerdamii*, *Hyperia medusarum*, *Podocerus capillatus*, *Idotea tricuspidata*, a young shrimp 7 mm., *Pandalus annulicornis* 9 mm., and a few examples of *Mysis flexuosa* completed the list.

The pelagic Crustacea of September are, therefore, both varied and numerous.

In the bottom-net throughout September young bivalves in the pelagic condition were uniformly present in every haul, though they did not occur in profusion. Amongst these the chief place was held by young mussels, which varied from ·012 to ·014 of an inch as a rule, an occasional example $\frac{1}{20}$ inch or more (2·5 mm.) in its long diameter also being found, as in a large collection on the 15th. Such, however, may have been swept by the net from other floating structures. On the 22nd some very small bivalves ·008 inch were present, but they more resembled the young of other mollusks, many of which were present amongst the mussels. Besides the bivalves numerous minute univalves were obtained. Such seemed to be the young of various forms abounding in the Bay, such as *Natica*, *Velutina*, and others. These pelagic univalves form a conspicuous feature in the fauna of the season, and they swim about as actively as the permanently pelagic forms, such as the young of *Spirialis*.

* It is right to state that a new mid-water net may have had some relation to this condition.

In the mid-water net some mussels ranging from ·045 to ·07 inch were obtained at the end of the month along with a few about 2 mm. in long diameter, probably swept from passing objects. Moreover, a Heteropod (*Atlanta*) was added to the British Fauna.

In the surface-nets mussels and other bivalves were nearly as numerous as in the bottom-nets, the sizes of the mussels being the same, viz., from ·012 to ·015, these being the usual ranges of the pelagic forms found in the Bay at this season. The univalves were also plentiful and apparently of the same types, such as *Natica, Velutina,* and other forms in shallow water.

The study of the pelagic fish-fauna of the Bay in September presents a contrast with that of the preceding months, for now the post-larval food-fishes have almost disappeared, if we except the gurnards and the Clupeoids. The young round food-fishes had indeed greatly diminished during the previous month, and therefore the disappearance was gradual.

The mid-water net still captured small Pleuronectids ranging from 5·5 mm. to 9 and 10 mm., probably dabs, while a young turbot of 11 mm. was also obtained. The smaller examples of the former presented no permanent rays in the fin. Young gurnards were not uncommon, varying in size from 5 mm. to 12·5 mm., thus showing a considerable increase on the previous month. Moreover, young Clupeoids made their appearance, the specimens ranging from 7 to 13·5 mm., the latter size occurring only after the middle of the month. Gobies were still frequent, their extremes in length being 6 and 21 mm. Most were small examples, viz., about 7 mm. Young examples of *Callionymus lyra* (dragonet) occurred several times, from 3·5 to 10 mm. The former size appeared at the beginning of the month, and presented the tapering larval tail with permanent rays below. This is one of the forms in which pigment occurs on the ventral surface of the abdomen in the post-larval stage, disappearing, as in the goby, in the adult condition. Two young *Cotti* about 9 mm. long complete the list in this net.

Besides these post-larval forms, young whiting from 1 to 2½ inches were occasionally procured, and young pipe-fishes (*Sygnathus acus*) were common. The latter ranged from 20 mm. to 2⅝ inches.

No fishes were captured in the surface-net, but in the bottom-net a Clupeoid of 7·5 mm. appeared.

October.

The pelagic Diatoms and Algæ were still in considerable numbers, along with spores of Algæ and Rhizosoleniæ. All were most numerous in the bottom- and surface- tow-nets. The number of species of Diatoms was considerable.

The surface-net throughout the month also presented a considerable number of Infusoria—such as *Ceratium tripos,* which occasionally appeared in vast numbers, as on the 16th and 17th; *C. furca,* which was less abundant; *C. divergens,* very few of which occurred; and the same with *Tintinnus denticulatus.*

The bottom-net again showed similar forms, and in the same proportion, the most abundant species being *Ceratium tripos*, while only very few examples of *C. divergens* and *Tintinnus denticulatus* appeared.

The Cœlenterata had now greatly diminished in the surface-net, only a very few *Pleurobrachiæ* of moderate size being present. A few ova of the same form with the embryos, well advanced, were also obtained.

The mid-water net captured many examples of *Thaumantias hemisphærica* from the beginning of the month to the 17th; indeed they were often very numerous, and ranged on each side of $\frac{5}{8}$ inch. In the earlier part of the month some were ripe, others nearly so. *Stomobrachium octocostatum* was likewise occasionally met with in considerable numbers, and of good size. None were mature. Various specimens of *Tima bairdii* made their appearance at and below $1\frac{1}{4}$ inch. Many ova apparently connected with this group were also captured, so that the food of the minuter forms would thereby be increased.

The Ctenophores were represented by myriads of *Pleurobrachiæ* throughout the entire month, their size ranging from $\frac{3}{16}$ to $\frac{5}{8}$ inch. None were mature. *Beroë* occurred in smaller numbers, but was present in most of the hauls, the average size of the specimens being from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches.

The bottom-nets presented *Pleurobrachiæ*, of varying size, ova and larval forms of the same species. Moreover, they were in limited numbers. It is possible some larval forms belonging to other Ctenophores were present.

Echinoderms.—A great change had now ensued in regard to this group, for only a few larval *Pleutei* appeared in the surface-net in the middle of the month.

Throughout October the larval annelids still abounded in the bottom-nets, showing how ample the food-supplies of the smaller fishes are from this group for a considerable period of the year. The forms chiefly consisted of larvæ of *Nerine*, and *Polydora*, larvæ and young of *Polynoë* and others. *Sagittæ* were obtained sparingly in this net in the earlier part of the month, but at the end they were very numerous, and ranged from 8 to 15 mm.

In the mid-water net *Tomopteris* occurred occasionally in small numbers. Some reached the length of $1\frac{1}{2}$ inch, others being much less. Very few Sagittæ appeared in this net, and only on one occasion.

In the surface-net the larval stages of *Nerine* and *Polydora* appeared during the first half of the month, occasionally with a few small examples of *Tomopteris.* Their numbers were, however, comparatively few, and in contrast with the months immediately preceding.

The bottom-nets still teemed with minute crustaceans from the beginning to the end of October. The Copepods were represented by swarms of *Halitemora longicornis* and *Acartia longiremis*, while *Calanus finmarchicus*, *Longipedia coronata*, and *Pseudocalanus elongatus* occurred in smaller numbers. *Evadne nordmanni* was frequent, but only occasionally in large numbers. *Nauplii* were still plentiful, and in most collections a few examples of the *Cypris*-stage of Cirripedes occurred, while the exuviæ of the adults were common. Other forms met with were, *Diastylis rathkii* and *Atylus swammerdamii.* The paucity of larval Decapods was a noteworthy feature, but the smaller fishes had an ample margin in the other groups.

The mid-water net yielded comparatively few representatives of the group. Young crabs in the pelagic condition were frequent; a few *Caligi*, *Atylus swammerdamii*, and a single *Idotea linearis* completed the list.

The surface-net exhibited a few *Nauplii*, which were most abundant on the 17th. The Copepods were represented by many examples of *Halitemora longicornis* and *Acartia longiremis*, and by the following in small numbers, viz., *Pseudocalanus elongatus* and *Oithona spinifrons.* A few specimens of *Evadne nordmanni* and of the *Cypris*-stage of Cirripedes occurred in most of the hauls.

The Molluscoida during October consisted of many examples of *Cyphonautes.*

The mollusks again were still procured in considerable numbers. The majority of the bivalves seemed to be mussels, though larval forms of other species were probably present. The size of these bivalves ranged from ·012 to ·016 inch in the bottom-net, in which they were present in larger numbers. Larval univalves (Gastropods) were also obtained, though, as a rule, they were not numerous on any occasion. A young *Spirialis* occasionally appeared amongst them.

In the surface-net the young univalves were sometimes more abundant than in the bottom-net, but the bivalves seemed to be fewer. The latter varied from ·011 to ·017 inch.

The post-larval fishes in the mid-water net were comparatively rare, and they were procured in the first half of the month, viz., on the 8th and 16th. They consisted of young Clupeoids varying from 11·5 to 18·5 mm., the former having no permanent rays in the fins, while the latter presented them. A gurnard 16 mm. long, was the only other form. The smaller gadoids had now for a time passed out of the upper regions of the water, and were either close inshore, or frequented the ground. The only other form was a young pipe-fish (*Sygnathus acus*) 2 inches long, obtained off the east rocks by the mid-water net.

November.

The surface- and bottom-nets gave many Diatoms, spores of Algæ, and fragments of the latter.

Instead of the numerous and varied representatives of the group so characteristic of the preceding months, the surface-net in November exhibited a very few *Pleurobrachiæ*, the place of the ordinary Hydromedusæ being taken by *Circe*, which was in considerable numbers, though none were large.

In the mid-water net, however, *Beroë* was represented by numerous large examples, which swam in the deeper parts of the water instead of seeking the surface as in the warm months. Many *Pleurobrachiæ*—some well grown—were also captured in this net.

In the bottom-net only a few examples of the latter (*Pleurobrachiæ*) were obtained.

The surface-net gave a very few small specimens of *Tomopteris*, while the bottom-net, besides one or two similar specimens, added a few Nematodes.

Sagitta, again, of considerable size, viz., fully three-fourths of an inch, occurred in all the nets, and often in great numbers. They took the place of the absent Hydromedusæ.

During November opportunities for examining the Bay were few, since the weather was often unsuitable, and hence the data for this month are less numerous. In the surface-net, however, *Acartia longiremis* was occasionally abundant, along with a few exuviæ of *Balani*. The bottom-net gave the same Copepod. Many specimens of *Pseudocalanus elongatus*, *Hyperia medusarum*, and *Mysis flexuosa*, while *Crangon vulgaris* also appeared occasionally.

The mollusks of November were a few bivalves (apparently mussels) 0·16 inch, some larger mussels, and a few minute univalves, both groups occurring only in the bottom tow-net.

The post-larval fishes had not quite disappeared from the Bay, for a Pleuronectid 11·5 mm., apparently a flounder, was procured in the mid-water net on the 1st, the left eye just appearing over the ridge. On the same date a few Clupeoids 14·5 to 16·5 mm. were also obtained. The contrast, however, to the preceding months was marked.

December.

As in the previous months Diatoms, spores of Algæ and fragments of the latter occurred especially in both surface and bottom-nets, only a few being procured in the mid-water-net.

In the surface-net various forms of *Infusoria* were procured on the 10th, and in considerable numbers. They consisted of *Ceratium tripos*, *C. furca*, and *C. fusus*. The same forms were also occasionally seen in the bottom-nets, but in comparatively small numbers. The northern waters differed chiefly from the southern, as in the estuary of the Thames, by the absence of *Noctiluca*.*

A few Foraminifera, and a young sponge—probably *Oculina*—were obtained in the bottom-net.

The surface-net in December still presented many *Pleurobrachiæ* from $\frac{5}{8}$ inch downwards, along with ova. *Circe rosea* occurred sparingly, but of somewhat larger size than formerly. A few examples of *Tima bairdii* of medium size appeared occasionally. Moreover, *Stomobrachium octocostatum* was captured in this net in numbers at the commencement of the month.

In the mid-water-net Cœlenterate life was more varied. The ubiquitous *Pleurobrachiæ* were in considerable numbers—and at no period throughout the year were finer examples procured than in December—their size ranging from $\frac{3}{4}$ of an inch downward to $\frac{1}{6}$ inch. The other Ctenophores were an occasional *Beroë* about $1\frac{1}{4}$ inch, and a few *Lesueuriæ* from $\frac{5}{8}$ inch to an inch. *Circe rosea* again occurred in profusion from the beginning to the end of the month, the large forms being about $\frac{5}{8}$ inch, the smaller less than $\frac{1}{4}$ inch. The reproductive organs appeared to be well developed. *Tima bairdii* reached its maximum size this month, as one fully 3 inches across was captured. The reproductive organs at this time were advanced, but not quite ripe. *Stomobrachium octocostatum* occurred occasionally, some being about half an inch in vertical diameter. Lastly, two or three examples of *Thaumantias hemisphærica* were also obtained.

The bottom-net produced a few examples of *Pleurobrachia* and one or two *Lesueuriæ* of moderate size. *Pleurobrachia* and *Circe* indeed occurred in three out of four hauls.

Contrary to what might have been anticipated one or two *Plutei* were observed in the surface-net about the middle of December. In these the arms were short and apparently atrophied or abnormal. The skeleton was still visible, but no star-fish.

In the surface-net a single *Tomopteris* $\frac{3}{4}$ inch long was obtained. The same form occurred in the mid-water-net occasionally, and from $\frac{1}{2}$ inch to $\frac{3}{4}$ inch in length. In the bottom-net only bristles of *Sabellaria* and of *Nereis*, with fragments of *Polynoë*, were taken. Such were probably swept from the bottom by currents. The same bristles occurred in the tow-nets at Sheerness-on-Sea.

The Sagittæ were remarkably numerous and of large size. In the surface-net and in the bottom-net they appeared in similar proportions, but not always in correspondence, thus the record of the surface-net on the 5th, 13th, 14th, and 18th was 'numerous, few, many, few,' while in the bottom-net it was 'few, many, many, few,' on the same dates. In the mid-water-net they were especially abundant and large, ranging from $\frac{3}{4}$ inch to 1 inch, and the reproductive organs were well developed. They formed a conspicuous element in the food of the various fishes at this season.

During December the surface-net showed a few Copepods, such as

* For the condition of the waters at Sheerness-on-Sea, I am indebted to the notes furnished by Mr Shrubsole.

Acartia longiremis, also a few *Nauplii*, exuviæ of *Balani*, and occasionally a specimen of *Atylus swammerdamii.*

The mid-water-net produced only the actively pelagic *Parathemisto oblivia*, which, moreover, was sometimes in multitudes. They occurred in every haul of the net in greater or less numbers.

In the bottom-net Crustacea were much more plentiful, especially the Copepods, which included *Halitemora longicornis*, *Pseudocalanus elongatus*, and *Calanus finmarchicus*, all three being abundant, though the examples of the latter were sometimes small. *Parathemisto oblivia* occurred occasionally, but in limited numbers.

The representatives of the Molluscoida were confined to the bottom-net, and to one species, viz., *Cyphonautes*, but they still occurred in considerable numbers. The extended period during which this larval species frequented the bottom-net is noteworthy.

The Mollusca likewise were found only in the bottom-net, and consisted of larval univalves of various kinds. It is remarkable that no pelagic cuttle-fish was captured during the year.

The post-larval fishes during the month appeared to be extremely rare; the only young form being a Clupeoid 1½ inch long, which was obtained in the mid-water-net.

PELAGIC OVA AND LARVAL FORMS OF FOOD-FISHES AND OTHERS.

The pelagic ova are much more numerous in the surface-waters on various fishing-banks, such as south-east of the Isle of May or North Carr, Smith Bank, and on similar grounds, than in St Andrews Bay. The eggs, however, captured in the tow-nets on these banks, present, as a rule, similar features. They pertain, for instance, early in April to the cod, plaice, haddock, dab, rockling, and others, besides the egg with the large perivitelline space. They are accompanied by larval forms of the same species. Certain observations point to an earlier deposition by deep-sea plaice and other forms than by the same species in shallow water. If this be sustained by further inquiries the differences in size amongst the young of a season would so far be explained. Hensen speaks of having found an ovum towards the end of April with an oil-globule, and which he referred to *Crenilabrus.* At St Andrews the eggs of the gurnard occasionally appear, though sparingly, at the end of April. They possess an oil-globule. Hensen obtained the ova and larval forms of plaice in the Baltic towards the end of April. It sometimes happens in spring that pelagic ova are much more plentiful near the bottom than in the upper regions of the water, so that careful observations are necessary in any given locality before conclusions are drawn with regard to their distribution.

The following table, given by Dr F. Raffaele,* will be found useful for comparison with the British species :—

Pelagic Eggs.

Dates.	Species.	Size in mm.	Oil-Globule.
January–March,	*Labrax lupus*, Lac.,	1·15–1·16	0·33–0·36
End March,	*Centropristis hepatus*, Gm.,	0·78	0·145
May–August,	*Serranus cabrilla*, L.,	0·90	0·15
do.	,, *scriba*, L.,	0·90	0·122
do.	*Mullus surmuletus*, L.,	0·93	0·23
do.	,, *barbatus*, L.,	...	...
All Summer,	*Sargus Rondeletii*, C. and V.,	1·00	0·18–0·20
do.	*Box vulgaris*, C. and V.,	0·89	0·2
do.	*Scorpæna*,	...	...
do.	*Corvina nigra*, Bl.,	1·10–1·26	0·30
May–September,	*Uranoscopus scaber*, L.,	2·	...
Spring and Summer,	*Trachinus draco*, L.,	...	...
Spring,	,, *vipera*, L.,	1·166	...
May,	*Lepidotrigla aspera*, C. and V.,	1·16	0·21–0·22
May–August,	*Callionymus festivus*, Bp.,	0·56–0·60	...
Summer,	*Mugil* sp.,	1 mm.	0·20
Spring and Summer,	*Coris* and *Julis*,	0·60–0·70	0·16–0·18
End of Winter, Spring, and Summer (rare)	*Gadus minutus*, L.,	1 mm.	...
	Merluccius vulgaris, Flem.,	0·94–1·03	0·27
November–February,	*Motella tricirrata*, Bl.,	0·75	0·218
Greater Part of Year,	*Solea*, sp. A.,	1·06	...
do.	,, sp. B.,	1·23	...
Summer,	*Rhombus lævis*, L., ?	1·33	0·23
February–April,	*Arnoglossus*? var. sp. v. *Rhomboidichthys*,	0·60–0·70	0·15–0·2
Autumn,	*Citharus linguatula*, L.,	...	...
May–September,	*Engraulis encrasicholus*, L.,	{larger 1·10–1·45 {smaller 0·45–0·66	... ...
September–February,	*Clupea pilchardus*, Walb. ?	1·50–1·70 yolk 0·80–0·90	0·16
End of Summer and Autumn,	*Clupea*, sp. B.,	...	..
June–August,	No. 1. (*Solea*?)	1·4	...
January (scarce),	No. 2.	0·75	..
Spring, principally in Summer,	No. 3.	1·1–1·15	...
January–March,	No. 4. (*Macrurus*?)	1·62	0·276
June–November,	No. 5. (*Lepidopus*?)	1·60–1·70	0·4
August–November,	No. 6.	2· yolk 1·20–1·30	5 oil-gl.
do.	No. 7.		6·12 oil-gl.
do.	No. 8.	same size as No. 6.	30 oil-gl.
do.	No. 9.	do.	...
do.	No. 10.	2·7	...

* 'Le uova galeggianti,' &c., *Mittheilungen zoolog. Stat. zu Neapel.*, viii. Bd. 1 Heft., 1888.

Plaice.—These eggs appear as a rule in the Bay about the beginning of March, in the surface and mid-water nets, and have a diameter of ·068 in., but they are comparatively few in number during this month. They are more abundant about the end of April. None were observed after the 4th of May. They have also been procured from the Moray Firth on the 20th April. The announcement that Mr Scott found ova of the plaice abundant in the Moray Firth in January shows that considerable latitude must be given to marine fishes in regard to the period of spawning, a feature formerly insisted on; indeed, a glance at the sizes of the various young forms at any given time demonstrates the same fact, though here irregularity of growth has also to be taken into account. The fact that so few ova of plaice occur in the Bay is in contrast with the condition on Smith Bank and other grounds and would corroborate the view already expressed that most of the large (spawning) plaice are beyond the limit.

The great size of the ovaries in a ripe plaice is noteworthy, and also the comparatively large proportion of the ova which become ripe at a given time. In one adult female,* 23 inches in length, each ovary measured 11 inches, and it was calculated that the ripe eggs amounted in bulk to about a third or a fourth of the total bulk of the ovaries.

The larval plaice is distinguished by its size, by the great breadth of the marginal fin, and the canary-yellow colour, which is well marked posteriorly. Mr Cunningham describes the yellowish pigment as in three rows on the lateral region, but, as already mentioned, this has not been observed at St Andrews. A peculiar feature is the presence of minute dark pigment-specks on the ventral lobe of the marginal fin, whereas only one or two of the yellowish corpuscles pass into the dorsal lobe from the tissue of the body. The larva swims actively near the surface of the water, and is not readily observed except by its large iridescent eyes, which now and then have a golden sheen. Like other Pleuronectids it hangs head downward in the water, and frequently bores its snout into the sand at the bottom. It appears to grow rapidly, as forms, apparently referable to this species, 12 mm. long, are met with in April.

What appears to be a larger egg of the same species occurs early in March off the Tents' Moor and elsewhere in the Bay. It measures ·073 in. in diameter. This egg was found at various times up to the 4th of May, the maximum period being about the 30th of April. In the majority of cases (8) it was captured by the mid-water-net, but twice appeared in the surface one. Each was characterised by a pale oleaginous area of comparatively limited size lying under the lateral expansion of the embryo at the upper arch of the egg. This area differs from an oil-globule in its optical properties, and probably represents an oleaginous region differentiated from the other parts of the yolk. The embryo was far advanced, with the heart in active pulsation. The pigment was well developed, chiefly chrome-yellow and black, especially the former. The eyes were iridescent silvery. The capsule (zona radiata) is mostly dotted, as in other forms, with a close series of rows of punctures.

The embryo is comparatively large, with a series of dull yellow pigment-grains from the front to the base of the tail, that is, they do not reach the latter. The eyes are still iridescent silvery. The mouth is widely open, and on the second day movements of the mandible were evident. The dorsal marginal fin comes off from the top of the head. The surface of the yolk is marked with stellate black chromatophores, and its anterior part is rapidly absorbed; moreover, a few processes projected from the posterior region forward into the anterior space. Some of the black

* Kindly sent from the Moray Firth by Capt. Burn and Skipper Girdlestone.

pigment corpuscles appear to pass in front of the yolk. The cells of the notochord are small. The anus is distinct.

The arrangement of the pigment and other features resemble those of the plaice, and when the larval fish is a few days older a greenish lustre pervades the eyes.

It is noteworthy that these eggs did not present the somewhat rough—almost rasp-like—appearance under both lens and microscope which is so characteristic of the ova of plaice removed from the ripe female, and which thus have a slightly silvery sheen in a bright light.

Ovum with Large Perivitelline Space.—Towards the end of April the large transparent eggs (with wide perivitelline space) were tolerably numerous, about a dozen being got in a haul amongst the eggs of cod, plaice, rockling, &c. Two sizes of these occur in the spirit-preparations, but such may be due to entrance of water into the perivitelline space, to a greater extent in some than in others.

Other ova become opaque when put in spirit, since the yolk fills the space, whereas in these only the embryo with its yolk-sac, or the small central yolk with the blastoderm, does. It has not yet been determined whether the ovum when shed has the same characters as when captured in the nets, or whether the perivitelline space largely increases by imbibition.

Dab.—Ova of this species were obtained early in April as well as towards the close of the month. Hensen also found these eggs in the Baltic towards the end of April. The larval-dab is about $\frac{1}{20}$th of an inch in length, and furnished with distinct lemon-yellow (or amber) pigment-specks in the form of two lateral bands. At the end of a week the pigment has increased, and the eyes are blackish. The mouth has opened, but not the anus. Three or four days later the eyes present a greenish iridescence, the anus has opened, the yolk-sac has almost disappeared, and the pigment generally has increased, 'large stellate ' black spots extending over the eyes, otocystic and hepatic regions to ' the anus, and along the dorsum and upper margin of the caudal trunk. ' Crescentic yellow pigment-patches appear in the caudal membrane.' *

Flounder.—An ovum resembling that of this species presented itself on 9th April in considerable numbers, and once or twice thereafter till the 26th of April. Ripe forms are abundant from the middle of March onwards. Hensen found the eggs of the flounder in the Baltic towards the end of April.

Müller's Topknot.—A female with some ripe ova was procured in the middle of May. The pelagic ovum has an oil-globule.

Turbot.—Ova apparently of this form were obtained at the surface 9th July 1884, 47 miles E. by S. off the Isle of May, and at the same time ripe females were observed.

Young stages of the turbot were procured in considerable numbers off the Isle of May in August.

Solea.—From the 20th May to the 6th of July, in various parts of the Bay, a few ova, measuring ·045 inch in diameter, were almost daily captured in the mid-water and bottom-nets along with some of the gurnard. They are characterised by a more or less complete ring of groups of minute oil-globules, which vary in appearance according as the light is transmitted or reflected, being faintly straw coloured under the former, yellowish-white under the latter. The zona is tough and very distinctly punctate, even more so than that of the plaice and in one instance flattened papillæ occurred on it, so that it had a scabrous appearance. The

* E. E. Prince, *Ann. Nat. Hist.*, May 1886, p. 459.

yolk, moreover, shows a vesicular border, and pigment of a dull whitish or faintly yellowish hue rapidly develops over its surface. When the embryo is partly formed the groups of oil-globules are found along its ventral surface, as in a species of *Solea* (?) described by Raffaele. They have been hatched, and the connecting links with the following stage observed.

A larval form (Plate III. fig. 4), 5 mm. in length, apparently referable to this species, was procured in the mid-water net on the 22d August. The body had already considerably increased in depth, while the notochord was slightly bent up posteriorly, and the hypural elements developing. The most conspicuous feature in coloration was the presence of deep ochre-pigment in the dorsal marginal fin. The first spot occurred at the occiput, and behind were other five ramose pigment-areas—somewhat conical in shape, the base being at the margin of the muscle-plates of the body. Two less distinctly marked spots existed in the ventral marginal fin, each being somewhat behind a vertical line from the corresponding dorsal areas. A series of small stellate chromatophores ran along the margin of the body, dorsally and ventrally. Various chromatophores of the same hue extended over the abdominal surface of the head and cheeks, and many minute blackish specks occurred on the same regions as well as on the sides of the body. Along the margin of the body, between the large and small chromatophores were specks of similar pigment. The eyes are relatively small and of a bluish silvery aspect.*

Sprat.—The pelagic ova and larvæ of the sprat are frequent in the bottom-nets, in May and June.

Larval Clupeoids abound in the Bay from March to the end of April, the youngest varying from 8–10 mm. in length. They also occurred in April, $\frac{5}{16}$ inch long, and on the 10th May, $\frac{3}{8}$ inch. From this period till the 13th September none were procured in the Bay, though on the 31st August one measuring 13 mm. was obtained 15 miles south-east of the Isle of May. They were abundant in September, their sizes ranging from 8 to 13·5 mm.† The double spawning season of the herring is as well marked in regard to the larval fishes as the masses of eggs.

Many sprats and young herrings from $1\frac{7}{8}$ inch to 2 inches are captured in January, February, March, and April, and they also occur at other times.

Grey Gurnard.—The pelagic ova of this species (*Trigla gurnardus*) appeared in the mid-water-net this year on the 30th April,‡ and they occurred at all stages till the 6th July. The maximum period may be placed in June, when many were procured (on the 13th). In the majority of instances they were obtained by the mid-water and bottom-nets, indeed they only appeared in the surface-net on the 2nd July. This is not a point of much moment, however, as such is in all probability due to the conditions of the sea as regards currents and temperature.

The larval gurnard is characterised by its chrome-yellow pigment.

Cod.—An egg measuring ·051 of an inch in diameter made its first appearance on the 6th April in the surface-net, and occasionally occurred till the 4th May. It was most abundant on the 30th April. The larval cod is easily recognised by its four somewhat regular black specks or

* The development of the sole up to this stage is described in the *Researches* by Mr Prince and the Author, *Trans. R.S.E.*

† The larval sprat, according to Hensen, is distinguished in its early stage by a loop or bend of the intestine not present in the herring.

‡ Mr T. Scott states he procured gurnards' eggs in January 1889 in the Moray Firth.

bands, and the embryo, even in spirit-preparations, can be distinguished by the same pigment.

Haddock.—An egg, resembling that of the haddock, appeared on the 2nd March, and had the embryo far advanced—with blackish pigment on the skin. The ova of this species are common towards the middle and end of the month.

The larval haddock is 3 mm. in length, and has black pigment-corpuscles somewhat densely grouped behind the otocysts, and extending backward a little beyond the commencement of the intestine. A line of the chromatophores passes along the infero-lateral region from the beginning of the mesentery to near the caudal tip, and a few appear on the lower part of the abdominal region. A delicate polygonal protoplasmic mesh-work occurs over the surface of the yolk as in the flounder.

Rockling (Motella).—The ova of *Motella* in small numbers were obtained occasionally from the 2nd March to the 18th May, being most plentiful at the end of April. As a rule, they appeared in the mid-water and bottom-nets, though an ovum, measuring ·04 inch, with an oil-globule ·01, was captured in the surface-net on the 20th May, and probably belongs to the same genus. They are often plentiful in the bottom-net in spring. That procured in March had the embryo fairly advanced, the eyes being outlined, but the tail was short. In January 1885 many rocklings spawned in the tanks in the laboratory, and specimens continued to do so till March. Ripe females occurred in the tanks till April.

Whiting.—Ova of the whiting are common in April.

Lump-Sucker.—Larval examples appeared on the 11th June, and several times (in all 4 times) subsequently, viz., till the 20th of July; their length was 5·6 mm.

POST-LARVAL FORMS OF FOOD-FISHES, &c.

During the months of January, February, March, and April (with the exception of the last few days of the latter), no young round fishes were observed, if we except a few sprats on the 20th January and 12th April. Again, for the last week in April to the 20th September, post-larval food-fishes abounded; only Clupeoids occurring after the last mentioned date.

On the other hand, in 1889 post-larval forms of various kinds were procured from the middle of February.

Generally speaking, the sizes of the pelagic forms do not increase as the months go by, apparently for the reason that the larger forms seek downward or migrate elsewhere as they grow.

In the pelagic phase of larval and post-larval fish-life many forms which issue from demersal eggs are included, and the importance of these is greater than at first sight appears, since they serve as nourishment for the more valuable kinds, such as the food-fishes. It is true that some of these, such as the young lump-suckers, are very active and voracious, darting hither and thither to snatch smaller fishes than themselves, but in turn they are preyed on by the larger kinds—which frequent the margins of the rocks, or find the young lump-suckers amidst the floating masses of sea-weed in the long tidal lines at a distance from shore.

Pleuronectids.—These made their first appearance on the 20th January, and measured $\frac{3}{4}$ inch. None were captured between this and the 26th April, and only once in June. In May, July, August, and September they occasionally occurred, most being procured in the latter month. Three or four were brought up in the net on each occasion, and the number of times was 17. Their last appearance was on the 18th September. The length of these varied from 5 to 13·5 mm.

Common Dab.—In the mid-water net of 26th April a specimen 27 mm. was obtained.

Brill.—Post-larval examples of the brill occur occasionally at the surface of the sea in July.

Turbot.—A translucent example, 13 mm. long, was captured on the 2nd August. The right eye had reached the margin, and the alimentary canal and other viscera were readily visible in the almost transparent animal. In regard to coloration—eight touches of white pigment occurred along the margin of the dorsal fin, the first and last being indistinct. Six touches existed at the margin of the ventral fin. Five touches, again, were situated at the bases of the interneural spines—mostly longitudinal in direction; while four or five specks of the same kind occurred ventrally at the bases of the interhæmal spines. Between the dorsal white patches (marginal) were fine yellowish pigment-grains, and a band of similar pigment stretches within the inner ventral series. Very considerable changes thus ensue in the coloration of this species during development.

Cod.—A tessellated example occurred on the 15th of June in the Bay; while on the 10th August another $1\frac{1}{2}$ inch was secured in the ground-trawl 15 miles south-east of the Isle of May. Four parasitic *Chalimi* (young of *Caligus*) were attached to it.

Green Cod.—Several young forms were met with in July. Thus two occurred on the 11th and four on the 16th, ranging from $\frac{11}{16}$ to $\frac{7}{8}$ inch; while on the 20th another 19 mm. long was captured.

The post-larval gadoids made their first appearance on the 30th April, and ranged from $\frac{1}{4}$ to $\frac{1}{2}$ inch, and they continued to be captured at intervals till the 20th of July. They were most plentiful during May and the first fortnight of June. Thus on the 18th of May 31 occurred near the mouth of the Eden, their size ranging from $\frac{1}{4}$ to $\frac{7}{8}$ of an inch; and on the 1st June 18 were caught in the haul, their size being from 24 to 7·5 mm. (from about an inch down to $\frac{1}{3}$), the permanent rays just appearing in the caudal region of the youngest.

In the smallest form just mentioned, viz., about $\frac{1}{4}$ of an inch, the marginal fin is quite continuous, commencing ventrally behind the anus, and passing round the tail to a point on the dorsum a little in front of a vertical line from the vent, though in front of this a membranous margin projects a short distance, indicating probably a further extension of the fin. Fine embryonic rays are present throughout, except in the caudal region, where slight linear thickenings dorsally and ventrally indicate the commencement of the permanent rays. The pectorals are large—with a chimæroid base and a fan-like membrane with embryonic rays. No trace of ventrals is present. The mandible when closed is bent upward at a little more than a right angle to the body, and the angle of the jaw is very prominent. The eye often shows a notch dorsally, and a well-marked choroidal fissure inferiorly. A little black pigment exists on the snout and top of the head, and along each side of the dorsal and ventral marginal fin; while a streak also occurs in the middle line laterally in front of the tail. The same pigment appears in touches on the prominent edges of the mandible and along the ventral surface of the abdomen.

In the next stage (8 mm.) thickenings occur at the base of the embryonic fin at the points where the two posterior dorsal (2nd and 3rd) and the two anal fins arise. Two minute ventral papillæ indicate the ventral fins. The body and tail have considerably increased in bulk, though the head and anterior region still remain of great proportional size. The eyes at this stage are large, of a bluish silvery hue, and with a dark arch of pigment superiorly. The abdomen has a slightly pinkish hue from the crustacean food (chiefly *Calanus finmarchicus*) which fill both stomach and intestine.

The three dorsal fins then become distinct and the ventrals show rays. The growth of the body and head diminishes the proportional size of the eye. Moreover, while in the previous stages the tail of the young cod presented terminally a straight notochordal process, it now (at and near $\frac{3}{8}$ inch) shows a distinct upward curvature, apparently from the development of the hypural elements inferiorly.

A month later the young cod is found somewhat deeper in the water, being caught in the trawl as well as in the mid-water-net. The smallest is about $\frac{1}{1}\frac{5}{6}$ inch, and the pigment on the sides is not yet arranged in transverse bars. The barbel is now distinct. But soon the black pigment groups itself along the sides in the characteristic manner formerly pointed out, and a series of pale dots becomes evident along the dorso-lateral region. It then assumes the tessellated condition.

Whiting.—A single example 1 inch long was captured on the 10th September. Specimens of various sizes abound in the offshore ground, especially in August.

Rockling.—Post-larval *Motellæ* are frequently met with both in the surface and mid-water-nets when the latter is sunk in deep water near the bottom in July and August. As mackerel-midges at a later stage they are also often obtained towards the end of July and in August. They are found both inshore and offshore.

Post-larval examples of this species first occurred on the 31st August, and were two in number, measuring 5 and 6 mm. They were occasionally (5 times in all) met with till 20th September, on which date they were 10 and 12 mm.

Armed Bull-head (Agonus).—Early in April (4th) the larval form of this species is occasionally met with in the Bay, and generally measures about 7 mm. It is remarkable for the bright yellowish and black coloration, and the great depth of both dorsal and ventral regions of the marginal fin, which thus gives the form a somewhat spindle-shaped aspect. The snout is comparatively blunt, and the large size of the eyes recalls the condition in the gadoids and Pleuronectids. The auditory capsule is also spacious. The abdomen presents a marked incurvation in front of the rectum. The pectoral fins are large and fan-shaped.

Older stages were procured in the mid-water-net towards the end of April, the length ranging to $\frac{5}{8}$ of an inch. The chief coloration is fine chrome-yellow, especially on the pectoral and dorsal fins and the cutaneous spicules. The spines along the sides form hispid rows—from the pectorals to the tip of the tail.

Unknown Forms.—(G) An unknown larval-fish, with the anus in the middle of the body (Plate III. fig. 8) and a large solitary oil-globule about the centre of the abdomen. A little dark pigment occurs along the ventral edge.

These were procured on the 2nd and 6th of March.

(D) Another and somewhat allied form—in external appearance—was procured about the middle of the same month (March). It is readily distinguished, however, by the presence of a considerable mass of yolk towards the posterior part of the abdomen, and in the centre of this a comparatively large oil-globule surrounded by the usual protoplasmic border. Like the former, the anus is near the middle of the body (somewhat behind it), moreover, it only reaches the middle of the ventral marginal fin, as in certain gadoids. A line of black chromatophores runs along the middle line of the abdomen, curves upward behind it, and is continued under the notochord to the rectum; the total length of the fish was a quarter of an inch.

(E) The post-larval form with the short snout and large eyes, described under the head of February (Plate III. fig. 6), is another unknown form. It is further characterised by the peculiar pigment-specks over the faintly yellowish mid-brain.

(H) The larval fish with the distinct incurvation in the rectal region, which is median in position (Plate IV. fig. 1), is also unknown. The oil-globule in this case lies with the remains of the yolk towards the anterior part of the abdomen. A line of black chromatophores runs along the ventral edge below the gut.

Sand-eel.—Larval sand-eels occurred on the 11th March (8·5 mm. and 10 mm.) and then on 18th and 30th April, those on the latter date being $\frac{3}{4}$ inch long. They are met frequently between this and the 18th September. They appeared to be most common in May, August, and September. None were procured in June.

Montagu's Sucker.—Larval Montagu's suckers appeared on the 18th April. This is a very abundant form in St Andrews Bay, the ova being attached to sea-weeds, zoophytes, and other structures on the bottom. The larval fishes, however, become at once pelagic on extrusion, and thus fall a prey to the larger young fishes.

Gunnel.—Larval gunnels abound off the rocks in April after their escape from the demersal egg.

Gobies.—Young gobies (chiefly *Gobius minutus*) occurred eleven times, viz., from the 26th April ($1\frac{5}{8}$ inch) to the 26th September (5 mm.), one of 21 mm. appearing on the 17th of the same month. They were most abundant in July and August; thus on the 6th July 33 were present in the net, their dimensions ranging from 3·5 to 11 mm., the first-mentioned having only embryonic rays in the fins; while 15 appeared on the 4th August—their lengths being from 5 to 10 mm.

Cottus scorpius.—This species was first observed in the net on the 7th March (7 mm. long) and again on the 28th May (9 mm.) and they occasionally occurred till the 20th of September, though none were got between May and the 31st August, the single example on the latter date being 9 mm. long. The latter would therefore seem to be its most active pelagic condition, unless the net had accidentally reached the bottom.

Dragonet.—Post-larval forms of this species occurred on the 31st August (5 mm. long), on the 3rd September (4·5 mm.), on the 10th (8·5 to 10 mm.), and again on the 20th (9 mm. long). The adult spawns in July.

EXPLANATION OF THE PLATES.

PLATE III.*

Fig. 1. Pelagic egg with large perivisceral space. Size ·072, and of yolk ·042. 16th March.
Fig. 2. Pelagic egg with large perivisceral space, embyro further advanced, and with yellowish pigment. 29th March. × 21.
Fig. 3. Larval fish from the foregoing egg shortly after hatching. 31st March. × 20.
Fig. 4. Early post-larval sole, 5 mm. long. 22nd August 1888.
Fig. 5. Larval stage of unknown Teleostean with the yolk still present. × about 10.
Fig. 6. Anterior end of an older stage, apparently of an allied form. An oil-globule appears under the liver. The large size of the eye and its proximity to the mouth are noteworthy. Enlarged under a lens.
Fig. 7. Dorsal view of the head of Fig. 5. × about 30.
Fig. 8. Larval fish of unknown relationships with large oil-globule, but no yolk. Slightly enlarged under a lens.

* For several figures of larval fishes I am indebted to the skilful pencil of Mr E. E. Prince, B.A.; other figures were drawn by Mr Pentland Smith, M.A.

PLATE IV.

Fig. 1. Larval fish with peculiar inflection at the rectum. 30th March. × 50.
Fig. 2. The same species shown in Plate III. fig. 8, placed on the side so as to show the broad marginal fin. 13th March. × about 12.
Fig. 3. Enlarged view of a dead example of the foregoing at a somewhat earlier stage. 2nd March. × 52.
Fig. 4. Head and anterior end of the same species viewed from the ventral surface. × 52.
Fig. 5. Dorsal view of a post-larval gadoid, to show the general arrangement of the pigment. Enlarged under a lens.
Fig 6. Lateral view of a similar gadoid as it appears in the mid-water-net of May and June. The pinkish colour of the crustacean food in the stomach shines through the body-wall. Enlarged under a lens.

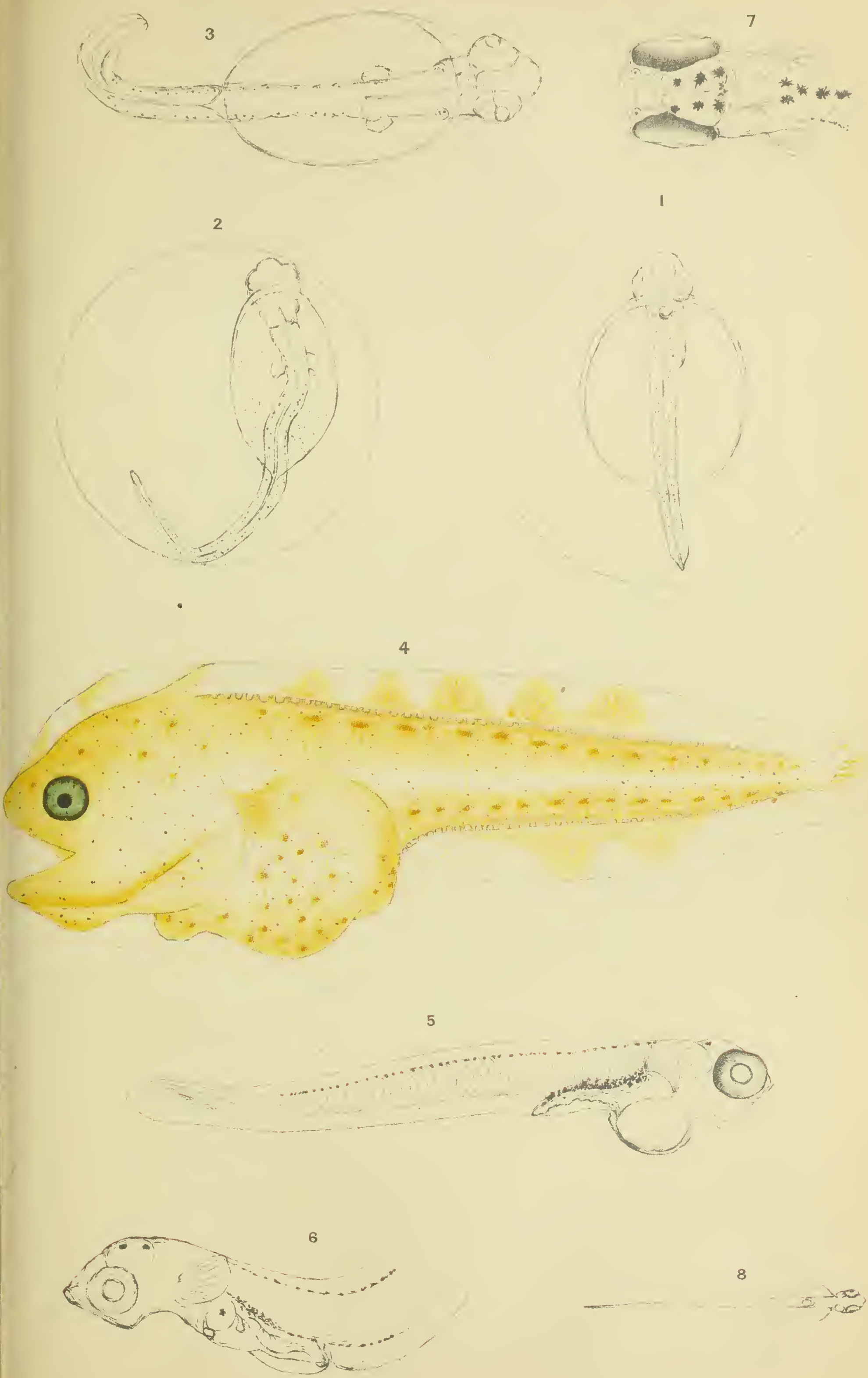
PLATE V.

Fig. 1. Gelatinous algoid, very abundant in the Bay in April, May, and June, and forming the food of many of the smaller animals. Magnified.
Fig. 1*a*. Optical section of the same. Similarly magnified.
Fig. 2. Minute structure of the gelatinous masses as observed in June. × 23 6.
Fig. 3. Spherical variety of the foregoing. June. Magnified.
Fig. 4. Another variety of the same. Magnified.
Fig. 5. *Thaumantias melanops*, with a parasitic young *Peachia* adhering to the margin of the disc. The anemones are thus carried about within easy reach of the pelagic fishes. Enlarged under a lens.
Fig. 6. *Thaumantias*, differing from any known form, though coming nearest *T. melanops*, about natural size. 24th July 1888.
Fig. 7. The same, enlarged under a lens. For simplicity the tentacles have been omitted posteriorly.
Fig. 8. Portion of the margin of the disc more highly magnified, to show the arrangement of the tentacles and ocelli. × 50.
Fig. 9. Reproductive band (in a male example). × about 10.

PLATE VI.

Figs. 1, 2, and 3. Various conditions of the larval form of *Phoronis* (*Actinotrocha*). In fig. 1, the larval tentacles are in full development. In fig. 2, the buds of the new tentacles are shown at the bases of the old. In fig. 3, the folded tube, which afterwards becomes the body of the adult, is observed.
Fig. 4. *Actinotrocha* undergoing transformation. The tube is unrolling, like the turning of the finger of a glove inside out. The hood is also shrinking.
Fig. 5. A further stage of the foregoing, a prolapse of the viscera having occurred at the anus.
Fig. 6. Anal ciliated ring of *Actinotrocha*.
Fig. 7. Young *Phoronis* after the transformation.
Fig. 8. The same, at a subsequent stage. The anus and mouth now lie near each other.
Fig. 9. A young Appendicularian. 28th June. The caudal appendage seems to be shrivelled. Enlarged.

The foregoing drawings (Plate VI.) were made by Mr Alford Anderson, formerly Prizeman in Zoology, and now a student of medicine in Edinburgh.



PELAGIC FISHES.

W.C.M., E.E.P. & J.P.S. del.

PELAGIC FISHES.

WCM., EEP & J.PS del

PELAGIC FISH FOOD.

A.W.A. & J.P.S. (FIG. 9) del.

V. SOME ADDITIONS TO THE FAUNA OF THE FIRTH OF FORTH WITH NOTES OF SOME RARE EAST COAST FORMS. By Thomas Scott.

Since the publication of the Revised List of the Crustacea of the Forth in the last Report of the Fishery Board for Scotland, several interesting additions have been made to some of the groups therein described, and it has been considered desirable that these should now be recorded, as well as some species belonging to the *Protozoa*, the *Echinodermata*, the *Mollusca*, and *Pisces*, which hitherto do not appear to have been observed within the limits of the estuary. Though the chief object of the present paper is the recording of species new to the fauna of the Firth of Forth, reference is also made to rare and interesting organisms which have from time to time been observed while engaged in the trawling experiments carried on, under the directions of the Scientific Committee of the Fishery Board, in the Firth of Forth, in the Moray Firth, and in the Firth of Clyde. Though the recording of such discoveries may be of secondary importance when compared with the Board's other investigations, yet this tends to show that the work that is being carried on is benefiting science in various ways.

INVERTEBRATA.

Foraminifera.

In a valuable paper by Mr H. B. Brady on Brackish-water Foraminifera, several species are recorded as occurring in the higher reaches of the Forth, particularly in the vicinity of Bo'ness. Professor Franz Eilhart Schulze, in the Report of the German Expedition of 1872, gives a list of species observed mostly in the lower parts of the estuary during that expedition, all of which are included in Leslie and Herdman's *Invertebrate Fauna of the Firth of Forth.* The *Foraminifera* recorded in that work comprise three species of *Miliolidæ*, two of *Lituolidæ*, thirteen of *Lagenidæ*, fourteen of *Globigerinidæ*, and three of *Nummulinidæ* ; to these Professor J. R. Henderson added *Astrorhiza limicola*, Sandahl. The following are some further additions of species (twenty-three in number), that have been observed while collecting data in connection with the trawling experiments.

Miliolidæ.

Cornuspira foliacea (Phillipi).

Orbis foliacea, Phillipi, Enum. Moll. Sicil., vol. ii. p. 147, tab. xxiv. fig. 25 (1844).

Cornuspira planorbis, Schultze, Uber den Org. der Polyth., t. ii. fig. 21 (1854).

Spirilina foliacea, Williamson, Rec. For. of G. Brit., p. 91, pl. vii. figs. 199–201 (1858).

Cornuspira foliacea, H. B. Brady, Foram. of the Chall. Exped., p. 199, pl. xi. figs. 5–9 (1884).

Habitat.—A few specimens among material dredged in the South Bay; one of the specimens was perfect, the others were young.

Cornuspira striolata, H. B. Brady.

Cornuspira striolata, Brady, Proc. Roy. Soc. Edin., vol. xi. p. 713 (1882).

Habitat.—One specimen, near Inchkeith, 10 to 12 fathoms. The specimen has unfortunately been damaged but is still perfect enough for identification. This species has been found in the cold water channel near the Faroe Islands in over 500 fathoms.

Vertebralina striata, d'Orbigny.
Vertebralina striata, d'Orbigny, 1826, Tableau Method, Modèles, No. 81.
Habitat.—One specimen from each of the following places, Aberlady Bay, Inchkeith, and Largo Bay.

Biloculina ringens (Lamarck).
Miliolites ringens, Lam., 1804, Ann. du Mus., vol. v. p. 351; vol ix. p. 2, pl. xvii. fig. 1.
Biloculina ringens, Williamson, 1858, Rec. For. of G. Brit., p. 79, pl. vi. figs. 169, 170.
Habitat.—A few specimens among material dredged in Aberlady Bay.

Biloculina depressa, d'Orbigny.
Biloculina depressa, d'Orb., Ann. Sc. Nat., vol. vii. p. 298 (1826).
Lagenula marginata, Fleming, Brit. Anim., p. 235 (1828).
Biloculina ringens, Williamson (in part), Rec. For. of G. Brit., p. 78, pl. vii. figs. 172–174 (1858).
Biloculina depressa, H. B. Brady, Foram. of the Chall. Exp., p. 145, pl. ii. figs. 12, 15–17., and pl. iii. figs. 1, 2 (1884).
Habitat.—One or two specimens among dredged material, also from South Bay; this species is of frequent occurrence in the Clyde.

Biloculina elongata, d'Orbigny.
Biloculina elongata, d'Orb.
Biloculina ringens, var. *patagonica*, Williamson, Rec. For. of Gr. Brit., p. 80, pl. vii. figs. 175, 176 (1858).
Biloculina elongata, Robertson, Fauna and Flora of the W. of Scot., p. 51 (1876).
Biloculina elongata, H. B. Brady, Foram. of the Chall. Exp., p. 144, pl. xi. figs. 9, *a*, *b* (1884).
Habitat.—A few specimens among material dredged in the same locality as last, and others from Aberlady and Largo Bays.

Miliolina oblonga (Montagu).
Vermiculum oblongum, Mont., Test. Brit., p. 522, pl. xiv. fig. 9 (1803).
Vermiculum oblongum, Fleming, Brit. Anim., p. 233 (1828).
Triloculina oblonga, D'Orb., Tableau Method, p. 300 (1826).
Miliolina seminulum, Williamson (in part), Rec. For. of G. Brit., p. 85, pl. vii. figs. 86, 87 (1858).
Miliolina oblonga, H. B. Brady, Foram. of the Chall. Exp., p. 160, pl. v. fig. 4, *a*, *b* (1884).
Habitat.—Two perfect specimens among dredged material from the vicinity of Inchkeith, and a few from Aberlady Bay.

Miliolina trigonula (Lamarck).
Miliolites trigonula, Lam., 1804, Ann. du Mus., vol. iv. p. 351, No. 3.
Miliolina trigonula, H. B. Brady, Foram. of the Chall. Exped., p 164, pl. iii. figs. 14–16 (1884).
Habitat.—A few specimens among material from Aberlady Bay.

Miliolina secans, d'Orbigny.
Miliolina secans, d'Orb.
Miliolina seminulum, var. *disciformis*, Williamson, Rec. For. of G. Brit., p. 88, pl. vii. figs. 188, 189 (1858).

Quinqueloculina secans, Robertson, Fauna and Flora of the W. of Scot., p. 51 (1876).

Miliolina secans, H. B. Brady, Foram. of the Chall. Exp., p. 167, pl. vi. figs. 1, 2 (1884).

Habitat.—Two specimens in material dredged, in 12 to 14 fathoms, to the east of Inchkeith, and one or two from Aberlady Bay.

Miliolina bicornis (Walker and Jacob).

Serpula bicornis ventricosa, W. & J., Test. Min. Rar., p. 2, tab. i. fig. 2 (1784).

Triloculina brongniartii, d'Orb., Ann. Sci. Nat., vol. vii. p. 300, No. 23 (1826).

Vermiculum bicorne, Fleming, Brit. Anim, p. 234 (1828).

Miliolina bicornis, Williamson, Rec. For. of G. Brit., p. 85, pl. vii. figs. 190–198 (1858).

Quinqueloculina bicornis, Robertson, Fauna and Flora of the W. of Scot., p. 51 (1876).

Miliolina bicornis, H. B. Brady, Foram. of the Chall. Exp., p. 171, pl. vi. figs. 9, 11, 12 (1884).

Habitat.—A few specimens in material dredged in the South Bay. It is over a hundred years since this species was first made known as British by William Boys, the well-known conchologist, in his work, *Testacea Minuta Rariora.*

Miliolina agglutinans, d'Orbigny.

Miliolina agglutinans, d'Orb.

Quinqueloculina agglutinans, Robertson, Fauna and Flora of the W. of Scot., p. 51 (1876).

Quinqueloculina agglutinans, H. B. Brady, Foram. of the Chall. Exped., p. 180, pl. viii. figs. 6–7 (1884).

Habitat.—One specimen in material dredged in the vicinity of Inchkeith, and others from Aberlady and Largo Bays. This does not appear to be a very common species in the Forth. It is easily distinguished by having numerous grains of sand incorporated in the matrix of the shell, so that it looks as if it properly belonged to the arenaceous group *Lituolidæ.* It is moderately common in the Clyde.

Miliolina ferussacii (d'Orbigny).

Quinqueloculina ferussacii, D'Orb., Ann. Sci. Nat., vol. vii. p. 301, No. 18 (1826).

Miliolina bicornis, var. *augulata*, Williamson, Rec For. of G. Brit., p. 88, pl. vii. fig. 196 (1858).

Miliolina ferussacii, H. B. Brady, Foram. of the Chall. Exped., p. 175, pl. cxiii. fig. 17, *a*, *b* (1884).

Habitat.—One specimen in material dredged in the South Bay, in 6 to 7 fathoms water, and a few from Aberlady Bay.

LITUOLIDÆ.

Haplophragmium pseudo-spirale (Williamson).

Proteonina pseudo-spiralis, Will., Rec. For. of G. Brit., p. 2, pl. i. figs. 2, 3 (1858).

Haplophragmium pseudo-spirale, H. B. Brady, Foram. of the Chall. Exped., p. 302, pl. xxxiii. figs. 1–4 (1884).

Habitat.—Not unfrequent among material dredged a little west of Inchkeith. Skye is the only locality given for this species by Williamson, where it was first discovered by Barlee. I have met with it in Loch Fyne and Rothesay Bay, but it does not appear to be a common species.

LAGENIDÆ.

Lagena hexagona, Williamson.

Lagena squamosa, var. *hexagona*, Will., 1858, Rec. For. of G. Brit., p. 13, pl. i. fig. 31.

Lagena hexagona, H. B. Brady, Foram. of the Chall. Exped., p. 472, pl. lviii. figs. 32, 33 (1884).

Habitat—One or two specimens dredged in Aberlady Bay. This differs from *Lagena squamosa* in having the surface reticulations in the form of more or less regular hexagons.

Vaginulina linearis (Montagu).

Nautilus linearis, Montagu, 1808, Test. Brit. Suppl., p. 87, pl. xxx. fig. 9.

Dentalina legumen, var. *linearis*, Williamson, 1858, Rec. For. of G. Brit., p. 22, pl. ii. figs. 46–48.

Vaginulina linearis, H. B. Brady, Foram. of the Chall. Exped., p. 532, pl. lxvii. figs. 10–12 (1884).

Habitat.—Two specimens in material dredged in Aberlady Bay.

Ammodiscus incertus (d'Orbigny).

Operculina incerta, d'Orb. 1839, Foram. Cuba., p. 71, pl. vi. figs. 16, 17.

Spirillina arenacea, Williamson, 1858, Rec. For. of G. Brit., p. 93, pl. vii. fig. 203.

Amonodiscus incertus, H. B. Brady, Foram. of the Chall. Exped., p. 330, pl. xxxviii. figs. 1–3 (1884).

Habitat.—Among some material dredged near Inchkeith.

Nodosaria pyrula, d'Orbigny.

Nodosaria pyrula, d'Orb, Tableau Method, 1825.

Nodosaria pyrula, Will., Rec. For. of G. Brit., p. 17, pl. ii. fig. 39 (1858).

Nodosaria pyrula, H. B. Brady, Foram. of the Chall. Exped., p. 497, pl. lxii. figs. 10–12 (1884).

Habitat.—An imperfect specimen in material dredged in the vicinity of Inchkeith, and two in Largo Bay. On account of the slender form of this species it is seldom a perfect specimen is found.

Cristellaria rotulata (Lamarck).

Cristellaria calcar, Williamson, Rec. For. of G. Brit., p. 27, pl. ii. figs. 52–53 (1858).

Lenticulites rotulata, Lamk., Annal., Mus., v. p. 188, tab. lxii. fig. 11 (1804).

Nautilus calcar, Flem., Brit. Anim., p. 228 (1828).

Cristellaria rotulata, D'Orb., Mem. Soc. Geol. France, tome iv. p. 26, tab. xxii. figs. 15–18 (1839).

Cristellaria rotulata, H. B. Brady, Foram. of the Chall. Exped., p. 549, pl. lxix. fig. 13 *a*, *b* (1884).

Habitat.—Two specimens in material dredged near Inchkeith, and one or two from Aberlady Bay. This is moderately common in the British seas, and is found in shallow as well as in comparatively deep water.

Cristellaria crepidula (Fichtel and Möll).

Nautilus crepidula, Fichtel and Möll, 1803, Test. Micr. p. 107, pl. xix. figs. *g–i*.

Cristellaria crepidula, d'Orbigny, 1839, Foram. Cuba, p. 64, pl. viii. figs. 17, 18.

Habitat.—A few specimens in material dredged in Aberlady Bay.

Polymorphina oblonga, d'Orbigny.

Polymorphina oblonga, d'Orb., 1846, For. Foss. Vien., p. 232, pl. xii. figs. 29–31.

Habitat.—A few specimens in material dredged in Aberlady Bay. This is not the *Polymorphina lactea*, var. *oblonga*, of Williamson, the cells (or segments) of which are differently arranged and having the sutures flush, whereas the species here recorded has the segments inflated and separated by excavated sutures.

Polymorphina gibba (d'Orbigny).

Globulina gibba, d'Orb., Foram. de Vienne, tab. xiii. fig. 13, 14 (1846).

Polymorphina gibba, Robertson, Trans. Geol. Soc. Glasg., p. 24 (1883).

Polymorphina gibba, H. B. Brady, Foram. of the Chall. Exped., p. 561, pl. lxxi. fig. 12 (1884).

Habitat.—One specimen among material dredged west of Inchkeith, and several specimens from Aberlady Bay.

Globigerinidæ.

Orbulina universa, d'Orbigny.

Orbulina universa, d'Orbigny, 1839, Foram. de Cuba, p. 3, No. 1, pl. i. fig. 1.

Habitat.—Several specimens from Aberlady and Largo Bays.

Bolivina dilatata, Reuss.

Bolivina dilatata, Reuss, 1849, Denkschr, d. k. Akad. Wiss. Wein., vol. i. p. 381, pl. xlviii. fig. 15.

Bolivina dilatata, H. B. Brady, Foram. of the Chall. Exp., p. 418, pl. lii. figs. 20, 21 (1884).

Habitat.—Two specimens in some material dredged in South Bay. This species differs from *B. punctata* in being triangular in shape, whereas *B. punctata* has the sides nearly parallel; it differs also from *B. pygmæa* in the cells not terminating in free spinous processes along the edges, as in that species.

Virgulina schreibersiana, Czjzek.

Virgulina schreibersiana, Czjzek, 1847, Haidingars. Naturw. Abhandl., vol. ii. p. 147, pl. xiii. figs. 18–21.

Bulimina pupoides, var. *compressa*, Williamson, Rec. For. G. Brit., p. 63, pl. v. fig. 131 (1858).

Virgulina Schreibersiana, H. B. Brady, Foram. of the Chall. Exp., p. 414, pl. lii. figs. 1–3 (1884).

Habitat.—One specimen from material dredged near Inchkeith, and a few from Aberlady Bay.

Polystomella crispa (Linné).

Nautilus crispus, Linné, 1767, Syst. Nat., 12th ed., p. 1162–275.

Polystomella crispa, Williamson, Rec. For. of G. Brit., p. 40, pl. iii. figs. 78–80 (1858).

Habitat.—A few dredged in Aberlady Bay. This is one of the commonest species of British foraminifera.

ECHINODERMATA.

Asteroidea.

Brissopsis lyrifera (L. Agass.).

Brissus lyrifer, Forbes, Hist. Brit. Starfishes, p. 187 (1841).

Brissopsis lyrifera, L. Agassiz, Des., 1847, C. R. Ann. Sci. Nat., vol. viii. p. 15.

Habitat.—Taken north-west of May Island; one full grown specimen. We do not find any previous record of the occurrence of this species in the Firth of Forth. It usually frequents a muddy bottom, and, where the conditions are favourable, is sometimes found in considerable abundance. While on board a trawler in Rothesay Bay in the early part of 1887, I found among a quantity of fine tough mud brought up in the net a large number of *Brissus*. I counted over sixty specimens, some of which were comparatively large, as the following two samples show—1st (?) male, length 69 mill., breadth 61 mill., thickness 38 mill. ; (?) female, length 69 mill., breadth 56 mill., thickness 41·5 mill. These measurements show a considerable variation in the form of the two specimens,—the one being high and narrow, the other broad and depressed and this variation was not confined to the two specimens of which the measurements are given, but was observable in most of those captured. I was not able at the time to ascertain satisfactorily whether the variation was due to difference in sex; but that, however, is the correct explanation of it. They were all of a dark purplish colour, which seems to be the normal colour of this species; but specimens of a light cream colour having the line which forms the supposed figure of a lyre on the dorsal aspect dark have been sent to the University from the Clyde.

CRUSTACEA.

COPEPODA.

Artotrogidæ.

Cymbasoma rigidum, I. C. Thompson.

Cymbasoma rigidum, I. C. Thompson, Journ. Linn. Soc. (Zoology), vol. xx. p. 154, pl. xiii. figs. 1–4 (1887).

Habitat.—Two specimens of this interesting Copepod were taken a little to the east of Inchkeith with the surface tow-net in October last year (1888), and is the first record of its occurrence in the East of Scotland. One specimen (the first) was taken by Mr Thompson with a tow-net at Orotava, Teneriffe, and he made it the type of the new genus *Cymbasoma*. It has been observed in several localities since it was discovered at Teneriffe. Mr Thompson has records of its occurrence in the Mediterranean and near Jersey (Channel Islands), also in Lamlash Bay, Arran, and Loch Linnhe in the west of Scotland; but there is no previous record of its occurrence on the east coast.

OSTRACODA.

Cytheridæ.

Pontocypris mytiloides (Norman).

Cythere mytiloides, Norman, Ann. and Mag. Nat. Hist., vol. ix. p. 50, pl. iii. figs. 1–3 (1862).

Pontocypris mytiloides, Brady and Norman, Mon. of the M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 107 (1889).

Habitat.—A few specimens among material from Aberlady and South Bays. This is a moderately common species.

Cythere cuneiformis, Brady.

Cythere ventricosa, G. O. Sars, Oversigt of Nor. Mar. Ostrac., p. 34.

Cythere cuneiformis, Brady, Mon. Rec. Brit. Ostrac., p. 404, pl. xxxi. figs. 47–54 (1868).

Habitat.—Two specimens of this species were found inside the dead shell of a *Cyprina islandica* dredged in Aberlady Bay, 2¾ to 3 fathoms.

Cythere pellucida, Baird.

Cythere pellucida, Baird, Brit. Entom., p. 173, pl. xxi. fig. 7 (1850).

Cythere castanea, G. O. Sars, Oversigt of Norges Marine Ostracoder, p. 32 (1865).

Cythere pellucida, Brady and Norman, Mon. of the M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 126, pl. xiv. figs. 13–15 (1889).

Habitat.—A few specimens taken with hand-net among sea-weed at low-water at Cramond Island. What has hitherto been known as *Cythere pellucida*, Baird, is now *Cythere confusa*, Brady and Norman (see Monograph).

Cythere (?) *semipunctata*, Brady.

Cythere (?) *semipuncata*, Brady, Mon. Rec. Brit. Ostrac., p. 411, pl. xxix. figs. 33–38 (1868).

Habitat.—One specimen dredged in Aberlady Bay, and another in Largo Bay, new to the east of Scotland. The position of this species in this genus remains doubtful.* I have also found it in Loch Fyne, near Tarbert.

Cythere navicula, Norman.

Cythere navicala, Norman, Last Report Dredging among the Shetland Isles, Brit. Assoc. Report, p. 292 (1868).

Cythere navicula, Brady and Norman, Mon. of the M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 143, pl. xvi. figs. 15, 16 (1889).

Habitat.—A single specimen of this species was dredged off St Monance (The Fluke Hole). The only previous records of its occurrence in Scotland are Shetland and the Minch.

Cytheridea punctillata, Brady.

Cytheridea punctillata, Brady, Mon. Rec. Brit. Ostrac., p. 424, pl. xxvi. figs. 35–38, pl. ix. figs. 9–11 (1868).

Cytheridea punctillata, Brady and Norman, Mon. of the M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 173 (1889).

Habitat.—Among material dredged in Largo Bay. New to the east of Scotland.

Loxoconcha impressa (Baird).

Cythere impressa, Baird, Brit. Entom., p. 173, t. xxi. fig. 9 (1850).

Loxoconcha impressa, Brady and Norman, Mon. of the M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 183, pl. xxiii. fig. 7 (1889).

Habitat.—A few specimens dredged in Aberlady and Largo Bays.

* Brady and Norman, *Mon. of the Marine and Freshwater Ostracoda of the N. Atlantic and N.-W. Europe*, p. 130.

Xestoleberis aurantia (Baird).

Cythere aurantia, Baird, Brit. Entom., p. 171, t. xxi. fig. 8 (1850).

Xestoleberis aurantia, Brady and Norman, Mon. of the M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 188 (1889).

Habitat.—Several specimens dredged in Aberlady and Largo Bays. The only previous record of it for the east of Scotland is Berwick Bay (Dr Baird). I have this species also from E. Loch Tarbert, the living shells of which had a pale rosy hue.

Cytherura producta, Brady.

Cytherura producta, Brady, Mon. Rec. Brit. Ostrac., p. 443, pl. xxxii. figs. 60, 61 (1868).

Habitat.—One or two specimens dredged in Largo Bay. There does not seem to be any previous record of this species from the east of Scotland.

Cytherura similis, G. O. Sars.

Cytherura similis, G. O. Sars, Oversigt of Norges Marine Ostracoder, p. 72 (1865).

Cytherura similis, Brady and Norman, Mon. of the M. and Fw. Ostrac. of the N. Atlantic and N-W. Europe, p. 203, pl. xviii. figs. 7–9 (1889).

Habitat.—Two specimens dredged in Largo Bay. This seems to be new to the east of Scotland.

Cytheropteron angulatum, Brady & Robertson.

Cytheropteron angulatum, B. & R., Ann. and Mag. Nat. Hist., Ser. iv. vol. iv. p. 62, pl. ii. figs. 7, 8 (1872).

Cytheropteron angulatum, Brady & Norman, Mon. of the M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 217, pl. xix. figs. 17, 18 (1889).

Habitat.—Two specimens from material dredged in Aberlady Bay. New to the east of Scotland.

Cytheropteron depressum, Brady and Norman.

Cytheropteron subcircinatum, Brady, Mon. Rec. Brit. Ostrac. p. 447, pl. xxxiv. figs. 39–42 (1868), (not *C. subcircinatum*, G. O. Sars).

Cytheropteron depressum, Brady and Norman, Mon. of the M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 218, pl. xx. figs. 22, 23 (1889).

Habitat.—One or two specimens in material dredged in Aberlady and Largo Bays. Apparently new to Scotland.

Bythocythere constricta, G. O. Sars.

Bythocythere constricta, Sars, Oversigt of Norges Marine Ostrac., p. 85 (1865).

Bythocythere constricta, Brady and Norman, Mon. of the M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 220 (1889).

Habitat.—Frequent among material dredged in Aberlady and Largo Bays.

Cladocopa.

Polycope compressa, B. and R.

Polycope compressa, B. and R., Ann. and Mag. Nat. Hist., p. 372, pl. xxi. (1869).

Habitat.—Four specimens of this species were found among material dredged off St Monance (The Fluke Hole). In form they are much more compressed laterally than *P. orbicularis*, and the shells are distinctly denticulate on the anterior margin and this differs from the typical *P. compressa* as described in the Annals. The valves of the *shells are white* and the surface polished. This appears to be a rare species and new to Scotland. Two species of *Ostracoda* recorded from the Forth in the monograph by Brady and Norman, viz., *Argillœcia cylindrica*, G. O. Sars, and *Pseudocythere caudata*, G. O. Sars, were also dredged in the 'Fluke Hole.'

AMPHIPODA.

Gammaridæ.

Stenothoe marina (Spence Bate).

Montagua marina, S. Bate, Brit. Assoc. Report, 1855, p. 57.

Montagua marina, Bate and Westwood, Brit. Sess.-eyed Crust., vol. i. p. 58, 1863.

Stenothoe marina, A. Boeck, Crust. Amphip. Bor. et Arct., 1870, p. 59.

Habitat.—In various parts of the Forth, from Inchkeith to May Island, but not very common. It has been taken at Banff by Mr Edward; at Dunoon and Cumbrae, Firth of Clyde, by Mr Robertson; and amongst trawled material near Eddystone Lighthouse by Messrs Bate and Westwood. This species is easily distinguished by the peculiar form of the hands of the second pair of gnathopods.

Callisoma crenata (Spence Bate).

Scopelocheirus crenatus, S. Bate, Brit. Assoc. Report, 1855.

Callisoma crenata, S. Bate, Cat. Amphip. Brit. Mus., p. 85, pl. xiv. fig. 5 (1862).

Callisoma crenata, S. Bate and Westwood, Brit. Sess.-eyed Crust., vol. i. p. 120 (1863).

Habitat.—Not unfrequent near May Island. In the Moray Firth, on board the Messrs Johnston's steam trawler 'Southesk,' in February last, a large dead cod-fish (partly decomposed) was brought up in the trawl-net, and these Amphipods were observed by me in great numbers crawling over, and burrowing in, the decomposing flesh of the dead fish. Mr Robertson also records * that he found a 'partly broken test of *Brissus lyrifer* crowded with this species,' which thus appears to be one of those very useful organisms termed the scavengers of the sea.

Metopa alderi (Spence Bate).

Montagua alderi, S. Bate, Brit. Assoc. Report, 1855.

Montagua alderi, B. &. W., Brit. Sess.-eyed Crust., vol. i. p. 61 (1863).

Metopa alderi, A. Boeck, Crust. Amphip. Bor. et Arct. (1870), p. 273.

Metopa alderi, A. Boeck, Skand. Arkt. Amphip. (1876), 456.

Habitat.—Occurred occasionally in bottom tow-nettings between Inchkeith and May Island (S.F.B.); Firth of Forth by the staff of the Scottish Marine Station; dredged between Cumbrae Lighthouse and Arran, 50 fathoms; Mull of Kintyre, in 49 fathoms, by Dr Murray; and Cullercoats by Mr Joshua Alder and the Rev. A. M. Norman.†

* *Amphip. and Isop. of the Firth of Clyde*, p. 19 (1888).
† *Loc. cit.*, p. 90.

Anonyx longipes, Spence Bate.

Anonyx longipes, S. Bate, Cat. Amphip. Crust. Brit. Mus., p. 79, pl. xiii. fig. 4.

Anonyx longipes, Bate and Westwood, Brit. Sess.-eyed Crust., i. p. 113 (1863).

Anonyx ampulla, Bate and Westwood, *loc. cit.*, i. p. 116.

Tryphosa longipes, A. Boeck, Crust. Amphip. Bor. et. Arct., p. 38 (1870).

Anonyx longipes, Robertson, Amphip. and Isop. of the Firth of Clyde, p. 18 (1888).

Habitat.—Several specimens among bottom tow-net material from the 'Fluke Hole,' off St Monance.

Pontocrates norvegicus (A. Boeck).

Œdiceros norvegicus, A. Boeck, Forhandl. ved. de Skand. Naturf., 8de mode (1860), p. 650.

Kroyera arenaria, S. Bate, Tyneside Nat. Field Club, vol. iv. (1863), p. 15, pl. i. pl. ii. fig. 1.

Pontocrates norvegicus, A. Boeck, Crust. Amphip. Bor. et Arct. (1870), p. 91.

Habitat.—Considerable numbers were observed on the sandy flat called 'Sand End,' east of Burntisland, at the edge of the retiring tide. They burrowed very quickly out of sight in the wet sand.

Phoxus holbölli, Kröyer.

Phoxus holbölli, Kröyer, Naturh. Tidsskr., 1 R. iv. (1842), p. 151.

Phoxus holbölli, B. & W., Brit. Sess.-eyed Crust., vol. i. p. 143 (1863).

Habitat.—A few specimens taken west of May Island; it does not seem to be very common in the Forth. This species has been taken in Loch Fyne, 80 fathoms; near low water, Balloch Bay, Cumbrae, and other places in the Clyde, by Mr Robertson; Moray Firth, by Rev. G. Gordon and Mr Edward; Dublin Bay, by Prof. Kinahan; and Vedlom Voe, Shetland, by Dr J. G. Jeffreys and Rev. A. M. Norman.

Lafystius sturionis, Kröyer.

Lafystius sturionis, Kröyer, Naturhist. Tidsskr., 1 R. B. iv. p. 157 (1842).

Darwinia compressa, S. Bate., Cat. Amphip. Crust., Brit. Mus., p. 108, pl. xvii. fig. 7 (1862).

Darwinia compressa, Bate and Westwood, Brit. Sess.-eyed Crust., vol. i. p. 184 (1863).

Lafystius sturionis, Robertson, Amphip. and Isop., Firth of Clyde, p. 93 (1888).

Habitat.—One specimen was found moving about on the deck of the 'Garland' among the contents of the shrimp-trawl which had been towed from near Port-Seaton to West Point in South Bay. A small cod was taken in the shrimp-trawl, and the *Lafystius* may have been brought up attached to the young cod. The ground colour of the Amphipod was white, ornamented with numerous pale pink lines, which extended the whole length of the animal; these lines could only be observed by using a hand lens. Though occasionally found in considerable numbers attached to diseased fishes, it does not seem to be a common British species. I have found this Amphipod on a cod-fish taken in Rothesay Bay. Mr Robertson states that a dog fish captured in Kilbranan Sound had been eaten into by great numbers of this species. These, when turned out, were nearly sufficiently numerous to fill a tea cup.* It has been found in the Moray Firth by Mr Edward of Banff, and Mr Grigor of Macduff.

Atylus vedlomensis (Bate and Westwood).

Dexamine vedlomensis, B. & W., Brit. Sess.-eyed Crust., vol. i. p. 242 (1865).

Atylus vedlomensis, A. Boeck, Crust. Amphip. Bor. et Arct. (1870), p. 112.

Habitat.—Occasionally in bottom tow-net material collected between Inchkeith and May Island. Not uncommon in the Clyde (Robertson); Vedlom Voe, Shetland (Rev. A. M. Norman).

Amathilla sabini (Leach).

Gammarus sabini, Leach, App. to Ross's First Voyage (Oct. 1819), 2nd Edit., p. 178.

Amathia carino-spinosa, White, Cat. Crust. Brit. Mus. (1847).

Amathilla sabini, B. & W., Brit. Sess.-eyed Crust., vol. i. p. 361 (1863).

Habitat.—We observed one or two specimens among bottom tow-net material collected near May Island, and also in St Andrews Bay. 'Only 'taken on one occasion at Cumbrae in the surface-net after sunset' (Robertson).† Two specimens were captured by me in East Loch Tarbert, Loch Fyne, in March 1886. The specimens found at Tarbert had the dorsal carina very little developed. The Forth specimens have the dorsum much carinated, and probably belong to that form described as *A. carino-spinosa.*

Gammarus edwardsii, Spence Bate.

Gammarus edwardsii, Bate, Cat. Amphip. Crust. Brit. Mus. (1862), p. 208, pl. xxxvii. fig. 2.

Gammarus edwardsii, B. & W., Brit. Sess.-eyed Crust., vol. i. (1863) p. 386.

Habitat.—Observed among some bottom tow-net material collected near May Island, and in St Andrews Bay. Taken in the sand at very low-water at Kames Bay, Millport, Cumbrae, by Mr Robertson; taken by me off Ardine Point, opposite Rothesay, March 1887. This species is easily distinguished by having the posterior pleopods short, the rami of which are equal, and not longer than the peduncle.

ISOPODA.

Anceidæ.

Anceus maxillaris (Montagu).

Cancer maxillaris, Mont., Trans. Linn. Soc., vii. p. 66, t. vii. fig. 2, ♂.

Anceus maxillaris, B. & W., Brit. Sess.-eyed Crust., vol. i. p. 187 (1863).

Habitat.—Near Inchkeith, November 1888. Not very common in Rothesay Bay, and Loch Fyne, near Tarbert. Inverkip Bay, Balloch Bay, Cumbrae, Clyde (Robertson). Those taken near Inchkeith were young females.

* *The Amphip. and Isop. of the Firth of Clyde*, pp. 93–94 (1888).

† *Amphip. and Isop. of the Firth of Clyde*, p. 49 (1888).

CUMACEA.*

Diastylidæ.

Eudorella truncatula (Sp. Bate).

Eudora truncatula, Sp. Bate, Ann. Nat. Hist., 2nd Ser., vol. xvii., p. 457, pl. xiv. fig. 111.

Eudorella inermis, Meinert, Crust. Isop. Amphip. it Decapod. Daniæ, p. 183 (mas adultus).

Eudorella truncatula, Norman, Mus. Nor., pt. iii. p. 10 (1886).

Habitat.—Occasionally in bottom tow-net material collected near Inchkeith (Nov. 1888).

SCHIZOPODA.

Mysidæ.

Erythrops goesii, G. O. Sars.

Mysis erythrophthalma, Goes, Crust. Decap. Mar. Svec., p. 18.

Nematopus goesii, G. O. Sars, Beretning om en i Sommeren, 1865, foretagen zoologisk Reise ved Kysterne af Christianias og Christiansands Stifter, p. 15.

Erythrops goesii, G. O. Sars, Mon. over de ved Norges Kyster Forekommende Mysider., Frste Hefte, p. 24, tab. i. (1870).

Habitat.—Frequent all over the Forth, from Inchkeith to May Island, as well as outside of the South Bay. How it happens that this species has escaped observation hitherto may not be easily explained. *Erythrops pygmæa* and *serrata* have recently been observed by me in considerable numbers in the Moray Firth. *E. pygmæa* was added to the British fauna in 1886, when specimens were taken by me in E. Loch Tarbert, Loch Fyne, while carrying on the Board's work at that place; the other has been taken at the Shetland Islands, by the Rev. A. M. Norman, and is described in his last Dredging Report (1868). All the species of Erythrops are small, but are readily recognised when living by their bright red eyes; when they are kept a while in spirit, however, the eyes turn white. *E. goesii* is an addition to the British fauna.

Mysidopsis didelphys (Norman).

Mysis didelphys, Norman, 'Dredging Report,' Trans. Tyne Nat. F. Club, vol. v. p. 270, pl. xii. figs. 9–11.

Mysidopsis didelphys, G. O. Sars, Beretning om en i Sommeren, 1863, foretagen zoologish Reise, p. 27.

Mysidopsis didelphys, G. O. Sars, Mon. Norges Mysider (2), 1872, p. 20, pl. vii. figs. 1–32.

Habitat.—Two specimens were observed in some bottom tow-net material, collected near Fidra, and one was taken near Inchkeith, November 1888. Though this species seems to be somewhat rare in the Firth of Forth, it was of frequent occurrence among bottom tow-net material collected in the Moray Firth. Dr Henderson records two

* The following Cumacea have been taken at Kames Bay, Bute, and at Tarbert, Loch Fyne:—*Iphinoe serrata*, Norman, Kames Bay, Bute, March 1887. *Vaunthompsonia cristata*, Bate, Tarbert, Loch Fyne, 1886. *Lamprops fasciata*, G. O. Sars, Tarbert, Loch Fyne, 1886, and Rothesay Bay, 1887. *Hemilamprops uniplicata*, G. O. Sars, Tarbert, Loch Fyne, 1886. *Diastylis rathkii*, Kröyer, Tarbert, Loch Fyne, 1886. *Diastylis lævis*, Norman, Kames Bay, Bute, March 1887. *Diastylis lamellata*, Norman, Kames Bay, Bute, March 1887. *Pseudo-cuma cercaria*, Van Ben., Tarbert, Loch Fyne, 1886, and Rothesay Bay, 1887. *Campylaspis costata*, G. O. Sars, Kames Bay, Bute, March 1887; new to Britain. *Leucon nassicus*, Kröyer, Tarbert, Loch Fyne, 1886.

specimens taken off the Cloch Lighthouse, in 43 fathoms, muddy bottom.* *Mysidopsis angusta*, G. O. Sars, was frequently observed among the tow-net material collected in the Moray Firth. Two specimens of this species were taken by me at North Bay, Barmore, Loch Fyne, February 12, 1886, which was the first record of its occurrence in the Clyde district.

Leptomysis gracilis, G. O. Sars.

Mysis gracilis, G. O. Sars, Beretning om en i Sommeren 1863, foretagen zoologisk Reise, p. 23.

Mysidopsis hispida, Norman, Last Report of Dredging among the Shetland Isles: Report of the Brit. Assoc. for the Advancement of Science, 1868, p. 267.

Leptomysis gracilis, G. O. Sars, Mon. over de ved Norges Kyster forekommende Mysider, P. 3, p. 31, pls. xix., xx.

Habitat.—Several specimens of this species have been taken among bottom tow-net material collected eastward of Inchkeith, off St Monance, and near Fidra during October and November 1888. Previous British records for *L. gracilis*, are the Shetland Islands (Norman), and the Moray Firth. A good number of specimens were observed by me among the tow-net material collected in the Moray Firth.

Heteromysis formosa, Smith.

Heteromysis formosa, Smith, Report upon the Invertebrate Animals of Vineyard Sound and Adjacent Waters.

Habitat.—One or two specimens taken in some tow-net material collected eastward of Inchkeith during October 1888. Two specimens were also taken by the Rev. A. M. Norman at Guernsey in 1865, and these are the only records of its occurrence in Britain. It comes very near *Heteromysis* (*Chiromysis*) *microps*, G. O. Sars, which only seems to differ from *H. formosa* in the inner branch of the uropods being furnished with only a single spine on the inner margin.

Siriella armata (M. Edwards).

Cynthia armata, M. Edw., Hist. Nat. de Crust.

Mysis griffithsiæ, Bell, Brit. Stalk-eyed Crust., p. 342 (1853).

Siriella armata, G. O. Sars, Nye Bid. til kund. om Mid.-hav. invert.-fauna, p. 96, tab. xxxv. (1876).

Mysis griffithsiæ, Henderson, Decap. and Schizop. Crust. of the Firth of Clyde, p. 41, and (*Siriella armata*), App., p. 43, (1886).

Habitat.—One specimen (fem.) among bottom tow-net material from the 'Fluke Hole' off St Monance, collected February 1889. This differs from the specimen figured by G. O. Sars by having five small spines between the two large ones at the distal end of the telson, instead of four as in his figure. The specimen he has figured is a male, and exhibits one or two other points of difference, but which are merely sexual. It was first described as British by Prof. Bell, from specimens sent to him by Mrs Griffiths, who obtained them at Torquay. It was taken by me in the vicinity of East Loch Tarbert (Loch Fyne) about the end of October 1885. It is also recorded from Cumbrae, on the authority of Mr Robertson in Henderson's *Decapod and Schizopod Crustacea of the Firth of Clyde.* Previous to the summer of 1887, only four authentic species of *Schizopoda* were known to occur in the Firth of Forth (the three forms recorded by Goodsir are not sufficiently described to admit of their being identified with known species); whereas, eighteen are now included among the invertebrate fauna of the estuary.

* *Decapod and Schizopod Crust. of the Firth of Clyde*, p. 39, 1886.

The following Schizopods have also been observed by me in the Moray Firth, in addition to those already referred to, viz., *Mysis ornata*, G. O. Sars, which was of frequent occurrence in the bottom tow-net material. *Boreophausia raschi*, M. Sars, taken on several occasions in great abundance in the tow-net attached to the end of the beam of the trawl. *Nyctiphanes norvegica* (M. Sars) occurred in the material along with *Boreophausia*, but was not very common. Where the Schizopods were plentiful, good hauls of fish were frequently taken by the beam-trawl yet Schizopods were very seldom observed in the stomachs of the fish examined, which included cod, haddock, whiting, gurnards, plaice, common dabs, long roughs, &c.

DECAPODA—MACRURA.

Palæmonidæ.

Hippolyte gaimardii, M. Edwards.

Hippolyte gaimardii, M. Edwards, Hist. Nat. des Crust., ii. p. 378.

Hippolyte pandaliformis, Bell, Brit. Stalk-eyed Crust., ii. p. 294.

Habitat.—Occasionally in the bottom tow-net above Queensferry, in moderately deep water. I have found it to be of frequent occurrence in East Loch Tarbert, and in neighbouring parts of Loch Fyne.

MOLLUSCA.

Lamellibranchiata.

Lepton nitidum, Turton.

Lepton nitidum, Turt., Conch. Dith., p. 63.

Kellia nitida, F. and H., ii. p. 92, pl. xxxvi. figs. 3, 4, and (*L. nitidum*), App., iv. p. 255.

Habitat.—Occasionally among material dredged in the vicinity of May Island.

Gasteropoda.

Stilifer turtoni, Broderip.

Phasianella stylifera, Turton, Zool. Jour., ii. p. 367, t. xxii. fig. 11.

Stilifer turtoni, Brod., Proc. Zool. Soc., 1832, p. 61.

Stilifer turtoni, F. & H., iii. p. 226, pl. xc. figs. 8, 9, and (Animal) pl. 00, fig. 5.

Habitat.—On the spines of *Echinus esculentus*, brought to Newhaven by one of the fishing boats from the vicinity of May Island, two living specimens were taken off the *Echinus*. This interesting species seems to be found nowhere else when living than on *Echini*, and although its distribution in the British seas extends from Shetland to the English Channel, it is not a common mollusc. We are indebted to Miss Janet E. Carphin, grand-daughter of the late Principal Cunningham, for this very interesting addition to the Fauna of the Firth of Forth.

Limapontia nigra, Johnston.

Limapontia nigra, Johnston, Louden's Mag. N. H., ix. p. 79.

Limapontia nigra, Ald. & Hanc., Ann. Nat. Hist., 2nd ser., i. p. 402, pl. xix. figs. 4–8.

Habitat.—In pools among the stones left dry at low water a little east of Newhaven Pier, August 1887. This very small and curious mollusc does not appear to be very rare in the pools referred to, but is not easily perceived unless when crawling. *Pleurophyllidia loveni*, Bergh, an interesting species belonging to a group closely allied to *Limapontia*, was found among some trawled material on board the steam trawler 'Southesk,' while engaged fishing in the Moray Firth. Dr Jeffreys says, 'My friend the late Mr Barlee, dredged on the coast of Shetland a single 'specimen, which I exhibited at the Birmingham Meeting of the British 'Association in 1849. The Rev. R. C. Abbes procured another specimen 'from a fishing boat at Whitburn, co. Durham.'* I do not know of any British habitat for this species, other than the two mentioned by Jeffreys, and that of the Moray Firth now recorded.

PTEROPODA.

Spirialis retroversus (Fleming).

Fusus retroversus, Flem., Mem. Wern. Nat. Hist. Soc., iv. p. 498, t. xv. fig. 2.

Spirialis retroversis, Jeffreys, Brit. Conch., v. p. 115, pl. iii. fig. 4, and pl. xcviii. fig. 4 (1869).

Habitat.—Occasionally in tow-nettings between Inchkeith and May Island, but not very common.

Clione borealis (Bruguiere).

Clio borealis, Brug.

Clio retusa, Müll. & Tab.

Habitat.—One specimen in some surface-net material collected east of Inchkeith. I kept the specimen alive for two days, when it was accidentally killed. The mollusc appeared to move only by means of the two fin-like processes placed immediately behind the head, which were thrown at the same time alternately backwards and forwards, something like the movement of the wings of a bird, but differing by the mollusc's fins nearly meeting every time in both the backward and forward movements. The plane of the fin was in line with the body, but the mollusc when propelling itself through the water did so by twisting the fin so as to strike the water with it in a manner somewhat similar to that of the blade of a steamship's propeller. The mollusc gradually sank to the bottom of the jar in which it was unless the fins were kept in constant motion, and it did not seem to have the power of moving very rapidly through the water.

VERTEBRATA.

Pisces.

Arnoglossus megastoma (Donovan).

Pleuronectes megastoma, Don., Brit. Fish., iii. pl. li.

Sail fluke, A. Carter, Couch, Fish. Brit. Isles, iii. pp. 163, 167, pls. clxiii. clxiv.

Arnoglossus megastoma, Day, Brit. Fish., ii. p. 21, pl. xcviii. (1880–84.)

Habitat.—A few specimens inside May Island and near Fidra. This species is not recorded by Dr Parnell in his *Fishes of the Firth of Forth*, and is probably not very common in the estuary. Its distribution in the British seas extends from the Orkneys to the English Channel. It is easily distinguished from the 'witch' or 'long flounder,' which it somewhat resembles, by having a much larger mouth, and especially by being a left-sided fish—that is, having the eyes and mouth on the left

* *Brit. Conch.*, vol. v. p. 18 (1869).

side, like the turbot. It may be stated that in St Andrews Bay two left-handed specimens of the common, or white fluke, or fresh-water flounder (*Pleuronectes flesus*), were observed. They were not merely coloured on the 'wrong' side, but the eyes, mouth, and fins were reversed, as in the turbot. These are the first of this abnormal form that have been taken during the investigations carried on by the S.S. 'Garland.' Both specimens have been preserved, and will be placed among the Board's Collection of Fishes.

Phycis blennoides (Brün.).
Gadus blennoides, Brün., Ich. Mass., p. 24.
Phycis blennoides, Gmel., Linn. p. 1165.
Greater Fork Beard, Couch., Fish. Brit. Isles, iii. pp. 125, 128, pls. clxiii. clxiv.
Phycis blennoides, Day, Brit. Fish., i. p. 303, pl. lxxxv. fig. 2 (1880–84).

Habitat.—Off St Monance, one specimen taken with beam-trawl, February 1889. There does not seem to be any previous record of the occurrence of this species in the Firth of Forth. Mr Cornish observes that the flesh of *Phycis* is extremely delicate, and superior to the whiting. It has been recorded for St Andrews Bay, but does not appear to be very common on the east coast. That so few fishes have been added to those recorded by Dr Parnell proves the great care and thoroughness of his investigation, and a revision of his *Fishes of the Firth of Forth* is only necessary because of the changes in the terminology that have been made since he wrote his valuable monograph.

Lumpenus lampetriformis, Walb.
Lumpenus lampetriformis, Day, Proc. Zool. Soc., 1884, p. 445, pl. xli.

Habitat.—Eight specimens were taken with the shrimp-net when trawling a few miles east of Inchkeith on the 14th May 1889, and several others a little outside the May a day or two afterwards. This species was first found in British waters by Professor MacIntosh, F.R.S., in May 1884, since then by Mr Sim of Aberdeen; it has been known for a long time as a Norwegian fish. Last year when examining the stomachs of cod trawled in the Forth I noticed this fish on several occasions among the contents of the stomachs, but the specimens being always more or less mutilated I failed to recognise the species.

Trachinus draco, Linné.
Trachinus draco, Linné, Syts. Nat., i. p. 435.
Greater Weever, Couch., Fish. Brit. Isles, ii. p. 43, pl. lxxiii.

Habitat.—One specimen taken with shrimp-net in 'Fluke Hole' off St Monance.

CORRIGENDA.

To Revised List of the Crustacea of the Firth of Forth in the Fishery Board's Report for 1888 (p. 235):—

COPEPODA.

Notodelphys agilis, Brady, should be
Notolelphys cœrulea, Thorell., Brady, Mon. Brit. Cop., vol. i. p. 130, pl. xxvii., figs. 10–13 (1876).

AMPHIPODA.

Orchomene serrata, Boeck, should be
Tryphosa ciliata, G. O. Sars = *Tryphosa nana*, Kröyer, Norman, Mus. Nor., part iii. p. 14 (1886).
Mæra grossimana, Mont., should be
Mæra loveni, Bruzelius, S. Bate, Cat. Amphip. Crust. Brit. Mus., pl. 193, p. xxxv. fig. 1 (1862).

For Gulland Bay, *read* South Bay.

Note.—Since this paper was written I have been informed by Dr A. M. Norman, that among the *Boreophausia* I sent him from the Moray Firth for identification are one or two specimens of *Boreophausia inermis*, Kröyer, new to the east coast, and which has just been added to the British fauna by Brook and Hoyle, who found it on the west of Scotland; and that a specimen of *Siriella norvegica*, G. O. Sars, new to Britain, was found among some tow-net material collected by me in the Moray Firth, February 1889.

VI. MUSSEL-FARMING AT MONTROSE. By J. H. FULLARTON, M.A., B.Sc., AND THOMAS SCOTT. (Plate VII.)

I. INTRODUCTORY.

The difficulty which line fishermen are experiencing in finding a sufficient quantity of bait at a reasonable cost, the destruction of valuable mussel-scalps in recent years resulting in a continual diminution of available mussels, and the comparative or almost total neglect of attempts to increase the supply of mussel and other animal forms used as bait, are accentuating the impoverished condition of those fishing communities dependent on the cod and haddock fisheries. These facts have been recognised in the appointment of the Mussel and Bait Committee, and have been amply illustrated in the evidence given by witnesses from the chief fishing centres.

The Committee Reports:—'We believe that were the mussel-beds of 'Scotland in general treated in a similar manner to those in the Montrose 'Basin, the bait question, of such importance to Scottish fishermen, would 'be solved, and that Scottish beds alone would yield an abundant supply 'for all Scottish requirements.'

The Scientific Report Committee of the Fishery Board for Scotland have accordingly asked us to make a survey of the Montrose beds, and explain the methods of cultivation which have been found so successful there. We have made personal examination of the biological, geological, and physical aspects of the Montrose Basin and of its outlet the Southesk, and have enquired into the organisation and mode of working of the beds both on the north and south sides of the River Southesk.

The Montrose Basin is a shallow tidal lagoon extending from the Bridge of Dun on the west to the town of Montrose on the east. It covers an area of about three square miles, but only a limited acreage can be utilised for the cultivation of mussels. A most cursory examination forces the conclusion on a visitor, acquainted with the conditions requisite for the growth of mussels, that only energy, perseverance, and methodical regulation could have commanded success in a situation presenting great natural difficulties to the rearing of mature mussels. The success of mussel cultivation at Montrose is all the more apparent when it is contrasted with other places in Scotland where the conditions are much more favourable, and only ruined beds are found. Nature has not been so bountiful to Montrose as it has been to the Clyde, the Tay, and some of the northern firths, yet the obstacles have been in a measure overcome notwithstanding the prolonged time taken by the Montrose mussels to fatten, and the small size, two inches, to which they grow even after three to five years tending.

The lagoon has a comparatively narrow outlet to the sea by the River Southesk, and is formed on the east side by Rossie Island, and a barrier of boulders (on which the present town of Montrose is built); this barrier is flanked on the seaward side by an accumulation of blown sand constituting the links. The River Southesk as it leaves the basin divides into two—the Inch Burn on the south, and the main stream on the north, which forms the harbour. Between these two streams lies the island of Rossie, which at low water is practically part of the south bank, the Inch Burn becoming dry or nearly so. The island of Rossie is connected to the town of Montrose by a suspension bridge, between which and the sea, the dredging by the 'seed gatherers' is done. On the northward shore a great thickness of blown or stratified sand overlies a bed of clay, the outcrop of which is seen at one or two places, and reveals considerable quantities of shells. These are enclosed *in situ*, and comprise *Scrobicularia piperata*, Bellon; *Cardium edule*, L. (the common cockle); *Mytilus edulis*, L. (the common mussel); *Tellina balthica*, L.; *Littorina litorea*, L. (whelk); *Hydrobia ulvæ*, Penn., all of which are littoral or shallow water forms, and were obtained by us in the Scrobicularia clay. They are also recorded as living forms in the present basin.* This Scrobicularia bed is well developed on the south side of the basin, and Dr Howden in his paper on the geology of the superficial deposits at the estuary of the Southesk, chronicles its occurrence higher up the estuary at Balwyllo, below the Free Church at Maryton, and below the Parish School. The occurrence of this shell-bearing clay at the places mentioned, indicates, if proof were wanted, that the estuary of the Southesk occupied a much larger area than it does now, and Dr Howden's opinion is that the tidal-basin extended up as far as the farm of Kincraig, a mile below Brechin.

II. Method of Cultivation.

The mussels with ripe reproductive organs are found on the estuarine flats of the basin, or on the sloping surface of the Inch Burn. The genital glands of the common mussel are known to be sexually ripe in certain localities in the spring months. Mr Johnston is of opinion that the mussels of Montrose spat in May, June, August, and the beginning of September, while others hold that the mussel spats all through the year. The liberated embryos, which are carried seawards by the quickly running tide, obtain a foothold on the shores of Rossie Island, on the Scalp, on the Binny Bank, on the north and south shores of the Esk from the suspension bridge downwards, and in the bed of the river. From the swiftness of the current only a very small amount of the spat obtains a resting-place in the Southesk, the bulk of it being carried out to sea. But wherever there are sheltered spots—where there are eddies and slowly running back-currents—there, the young mussel may obtain a resting-place. A glance at the map, with its serpentine lines indicating the position of the 'seed' beds, illustrates this. The outgoing

* *Trans. Edin. Geol. Soc.*, vol. i. p. 138.

tide flows like a mill race through the narrow and shallow Inch Burn, so that none of the young molluscs are found on the south side of Rossie Island. Where, however, the Inch and Southesk currents divide to the north-west of Rossie Island, there is a narrow strip of the shore of the island which, in alternate years, is carpeted with a covering of young mussels. Binny Bank, stretching out like a spit of land into the stream, forms an obstruction, diverts the outgoing tide to the south in a deeper channel, and serves as a catchment bed. The Scalp on the east side of the suspension bridge is analogous to the convex bank of a river where the water flows much slower than on the concave opposite bank, and so forms a suitable area for the anchoring of the embryonal forms by their byssus secretions. The backward eddy between the Scalp and Rossie Island carries the embryos on to the north-east shore of Rossie, and so every second or third year a quantity of 'seed' is to be obtained from a narrow stretch of shore there. When the velum of the embryo atrophies, the active young mollusc loses its most important locomotor apparatus, and so sinks, becoming fixed to the bottom on the development of its byssus. Consequently the bed of the river is a fruitful source of 'seed.' We might almost expect a greater development of seed on the north and south banks of the river below Ferryden and Montrose, but there a strong rush of a backward current runs in an opposite direction to the flowing or ebbing tide. This current operates against the fixing of the young on the banks of the river, and even when the young do fix themselves to the shingle, the silting of the river sometimes destroys the seed by burying it.

'Seed' is, therefore, obtained from the river for Messrs Johnston's beds, and also for the Ferryden beds. Fortunately for the Ferryden Society, the spat of the mussel is fixed over a good extent of their ground. The most favourably situated Ferryden ground is the Scalp, which lies between Rossie Island and the harbour. Every second or third year the young attach themselves to a portion of the shore of Rossie Island, in close proximity to the Scalp, where the down stream forms an eddy in the lee of it. Where the Southesk impinges against the westward bank of Rossie Island, in the neighbourhood of the Trout Shot, the young mussels become attached, but this is not oftener than every alternate, or sometimes every third year. All these are places where one would naturally expect the young on liberation from the mother to come in contact with, for they lie in the course of the current, from the beds on which the mature molluscs are situated, and the current of the ebbing tide, especially below the suspension bridge, is not so strong on the south side of the river. Besides these three localities which furnish seed, the south bank of the river below Ferryden sometimes supplies as much seed as will cover all the Ferryden Society's beds.

Messrs Johnston & Sons have a very small extent of ground as compared with this on which they can gather 'seed.' They must either buy it from the fishers who rake the river-bed, or obtain it from Binny or Briggs of Binny. The result, of course, is a greatly increased expenditure for stocking the beds with growing mussels. Sometimes seed has been obtained by taking quantities off the foreshore rocks. These rocks on the sea coast and on the north side of the river below the wet-dock, and the pier-supports are partially covered with young molluscan forms, but the barnacles are much more numerous.

When the seed attains a suitable size—about the size of an ordinary bean—it is dragged from its bed by means of rakes into the cobles. The Ferryden Society employ several men who combine the occupations of seed gathering, planting, and lifting mussels, while a number of other men belonging to the town of Montrose rake the seed out of the river and sell it to Messrs Johnston & Sons, or transplant it to a portion of ground on the east side of the Tayock Burn, which is claimed by the municipality of Montrose.

When Mr Johnston started the mussel society, 'the members, with their boats, took the seed to the ground,' but in September 1856, after a good deal of correspondence and many enquiries as to the cultivation of mussels, and a visit of Mr Johnston to St Andrews, a change took place in the working of the beds. A regular staff was organised to seed and plant the Rossie beds, so that it was no longer necessary to interrupt the labours of the line fishermen, by withdrawing them even for a day from the fishing, nor for the women to wade and gather the mussels from the banks.

So that now at Montrose there are three classes employed in connection with mussel culture—1st, those who rake the seed from the river; 2nd, those who lay it on the beds and perform the duties of subsequent cultivation; and, 3rd, those who combine both duties.

The seed, once secured, is carried by the cobles or boats up the river and transferred to the mussel banks, where it grows and matures. The bank selected depends on various circumstances, such as the quantity of mud on it, whether it is ready for the planting of seed, and the condition of the other banks. When mussels lie for several years on a bank, the height of the bank is greatly increased by the accumulation of mud, so that immediately after the removal of bait-mussels the surplus mud has to be got rid of, and the height of the bank lowered. But owing to the slowness of the currents in the Montrose Basin, except at its narrow outlet side, and the small quantity of running water which is in the River Southesk, it takes from one to two years to clear and lower the banks.

When the bank is ready for planting, the young mussels, which are from half to three quarters of an inch in length, are laid down on it. In the laying down of the 'seed' on suitable ground, the molluscs are placed regularly and carefully in a sloping position, with the end, where the siphons of the mollusc project, uppermost. The tendency seems to be to transfer the seed first to one of the higher banks on which it is impossible for mussels to attain any great size, unless after a lapse of from five to eight years. In this way the lower and best growing banks can be utilised to rear mussels of bait size by the transference of the smaller mussels from the higher banks, and so economical management of the beds is promoted.

After a tide or two the mussel spins a new byssus, and becomes attached to the sand and gravel of the banks. The mussels are, likewise, attached by the byssus threads to one another, so that in attempting to lift one, the matted cluster of which it is a member is taken away. For some time after transplanting, growth does not rapidly take place except in the case of those situated on the edge of the bank. The mussel retains the vertical, or nearly vertical, position, the posterior or siphonal end being directed upwards, while the hinge end is buried in the ground. If the mussels are left long on a high bank they become stunted in appearance, and additions take place to the shell in thickness rather than in length, the consequence being that the mussel assumes an inelegant shape and a blunted aspect at the posterior end, and instead of a brownish black layer of periostracum on the outside of the shell, a greyish coating there indicates the dwarfing of the mollusc. These mussels are locally known as 'Crocks.' When they are transferred to lower banks, and banks more within the reach of the tide, they soon begin to grow, and the capacity of the contained space becomes enlarged.

It is found that the time required for the 'seed' to mature and reach the bait size varies from three to eight years. If it is immediately planted on one of the best banks it may grow to two inches in length in three years or so, but on most of the banks, unless the mussels are shifted once or twice to lower banks, a much longer time than three years is requisite. Besides, if there is a succession of mild winters the mussels are found to mature more rapidly than when the winters are severe. Cold winters generally retard the growth of the mussel. Exposure too long to the air also tends to hinder rapid growth. This is remarkably well-illustrated in the experimental *bouchôts* erected by Messrs Johnston. Mussels were fixed to the wattling of the hurdles by netting, and mussels of the same kind and size were planted alongside in beds. The *bouchôt* mussels gradually died off, while those of the bed alongside continued to thrive. Of course the temperature of the air would tend to lower the temperature of the *bouchôt* mussels more than the temperature of the bank would that of the bed mussels. If, however, the *bouchôt* system is to be tried again, the trial ought to be made where the conditions of temperature are more favourable than on the east coast, and it might also be preferable to try it where the difference of tide is greater. If the latter were the case, then the *bouchôt* mussels might be high out of the water at low-tide, and yet not be long altogether out of the water between tides.

Moreover, if the *bouchôts* are to be employed, they may possibly be useful in affording surface for the embryo mussels to attach themselves to during the warmer months of the year, but the trial at Montrose has undoubtedly been unsuccessful so far at least as adult mussels are concerned. Whether a greater quantity of seed could be obtained, and at a cheaper rate than is obtained at present from the rocks, sand, and shingle near the mussel-beds, seems very doubtful. Where, however, seed cannot be got in sufficient quantity, they may prove valuable additions to the catchment area.

III. Description of the Mussel-Beds.

Long stretches of mud and sand banks occupy the lower central area of the basin, especially towards the south side. During spring-tides these banks are uncovered throughout their whole extent at low-water, but at 'neaps' only the higher are completely uncovered, and portions of others are bared. For convenience we have treated those on the south side of the River Southesk, tenanted by the Ferryden Society, separately from those cultivated by the Messrs Johnston & Sons. In the map appended this distinction is also brought out by lines, and the seed banks are likewise distinguished from the growing banks.*

A. *Ferryden and Usan Society's Beds.*

1. *The Scalp.*—This bank is opposite the harbour of Montrose, and skirts the north side of Rossie Island. It is dry at low-water from a few yards below the suspension bridge to almost abreast of the eastern extremity of Rossie Island. It is composed of gravelly sand which, after the spatting season, becomes covered with the young of the mussel. On the north side of it a few large mussels are present on the hard ground, but its chief utility consists in its suitability for raising 'seed.' The young mussels after they are about a year old are removed from it to one of the beds further up the stream, or to the ground on either side of

* From measurements of the growing beds cultivated by the Ferryden Society, we have ascertained them to be about 60 acres in extent. The acreage that is or has been under mussel culture by Messrs Johnston & Sons will amount to three or four times that of the Ferryden Society.

the Inch Burn. Great quantities of 'seed' lodge on it as it is most favourably situated for the settling of the free embryos which are carried down from the banks on which there are mature mussels. The seed-bearing portion is about 400 yards long and about 100 yards broad. Seed is got from the Scalp every year.

2. 3. *Rossie Island.*—There are two strips of the shore of this island on which the embryo mussels settle, and from which 'seed' is obtained. The north-east part (2) is opposite the lower end of the Scalp, and extends for a length of fully 100 yards, the seed-bearing breadth averaging from 10 to 15 yards. The seed which is obtained from the outer edge of the north-east shore here, every third year, is removed when it attains the regulation size to the fattening banks.

The north-western portion (3) is 10 or 12 yards in breadth, and faces the lower end of what once was part of the Broadwater Bank and the mouth of the Steinschell Burn. The length of this part of the Rossie Island shore on which young mussels fix themselves is about 200 yards. Seed is got from this portion every second or third year. Neither of these banks yield anything like the quantity of seed that the Scalp does; in both, however, the character of the ground is much the same as that of the Scalp.

4. *Ferryden Shore of River.*—The south bank of the river from the eastward end of the village of Ferryden to midway between the beacons near Johnny Mains' Harbour used to yield enormous quantities of seed. Formerly the shingle below the rocks was covered by the embryo molluscs for the distance of half a mile at least, but now the produce is not nearly so great. Only a very narrow strip of shore was covered by the seed, but the manager of the Ferryden beds states that twelve years ago seed sufficient to cover the whole of the Society's ground could be taken from it, and in 1885 the seed, as large as barley, which was very plentiful on it, was buried by shingle thrown up by the river, the depth of the covering being 8 inches. This silting, however, is temporary and is owing to the dredging of the river by the Montrose Harbour Trustees. After these dredging operations are finished it is expected that matters will attain in two or three years a normal state, and the resting of the mussel spat will not be affected.

5. *Inch Burn Bed.*—The Inch Burn, which is dry, or almost dry, at low-water, runs on the south side of Rossie Island, and affords a secure haven for the wintering of fishing smacks. From the upper end of the graveyard on Rossie Island as far down as Ferryden Free Church, the Ferryden Society utilise the hollow of the burn as 'growing' ground. The bed is composed of shingle, sand, and mud, and the mussels after being transplanted to it arrive at maturity in three years. It is very good growing ground, and although its breadth is only 4 yards on the north side, and 20 yards on the south side, yet its great length of one third of a mile permits of mussels being grown in quantity.

6. *Big Bank.*—The mussels are transplanted to this bed chiefly from the Scalp. The Southesk separates it from the Broad Water Bank, and branch streamlets run between it and the other banks of the Society. This bank has broadened in recent years, both on the north, east, and south sides, and is continuous with a smaller bank at its eastern end, which in the plan of the ordnance survey is marked as a distinct bank. In this way the bank has increased in size by an additional breadth of 10 to 20 yards, and also in length by the union to it of the small eastern bank. The bank is all mud, which is very soft, but before the laying down of the mussels it was a sand bank. This bank requires to lie fallow for one or two years in order that its increased height may be reduced. Mussels that are transplanted

to it when the size of turkey beans require from three to five years to attain a length of 2 inches. Its approximate length is 500 yards, and it is 200 yards in breadth at its broadest part.

7. *Guano Bank.*—The character of this bank is much the same as that of the preceding one. It was divided into two portions about ten or twelve years ago by a small branch of the Southesk, the bed of which, however, becomes dry at spring-tides. It is bounded on the west and on the north by the main stream of the River Southesk, and is separated off from the Inshore, Middle, and Big Banks by a small branch of the same river on the east and south. The name Guano Bank is now restricted to the northern half of it, the southern portion being called the Twamill Bank. The two banks are 400 yards in length and the same in breadth, and are good growing ground. The seed for it is usually obtained from the Scalp.

8. *Middle Bank.*—This bank was cut off from the southern shore eighteen or twenty years ago by a small branch of the River Southesk, and is divided off from the Big and Guano Banks by branch streams. It is between 300 and 400 yards long by about 80 yards broad. The rate of growth of mussels on this bank, and the character of the soil, are similar to the Guano and Big Banks. Mr West states that the last time it was laid down in seed was one year before the transplanting of seed to the Inch Burn, and yet during last winter when the mussels from both were being used as bait, those lifted from the Inch Burn were larger and better than the older ones taken from the Middle Bank.

9. *Salthouse Bank.*—This is the name given by the fishermen to the shore bank above the Trout Shot, and must not be confounded with the Big Bank which is marked in the ordnance survey map as the Salthouse Bank. It is opposite the lower end of the Big Bank, and is divided from it by a branch of the Southesk. It affords an example of what can be done by forming new banks by cultivation. It has been reclaimed from the shore, and was one of the first banks to be formed when the Society began to cultivate the mussel. Mr West describes it as the 'best growing ground the Society has,' and mussels of one year old come to maturity in three years. The length of the bank is 350 yards, and it is 120 yards in breadth. The ground is similar in character to that of the banks already described.

10. *Inshore Bank.*—This is the longest bed which the Ferryden Society has, being 650 yards by a breadth of 80 yards. It is not such a good bed as any of the others, and after mussels have lain on it for two years they must be transferred to either the Guano, the Middle, the Big, or the Salthouse Banks, on which they will rapidly fatten and grow. The mussels are not quite so thick on the shoreward side. It stretches from the upper boundary of the Rossie beds, opposite Rossie Mills, as far as the lower end of the Middle Bank. In some places the mud is very soft, and the Society placed at the upper end a bridge of planks in order that the gatherers might get easily to the mussels which they were to lift.

B. *Messrs Johnston & Sons' Beds.*

1. *Binny Bank and Briggs of Binny.*—Binny Bank is situated a short distance above the railway bridge, and projects to the south-east into the confluent Steinschell Burn and Southesk River. The mud on the surface of it rests on a layer of gravel. Binny is about 150 yards long by 50 yards broad, and is a nursery for seed for other banks. Seed can be taken off it in alternate years of about the size of turkey beans. In March 1889, when it was examined by us, there was not much seed on it, as it had been transplanted to the Broad Water Bank.

Binny may be regarded as a peninsula joined on to the Basin by the Briggs of Binny. Mussels thrive very well on it, so long as they are in what the mussel gatherers called the 'seed' condition, but the adults will not attain any great size on it.

On the east side of the Briggs of Binny two experimental *bouchóts* have been erected.

2. *Broad Water Bank.*—This is Messrs Johnston's best mussel growing bank, and lies between the Southesk on the south and the Steinschell Burn on the north. It is separated from the West Steinschell Bank by a connecting branch of the Southesk and Steinschell Burn, and the eastern point of it, as marked on the map of the ordnance survey, is now lopped off by a small hollow, and called by Messrs Johnston's foreman, *Rob Miller's Bank.* The soil here is sandy gravel with a thick coating of mud overlying it. Its upper end is opposite the middle of the Guano Bank, and it stretches as far eastward as the lower end of the Big Bank. In length it is 500 yards, and its greatest breadth is about 300 yards. The mussels are transferred to it from such banks as the West Steinschell and the Sticks Burn, the particular bank selected depending on the relative abundance of the mussels on each. When we visited the bank in March 1889, it was in good condition for laying down mussels upon it, as most of it had lain fallow for the past one and a half years in order that the surface of it might be worn down. When mussels of an inch and a half are laid down on it they soon attain a length of two inches, and become well filled.

3. *R. Miller's Bank.*—This is a bank of sandy gravel, and formerly was in continuation with the Broad Water Bank. Seed is taken off the upper corner of it, but otherwise it is not fruitful at present.

4. *Sticks Burn Bank.* – The ground of this bank is all clay and very soft. The extent of the bank utilised as mussel growing ground is about 450 yards long and 250 broad. The Sticks Burn flows between it and the West Steinschell Bank, and the Southesk divides it from the Guano Bank on the east; mussels have been transplanted to it for the last ten years, but in order that they may come to maturity, it is necessary to transfer them to the Broad Water Bank.

5. *West Steinschell Bank.*—The mussel carrying ground to the west of the Steinschell Burn extends from Dronner's Dyke in a curve to the head of the Sticks Burn. At Dronner's Dyke the mussel area is 10 yards broad, gradually increasing till it is half a mile opposite the mouth of Steinschell Burn. The bottom is entirely of clay and is very soft. The manager of the beds has had the whole of this vast area filled with mussels, but he regards it only as a reservoir to store mussels till they are required for transference to the Broad Water Bank or the bed of the Steinschell Burn. The mussels take too long to grow as the bank is too high. The mussel manager by planting mussels close to the edge of the Steinschell Burn has diverted the course of that Burn more to the eastward, and has added a strip of 50 yards broad to the Bank within the last thirty years. The consequence is that a corresponding breadth of 50 yards has been taken off the eastern side of the river bank.

6. *East Steinschell Bank.*—The gravelly ground immediately below Dronner's Dyke, and to the eastward of Steinschell Burn, was covered in 1887 with mussels, which were taken from the bed of the river. At the lower or south end the breadth is about 20 yards, gradually increasing to about 200 yards beneath Dronner's Dyke. The length of the ground is about 400 yards. Although the mussels have lain for two years there is no preceptible increase in size. As the mussels don't succeed on this experimental bank the manager thinks they must be shifted soon.

7. *Scaud Man's Head Banks.*—The gravelly, sandy, and muddy ground

extending for 500 or 600 yards north of Dronner's Dyke on both sides of the small stream Scaud Man's Head was laid down with mussels nine years ago. The mussels were laid down close together, but after an interval of nine years only small clumps here and there are to be seen. The mussels are stunted, thick shelled, blunt at the siphonal end, and a thick greyish crust is formed on the outside of the shells. Such mussels are known as 'Crocks,' and if transferred to suitable soil begin to grow, but should they be allowed to remain on the soil north of this part of Dronner's Dyke they seem to continue in a stunted condition.

8. *Tayock and Gaswork Burn Banks.*—A triangular shaped area at the junction of the Gaswork Burn with the Tayock was laid with mussels six years ago. The length of it along the Gaswork tributary is about 400 yards, and the breadth of the part south of the Gaswork Burn is 100 yards at the most, that to the north being a little more. The bottom is sandy clay. The mussels laid down on it six years ago were shifted to Broad Water Bank to fill up. The mussels on the south of the Gaswork Burn are in better condition than those to the north.

9. *The Basin Bank.*—In the neighbourhood of the Briggs of Binny, an area of 600 yards by 400 yards called the Basin, is utilised as a mussel bank. Mussels which were laid on it seven years ago are not nearly ready. The manager says that seed after being transferred from the river to this bank, if left to come to maturity here without transplanting them to the Broad Water Bank, will take ten years before they attain to the size approved for bait. This is chiefly due to the ground being a little too high for mussel growing.

C. *Common Bed.*

East Tayock Bank.—This is a portion of ground claimed by the town of Montrose, and lies to the East of the middle of Tayock Burn from about opposite the Flour-mill to opposite the Royal Infirmary. It is about 200 yards in length along the burn, but its breadth is not great. Mussels have been laid down on this bed recently by seven men who took them from the bed of the river It is alleged that although the town claims this bed, it has no power to let it, and consequently there is no protection obtainable by those who lay mussels down on it.

IV. Fauna of Beds.

We have made a preliminary examination into the fauna of the mud of Broad Water Bank and Salthouse Bank. The mud was gathered in March last just after a 'fresh' in the River Southesk. Doubtless after the waters are heated during summer the fauna will be much more numerous and very different. Much yet may be done in the way of ascertaining the life present on mussel scalps, and great assistance may be derived from a knowledge of the minuter animals associated with mussels, and of the forms on which the mussel lives. When these biological facts become better known, and the physico-chemical properties of the water suitable for mussel culture are tabulated, a scientific basis will be gained which should be helpful to the mussel cultivator.

The following is a list of the Foraminifers, Ostracods, and Copepods found on two of the best growing banks. Besides these, great numbers of embryonal mussels and the cast off cases of the barnacle were found.

Broad Water Bank.

Foraminifera.

Miliolina seminulum, L. Not very common.
,, *subrotunda*, Mont. Frequent.
,, *agglutinans*, D'Orb. Scarce.
,, *oblonga*, Mont. Frequent.
Lituola canariensis, D'Orb. Scarce.
Lagena globosa, Mont. Few.
,, *sulcata*, W. and J. Few.
,, *sulcata*, var. Few.
,, *striata*, D'Orb. Few.
,, *squamosa*, Mont. Frequent.
Globigerina bulloides, D'Orb. Rare.
Nodosaria pyrula, D'Orb. Rare.
Discorbuia rosacea, D'Orb. Rare.
,, *globularis*, D'Orb. Frequent.
Bulimina marginata, D'Orb. Few.
Truncatulina lobatula, Walker. Common.
Planorbulina mediterranensis, D'Orb. Rare.
Polystomella striato-punctata, F. and W. Frequent.
Nonionina depressula, W. and J. Common.

Ostracoda.

Cythere pellucida, Baird.
,, *confusa*, Brady.
,, *porcellanea*, Brady.
,, *macallana*, B. and R.
,, *lutea*, Müller.
,, *robertsoni*, Brady.
Cytherura nigrescens, Baird.
,, *similis*, G. O. Sars.
,, *sella*, G. O. Sars.
,, *cellulosa*, Norman.
Cytheropteron nodosum, Brady.
Loxoconcha pusilla, B. and R.
,, *tamarindus*, Jones.
,, *viridis*, Müller.
Paraoxdostoma variabile, Baird.
,, *eusiforme*, Brady.
,, *flexuosum*, Brady.
Candona candida, Müller.

Salthouse Bank.

Foraminifera.

Miliolina seminulum, L. Very rare.
,, *subrotunda*, Mont. Rare.
Polymorphina lactea, W. and J. Scarce and miniature.
Truncatulina lobatula, Walker. Scarce.
Polystomella striato-punctata, M. and F. Very common.
Nonionina depressula, W. and J. Very common.

OSTRACODA.

Cythere pellucida, Baird. Common.
,, *confusa*, Brady. Frequent.
,, *porcellanea*, Brady. Frequent.
,, *macallana*, B. and R. Scarce.
,, *lutea*, Müller. Scarce.
Paradoxostoma variabile, Baird. Scarce.
,, *flexuosum*, Brady. Scarce.

COPEPODA.

Longipedia coronata, Claus. Very rare.
Ectinosoma melaniceps, Brady. Common, habit burrowing.
Dactylopus sp. Very few.

On the higher banks great quantities of the eggs of the edible whelk were present. In close correlation with the stunted appearance of the 'crock' mussels was the existence of the stunted variety of the edible whelk, *Littorina litorea*, L., var. *paupercula.* Egg cases of *Buccinum undatum*, L., doubtless washed in from the sea, were picked up, and here and there could be seen dog-whelks *Purpura lapillus*, L., in close proximity to their egg cases. The number of dog-whelks were comparatively few, the policy of the Ferryden Society and Messrs Johnston's manager being to gather and bury them. Star-fish do not give the cultivators much trouble, as the water is too brackish for them to maintain a vigorous foothold.

V. FERRYDEN AND USAN FISHERMEN'S MUSSEL SOCIETY.

The formation, organisation, and mode of working of the Ferryden and Usan Society, furnishes an example of what fishermen can do, when assisted by energetic and capable leadership, to help themselves. The proceedings which led to the foundation of this society are given in a 'Report of the Proceedings of the Ferryden and Usan Mussel Society,' by James Johnston, junior, manager and treasurer, dated March 1858, and published at the *Standard* Office, Montrose. Information as to its organisation and the mode of working is given in the 'Rules and 'Regulations of the Ferryden and Usan Fishermen's Mussel Society,' and in the evidence taken by the Scottish Mussel and Bait Bed Committee * at Montrose in October 1888. Besides these sources we have had the advantage of receiving the personal testimony of Mr James Johnston, of Messrs Johnston's manager—Mr Andrew Lonie—and of Mr James West, the Secretary and Treasurer of the Ferryden and Usan Society, on the formation and management of the beds, and desire to express our obligations to them for the ready manner in which they answered all our enquiries, but this slight acknowledgment cannot exhaust our recognition of the indebtedness due to Mr Johnston for the facilities which he placed at our disposal in furthering a complete examination and survey of the beds.

The Ferryden and Usan Society was formed by Mr James Johnston, fish-curer, Montrose, on 17th October 1853, at a meeting in Ferryden, when all the line fishermen in the village attended. A week afterwards a

* Report of Committee on Scottish Mussel and Bait Beds, together with evidence and appendix, page 78 *et seq.*

meeting was held at Usan, when it was agreed to co-operate with the Ferryden men. The society consisted of 144 members, of whom 116 belonged to Ferryden, while 28 were Usan fishermen. Mr Johnston was appointed manager and treasurer of the society, and, without fee or reward, other than being the pioneer of a new enterprise and benefactor of the fishermen, established the Ferryden and Usan Society on a firm basis from which has developed the present successful organisation for the cultivation of the Montrose beds.

The co-operation of the fishermen for their own benefit was easily secured by Mr Johnston, as the sentence to imprisonment for three months of five of the fisherwomen of Ferryden, 'whose character for honesty was 'unimpeachable,' for stealing mussels from the Dun Sands, and the apprehension of the crews of five Usan boats on a similar charge, excited indignation in the fishing committees and sympathy for the fishermen. Backed up by the proprietor Colonel Macdonald of Rossie and St Martin's, Mr Johnston, 'having carefully inspected the Rossie sands on the south 'side of the river,' was 'convinced that it was practicable by a proper and 'careful system of cultivation to raise there a sufficient supply of mussels.'*

'Prior to 1853 there were no mussels on the Rossie ground, and what 'mussels were required were dredged from the bed of the river by the 'fishermen themselves, or purchased from the lessee of the Dun mussel 'beds.'†

The method which was employed when the society began operations is told by Mr Johnston in his report:—

'Immediately a commencement was made in the cultivation of mussels 'on the Rossie ground, south of the River Southesk, a great quantity 'of seed, obtained in the river, and on both sides of its banks below the 'suspension bridge, was planted on a large portion of the ground above 'the Salthouse Bank. The members, with their boats, took the seed to 'the ground. On the return of the boats from the herring-fishing of '1855, the tacksman of the Dun sands intimated that he could not give 'a supply of mussels for the ensuing season. ‡ The society were thus 'compelled to resort to their own ground; and, although there had been 'too little time to admit of a sufficient growth and increase of mussels, 'the sale was commenced after a survey of the ground.'

This premature and continued sale of the mussels, and the destruction by the women who gathered mussels from the beds of 'three times as 'many as they collected,' impoverished the new beds, and induced the society, after correspondence with the manager of the St Andrews beds, to alter their methods of cultivation, especially of collecting the mussels for bait.

'About September 1856 an additional number of men were employed 'by the Society, both to plant seed and to gather mussels by raking; and 'the women were stopped from gathering in the old way by wading on 'the sands.'

The ground was parcelled out into four divisions, so that a continuous supply of mature mussels might be obtained for four years from 1858.

In his report Mr Johnston gave the profit derived during his management up to March 1858 as follows:—

* Report by James Johnston, junior, Montrose 1858.

† From Statement of Secretary and Treasurer of Ferryden and Usan Society to Scottish Mussel and Bait Committee, page 78.

‡ This was meant to destroy the work on the society's grounds. He wished to buy up all the seed and half grown mussels, but the members of the society took the advice of Mr Johnston and would not sell. Had they sold, the preliminary work would have been destroyed.

Market value of mussels on Rossie ground, allowing three years to remove the crop, . . .		£1500 0 0
Estimated saving on		
1st year's sale, ...	£215 15 0	
2nd year's sale, . . .	284 0 0	
3rd year's sale, ...	145 6 6	645 1 6
	Total	£2145 1 6

It is interesting to note the conclusions which Mr Johnston formed twenty-one years ago, and we give them in full as follows:—'From the 'experience of the five years, now nearly elapsed, since attention was 'directed to the cultivation of mussels on the Rossie sands, the Society may 'consider it as ascertained that—1st, The Rossie ground, if properly 'cultivated, and the gathering of the mussels by raking is continued, will 'afford a sufficient supply of bait for Ferryden and Usan; but, if the old 'system of gathering by the women daily wading on the ground is returned 'to, a sufficient supply will not be got. 2nd, The ground should be 'cultivated in four divisions, each division to yield a full year's supply of 'mussels. 3rd, The mussel seed should be transplanted when about the 'size of beans, and three years are required to bring it to maturity. 4th, 'It is better, and cheaper in the long run, to employ men specially to '"seed" the ground than to depend on its being done by an occasional 'turn-out of the whole of the fishermen. 5th, If there shall be at any 'time a deficient crop on the Rossie ground, a supply may be got either 'on the Dun ground or from the Clyde.'

These conclusions formed after the Society had been four years at work, show how accurately the possibilities of the cultivation of the Rossie mussel beds had been gauged, and if the membership had continued at 184, the figure it reached to in March 1858, there might yet be a sufficiency of bait for the Ferryden and Usan fishermen. With a membership now of 325 it is hardly possible for the limited acreage of the beds to supply the greatly increased quantity of mussels required throughout the year by the Ferryden and Usan men.

The affairs of the society are now managed by a committee of fifteen, of whom thirteen are resident in Ferryden and two in Usan. They 'appoint 'the servants and workmen, fix their wages, regulate the disposal of the 'tickets for delivery of the mussels, and the prices thereof, the grounds 'from which the mussels are to be taken, the purchase of boats and 'implements, and generally administer the ordinary affairs of the Society.' Penalties are attached to removing mussels without the consent of the committee, or of those authorised by the committee, to trespassing on or wilfully injuring the beds, and to selling mussels to strangers. The committee may sell to non-members if there is a surplus of seed or mussels of bait size.

'No mussels can be sold for manure or any other purpose, neither are 'they sold for bait of a less size than two for each hook.' To prevent 'any 'rash selling of seed' a royalty of 3d. per heaped cran basket is payable to the proprietor. 'The committee in exercising this permission are requested 'to be careful not to impoverish the grounds, but keep a sufficient supply 'of bait always for the use of the members.'*

This permission of selling seed has only been exercised once, when the Society received £50 for seed sold from the Scalp.

Altogether the Society is fortunate in having such an intelligent manager as Mr James West, who accompanied one of the writers in his

* Rules and Regulations of the Ferryden and Usan Fishermen's Society.

the beds, readily answered all enquiries, and entered into the details of his management. Mr West supplied us with a copy of the rules and regulations of his Society, which are referred to in the lease by Colonel William Macdonald, in favour of seven fishermen residing in Ferryden and one fisherman in Usan, the trustees for behoof of the Society.

In regard to the financial arrangements of the Society, so long as Mr Johnston acted as manager and treasurer of the Society, no rent was exacted, and in 1858 the proprietor offered the fishermen 'a ninety-nine ' years' lease or partnership at 1s. 6d. per heaped cran basket, he to pay half ' of the loss and they to pay half of the loss, and he to get half of the ' profit and *vice versa.* But he was bound to spend all the profit he received ' in the village among the widows and the orphans.'* This proposed arrangement was not completed. The rental now is £100 per annum, £10 of this being annually repaid to the fishermen's reading-room, and the condition of the Society is most satisfactory from a financial point of view.

When one compares the cost of mussels to the members of the Ferryden Society with that paid by fishermen in other parts of the country, the very favourable position of the Ferryden and Usan fishermen is at once apparent. The average price paid at Ferryden per measure of 96 lbs. is about 6d.; this measure is sufficient to bait a line of 1040 hooks, and contains upwards of 2000 mussels of about 2 inches in length. Each hundred-weight of mussels taken from the Ferryden beds costs the members about 7½d. The evidence given at different fishing centres before the Mussel and Bait Commission, places the lowest estimate of a fair sum to be paid for mussels at the figure of the Ferryden Society, and even the double of that sum is regarded by some as a fair price.

But when the actual sums paid by the fishermen are examined it is found that at times as much as four times the Ferryden price is paid at various fishing-stations. The Helmsdale, Portmahomack, Hopeman, Aberdeen, and Eyemouth men have paid as much as 2s., 2s. 6d., 3s., and 3s. 6d. per basket.

VI. Conclusion.

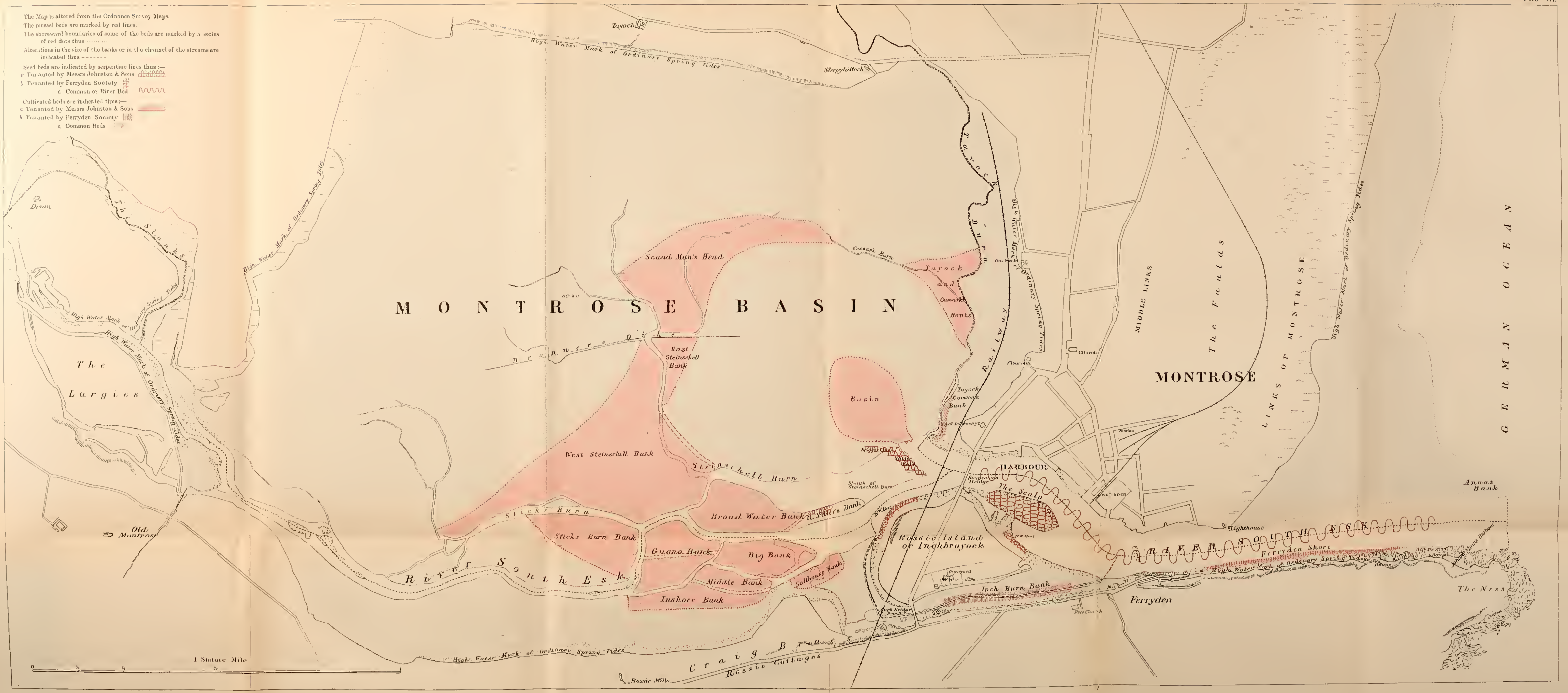
The work which has been done at Montrose Basin affords one great lesson to the fishermen of Scotland; and shows how it is possible to obtain by co-operation an increased supply of bait. A consideration of what has been effected at Montrose might stimulate the fishermen of other communities to band themselves together for their mutual benefit. Mr Johnston, when he led the Ferryden and Usan men, had no example which he could follow, but now other fishermen can profit by the experience of thirty-six years' successful mussel culture in Scotland. There is great room for the development of the co-operative principle among fishermen, and already the Nairn men have made a beginning. If it were possible to give the fishermen of different communities some assistance and advice, not to speak of active help in organising them, something might be done towards increasing and cheapening the supply of mussels, clams, and other forms of bait.

Much still remains to be done. Even the Montrose men complain that there are no regulations to prevent the using of immature mussels, or the depletion of beds. So long as matters proceed as at present, it can hardly be expected that individual mussel 'rakers' and gatherers will consider the condition of beds as a whole, rather than their own daily or weekly earnings. Regulation to be beneficial must be not only practical but also scientific. There is a host of subjects to be tackled by the regulating

* Report of Mussel and Bait Committee, Mr J. Johnston's evidence, page 84.

CHART SHOWING THE MUSSEL BEDS OF MONTROSE.

Plate VII.



authority, such as questions of rotation; the life histories of the animals constituting our bait supply; the determination of the organisms, animal and vegetable, embryonic and adult, on which the worms and shell-fish, used as bait, subsist; the determination of physico-chemical conditions favourable to a vigorous life; and the intelligent appreciation of the problems to which workers in other countries are devoting their energies. Perhaps the scientific man has in the past been too apt to disregard the experience of the practical fisherman, and the fishermen too ready to look askance at the work of the naturalist, with the result of mutual injury. It may, nevertheless, be perfectly possible for the two to work in harmony, and it will not redound to the credit of Scotland if this burden which oppresses the fishermen is not greatly lightened, and bait obtained at a reasonable rate.

The favourable position of the members of the Ferryden and Usan Society is most marked, and the wisdom of the cultivation begun upwards of thirty years ago has been fully manifested by the results of their system.

VII. ON THE HABITS OF PECTEN AND ON THE CLAM BEDS OF THE FIRTH OF FORTH. By J. H. Fullarton, M.A., B.Sc. (Plate VIII.).

I. Introductory.

The scallops, which are known locally in most places of Scotland as clams, flourish in great numbers in the waters of the Forth, and furnish a regular supply of bait to the line fishermen of certain districts. It is perhaps unfortunate that the name 'clam' should continue to be applied to so many different kinds of bivalve molluscs. In the Forth district clam is applied to the genus *Pecten;* in other parts of Scotland such widely separated genera as *Mya*, *Mactra*, and *Lutraria* are called clams. It is, therefore, necessary when fishermen and others speak of clams to ascertain whether *Pecten*, *Mya*, *Mactra*, or *Lutraria* is meant. In some districts clam to one person means *Pecten*, while others, even in the same district, do not regard the species of *Pecten* as clams, reserving the name for one of the other three genera mentioned. In America the pectens are called scallops, and clam seems a kind of indiscriminate term which, with an adjective prefixed, can be made to represent species of at least a dozen genera.

The following list, taken from the *Fishery Industries of the United States*,* illustrates the use or rather the abuse of the name:—

Ensatella americana = Razor clam.
Mya arenaria = Soft clam or long clam. (This species is also called clam in parts of Scotland).
Spisula solidissima = Beach clam, sea clam, or surf clam.
Venus mercenaria = Hard clam, or round clam. (In New York called clam, without any adjective).
Semele decisa = Flat clam.
Pachydesma crassatelloides = Hen clam.
Callista gigantea = Painted clam.
Argina pescata = Bloody clam.
Schizothœrus Nuttalli = Gaper clam.
Glycimeris generosa = Giant clam.
Cyprina islandica = Sea clam.

* U.S. Commission of Fish and Fisheries: G. Brown-Goode, *Fishery Industries of the United States*, Washington, 1884.

With such a diversity of nomenclature as this, and the restriction to the northern part of our island of the use of the term clam, if we really must apply to the genus *Pecten* an English equivalent other than the name pecten it would tend to lighten an already overburdened scientific catalogue by using the more widely applied name 'scallop.' All English-speaking naturalists know the term 'scallop,' but that of 'clam' is, I fear, known to a comparatively limited number. Few Scotch naturalists will have any difficulty in understanding what mollusc is meant by the clam, but most would be perplexed if 'Frills,' or 'Queens,' or 'Squinns' were spoken of, yet 'Frills' or 'Queens' of the South Devon man, and 'Squinns' of the Dorsetshire fishermen are the synonyms of 'clams' or 'scallops,' just as 'Vanneau' and 'Olivette' are the names given in the north of France to the genus *Pecten*.

Several well-marked species of the genus *Pecten* occur in British seas; but except the common scallop (*P. opercularis*), the variegated scallop (*P. varius*), and the great scallop (*P. maximus*), they are not of much economic importance to the fisheries. These three species are used for baiting hooks, but I am not aware that either the variegated scallop or the great scallop is so plentiful as to be continuously used as bait by fishermen in any part of Scotland. The common scallop, however, occurs in such abundance in the Firth of Forth, that an industry has been created, in which the whole time of a large number of men and boys is employed in dredging for clams, and on the continued supply of the species depends the sustenance and comfort of several fishing communities. The boats engaged in this way in dredging clams, for sale as bait to the larger smacks that pursue the fishing to the seaward side of the Isle of May, along with the smaller boats that combine dredging with long-line fishing, succeeded in landing in 1887, upwards of 860 tons of clams. This represents a value of at least £2300, and shows a marked advance on the quantity obtained during the previous year, when only 400 tons were secured as against 1033 tons in 1888 of the value of £2918. But the money value which is placed on the quantity landed in 1887, does not represent the value to the fishermen of the produce of the dredge, and it is not unlikely, if a taste for this delicious bivalve could be created among a shellfish-loving people, that the clams would yield a greatly increased revenue to the dredgers. The abundance of the common scallop consequently entitles it to more attention, and none the less because questions in reference to an adequate supply of bait are intimately connected with the presence of it and other bivalves in our seas. Moreover, its cultivation may afford a means of relief to those fishing districts where supplies of mussels have to be obtained from the Clyde, Ireland, King's Linn, or other mussel bearing areas.

The common scallop, to the consideration of which this paper will be restricted, is distributed throughout the Scottish seas, and generally at no very great distance from land. Just as marine zoologists talk of the *Laminarian zone*, so they also speak of *Pecten ground*. The general character of the sea-bottom on which they are oftenest found is sandy gravel, with an intermixture of mud and dead shells; in some localities the mud predominates. They associate together in great numbers in water from 5 to 12 or 15 fathoms. Though they are most numerous between these depths, yet they are to be found in shallower waters, and in water as deep as 100 fathoms. The species is not confined to the British seas, but its occurrence is chronicled* from places so far apart as Iceland (Steenstrup) and Faröe (Möhr) in the north, and Algeria (Weinkauff), the Ægean (Forbes), and Madeira (M'Andrew) in the south. Its geological is nearly

* Jeffrey's *British Conchology*, vol. ii. p. 60, London, 1863.

as wide as its geographical range. The existence of the species can be traced back from the present day to Tertiary times, shells being found in the Scottish glacial beds, and in the Red and Coralline Crag formations of Suffolk.

II. Habits of the Clam.

Unlike its relative, the oyster, the common scallop is in its adult state free, and is not perforce compelled to dwell in one place. It can move about in search of food, but the journeys which it undertakes must be rather limited in range. Most other bivalves move slowly by means of a highly muscular organ called the foot. This organ is capable of protraction and of withdrawal, and the locomotive function is further assisted by the ejection through the siphons of the water contained in the mantle chamber. In *Pecten*, however, the foot always remains in a comparatively undeveloped state, and in the adult stage is, so far as we know, functionless. The animal has the 'power of flight,' and darts through the water in a zigzag line by the flapping of the two valves of its shell. This flapping is brought about by the alternate contraction and relaxation of the single large and well-developed adductor muscle. The adductor, which is composed of innumerable muscular fibres, stretches from the right to the left valve, and on the application of a nervous stimulus contracts, thus closing the valves. The shell is opened by the simultaneous relaxation of the muscular contraction and the action of the elastic ligament which unites both valves along the hinge line. When the muscle is in a state of contraction the ligament is like a piece of cane bent on itself, and rapidly assumes a straightened position whenever the opposing force of contraction ceases, the result being the separation of the valves and the opening of the shell. By a rapid series of contractions and alternate relaxations the valves perform a flapping movement, and the animal darts hither and thither. But even this power of rapid movement is limited, and it is doubtful whether some of the more quickly creeping molluscan forms may not at the end of a day's journey show as good a record in the distance attained from the morning's starting point.

While the adult leads this free existence, in its younger days, like the ordinary mussel, it is moored to the tangle, to shells, or to stones. It is fixed to these neighbouring objects by hair-like processes which arise from a groove on the posterior surface of the small foot. These filiform structures are the hardened excretions or products of a special organ, the byssus gland, which is well developed in the embryonal bivalve, and in some persists throughout adult life. While, therefore, the foot of the adult scallop may be without any important function, yet during its larval and post-larval history it contained an actively secreting organ, analogous to the spinning glands of the spider and the caterpillar. The products of the glandular secretion—the byssus threads—anchor the young animal and enable it to withstand currents and storms, which periodically destroy many shell-fish all along our coasts. On the West Coast great quantities of shell-fish, especially littoral species, are often cast ashore. Burrowing shell-fish, like cockles, spout-fish or razor-fish, *Myæ*, and others, after the sand of the banks in which they are embedded has been loosened, and the banks broken up by the action of the waves and breakers, are thrown on the shore. These periodic storms furnish the inhabitants of some of the Western Isles with a plentiful supply of food or bait, if they care to profit from the riches of the sea. Not unfrequently the molluscs so uncovered are allowed to die and decompose on the beach.

It is highly probable that the 'extraordinary quantities of fine cockles' which were found during the famine years of 1782 and 1783 * at Tongue, at Kilmuir Easter, at Tain, and on the island of Sanday, and were regarded as 'almost a miraculous supply,' were placed within reach of the starving people by the agency of the sea invading with its ponderous artillery comparatively sheltered spots. In this we may find an explanation of the great quantities of recent shells which carpet the exposed beaches of the Hebrides, and it may be that the occurrence in certain geological zones † of countless bivalve fossils are as much due to the prolonged and destructive action of the sea, as to the obliteration of individuals and species by the movements of the earth's crust and alteration of the level of the land, or by a sudden change in the physical conditions. Marine action may also furnish a clue to the destruction of shallow-water bivalves in our seas, and account in part, at least, for the scarcity of bait on the East Coast.

The exposed nature of the East Coast, and the want of suitable harbours are consequences of the character and age of the geological strata of the shore, and of the nature of the rocks in the drainage area of the rivers. With the character of the coast-line is correlated the distribution of the bait-beds. These only exist in such sheltered places as are to be found in the estuaries of the rivers, and the common scallops, with no mode of attachment and requiring a depth of about 6 to 12 fathoms, flourish in such protected areas as we find in the Forth.

The adductor muscle is the most important organ of the scallop to the fisherman, and when the fisherman divides the scallop so as to obtain two baits the division is made by a longitudinal vertical cut through the adductor and other organs. The organ next in economic importance is the mantle. It is a thin and transparent covering enveloping the body and lining the valves of the shell. Along its outer margin it is much thickened and beset with about forty iridescent circular organs on each mantle lobe. These iridescent organs are called 'ocelli' or 'eyes' and structurally resemble some other molluscan eyes, and certain stages in the development of vertebrate eyes, but whether they perceive light many persons are doubtful. In breathing and feeding the valves are slightly separated, the opening of the shell being protected from the ingress of foreign matters by a fold of the mantle of either side which is beset with a series of tentacular cirri. These tentacular processes, along with the minute cilia which line certain parts of the body and the labial palps set up currents of water carrying oxygen to oxygenate the blood of the mantle and of the gills. In these currents the food is borne to the mouth, which is situated underneath the hinge at the anterior end of the shell. The gills, two pairs of which are situated on either side of the body inside of the mantle, and the mantle lobes constitute what the fishermen call the 'beard.' Sexual products are formed in distinct generative organs. The sexual organs are situated alongside of and behind the rudimentary foot, the ovary and testes being found in the same individual, occupying, however, different parts in the post-pedal mass. As the contents of the ovary ripen the colour of the hinder portion of the 'abdomen' or 'tongue,' as the fishermen call it, assumes a brilliant red colour. When the ovarian products are shed the ovary loses its red hue and becomes of a light brown colour. In February

* *Statistical Account of Scotland* (Sir John Sinclair's), 1791–9, iii. 391, 396, 522; iv. 300; vi. 185; vii. 497.

† In the mussel band of the carboniferous the fossil mussels lie horizontally, and the two valves are still united at the hinge, showing that the molluscs were cast on shore and buried alive. Had they been buried *in situ*, they would be found in their natural vertical position, or had they died before being enclosed the valves would be separated by the destruction of the ligament. In the Crag formation, on the other hand, the shells died before being covered, and in this are in striking agreement with the shelly beaches of the present day, such as Broad Bay, in the island of Lewis.

and March I obtained specimens of most diverse colours, from brilliant red to almost milky white, indicating that the spatting period was not confined to the early spring. This conclusion was also supported by the microscopic character and degree of maturity of the ovarian cells.

III. The Forth Clam Beds.

In the Forth the common scallop is so plentiful as to form regular beds, the position and extent of which are shown on Plate VIII., which embodies the results of Mr Scott's and my own dredging operations on board the 'Garland.' The chief bed extends for a distance of about 12 miles, from Inchmickrie on the west to almost Gullane Ness on the east. Its breadth varies much, attaining its greatest dimension about opposite Cockenzie. The northern limit of the bed might be defined by a line drawn from Inchmickrie to the north end of Inchkeith, and continued south-eastwards in a direct course to the West Point of Aberlady Bay. The $3\frac{1}{2}$ fathom line from West Point westwards might be taken as the extreme shoreward boundary, but the scallops are more plentiful in the deeper water. These boundaries would give the greatest dimensions of the bed as 12 miles long and about 5 miles in breadth. A glance at the map appended will show the irregular configuration of the scallop-bearing area, and how the bed tapers both at the eastern and western extremities till it is less than a mile broad. Inchkeith divides the beds into a large eastern and a small western portion. The eastern portion covers an area of about 20 square miles, the extent of the western area being only a few square miles. Over all this great area scallops are found in great quantities; but in the second bed, which is much smaller and situated about a mile to the north-east of Inchkeith, the scallops are even in greater numbers associated together. The length of the bed is about two miles, and its shoreward boundary is fully two miles from the shore between Kinghorn and Kirkcaldy. Its western limit is not far distant from the northern boundary of the principal bed. The sudden deepening of the water to the north of the eastern portion of the principal bed, perhaps as much as the comminuted character of the mud, hinders the migration of the scallops in this direction. Scallops flourish best in water from 5 to 12 fathoms deep, so the sudden deepening of the Forth from the gently sloping platform of 12 fathoms and less in depth, to a submarine valley of 20 to 30 fathoms, raises bathymetrical obstacles to the migration of such animals as the scallops. The occurrence of this deep gulley in the Firth places as great a hindrance to the extension of the bed as does a high mountain range to the distribution of birds, insects, and other animals. But these bathymetrical conditions do not obtain in the vicinity of Inchkeith. It is, therefore, here that the smaller northern and the large principal beds approach each other. That they are not united together cannot be accounted for by any deepening of the sea-floor. The suggestion that the smaller is an offshoot from the larger bed is quite likely to be a true indication of the origin of the former bed, as doubtless some individual scallops might be able to accomplish the journey. But the question may be raised, if migration is possible, why are scallops not found on the area intervening between the two beds? An odd example may be and has been dredged from this interval, which shows that migration is perfectly possible, even likely. That the beds are not continuous is doubtless due to the character of the estuarine deposit covering the sea-floor. The mud there is in such a fine state of division as to prevent the scallops living for any length of time among it and differs very much from the material of the bottom upon which scallops are usually found. So finely comminuted are the particles of which the mud is made up that it resembles closely in character the till of glacial deposits. The muddy interval is barren of molluscan life and presents an unfavourable resting place and feeding ground for the active scallop. The single pecten or so dredged in this part of the Firth was doubtless caught on its journey from one bed to another, or on its wandering in search of new feeding grounds.

The greatest depth of water over the beds is, as stated, 10 or 12 fathoms, and the bottom shallows gradually to the flat shores on either side of the Firth. The water, moreover, is deeper on the northern than on the southern bed, and the sea eastwards or seawards from Inchkeith is much deeper than between that and Inchmickrie. On the whole, the conditions of water, as regards depth, are the best possible for a vigorous growth of clam life. The bottom, too, is composed for the most part of dead shells of scallops lying on the top of sandy mud which, though somewhat finer than the sandy gravel on which pectens usually occur, yet affords a suitable habitat for the species.

The clams are most plentiful to the north-east of Inchkeith, and the number of dead valves are proportionally fewer than on the southern bed. On the latter, the dead shells are, at least, three times as numerous as the living, but the proportion of dead to living shells on the smaller bed is something like two to one. Besides, the dead shells of the southern are more worn than those of the northern bed, a fact that lends support to the suggestion that the northern is the younger bed.

From the nature of the bottom on the north side of the Firth it may be expected that the north bed will go on increasing. On the south side, however, the available ground is pretty well covered by pectens and unless expansion goes on towards and to the east of Gullane Ness there is not much room for an increase of the area of this bed. The expansion of either bed seawards will be retarded by the less sheltered nature of the ground to the east of Gullane Ness. In addition to ground suitable, from a physical point of view, to the development and increase of the scallops, ground where there is abundance of food is a necessity to a vigorous growth. Only a limited quantity of pecten food is contained within a given cubical space, so that the quality and size of the scallop depends on the crowding or otherwise of the species within a restricted area. The proper cultivation of the beds is also dependent on the 'thinning' of the scallops, and on the removal of great numbers of them, in order that those left behind may obtain a rich supply of crustacean and other microscopic forms from the surrounding water. In this way 'the struggle for existence' may be considerably modified by a judicious system of dredging and the value of the beds enhanced.

IV. The Clam as a Source of Bait Supply.

The beds provide a constant supply of bait during ten months of the year to the fishermen of Port Seton, Cockenzie, Prestonpans, Leith, and Newhaven. The fishermen of Fisherrow, Burntisland, Largo, St Monance, Anstruther, and other Fifeshire fishing villages, where a greater variety of bait is used, bait their lines with clams at different seasons of the year. The quantity of clams landed in 1887, within the limits of the Leith district, amounted to 16,020 cwts., and 1374 cwts. were secured in the Anstruther district. These quantities are greatly in excess of the produce of the clam fishing in 1886, when the total weight in both districts only amounted to 9100 cwts. In 1888 the total yield of clams was 20,774 cwts., so that, with care and attention, it is quite possible that the productiveness of the beds may be still further increased and the annual supply of clams augmented.

When the fishermen are absent at the herring fishing during the months of May and June, a close time is practically adopted, and the clams get rest from the almost daily presence of the dredge. During the colder months of the year, beginning with the month of October, clam dredging is pursued more vigorously than in summer, and the quantities landed in winter are greatly in excess of those obtained in the warmer months. It has already been mentioned that one class of boats dredge clams for sale to the large fishing boats that proceed to the banks east of the May, while other boats, which are engaged in long-line fishing within the Firth, secure the clams to bait their lines as they return from the fishing ground. In both kinds of boats, the dredge used is an oyster dredge of five or six feet breadth of mouth. The net attached to the mouth-frame is, on the lower side, made up of a series of lacing iron rings, and, on the upper side, it is composed of ordinary twine network. Such an arrangement of iron netting, on the side of the bag that is dragged along the bottom, prevents holeing of the net by the sharp valves of the scallop. The length of dredge rope 'paid out' is regulated by the speed at which the boat is moving and the depth of the water. Whether the dredge is securing a selection from the animals living on the bottom is easily ascertained by the presence or absence of the characteristic pulse with which every worker at dredging is familiar. When the boats dredge right over the banks, and not merely on their edge, if there is plenty of wind to propel boat and dredge, a short time suffices to obtain a dredgeful of clams. When the contents of the dredge are emptied into the boat, a process of selection takes place, the fully grown scallops being separated from the smaller and younger individuals. The latter are returned to the sea, as is all that remains of former generations of clams, viz., the dead shells. The policy of returning the shells to the sea is good, as it makes the muddy ground more suitable as a habitat for the living, supplies the young with a firm object for attachment, and returns gradually to solution the salts of lime which the shell-gland and the mantle of the animal secreted from the sea water.

Living in close association with the scallop is the horse-mussel (*Mytilus modiolus*). The beds, judging by the quantities of these obtained on the southern bed at each haul, are strewn with these bivalves. The horse-mussels attach themselves to each other and to other objects by 'byssus threads' which act much the same part as does the 'bent' of sandy dunes. This coarse grass, by its branching rootlets and stems, binds together the sand, which otherwise would be carried about and shifted during every storm. So the 'byssus threads' link mussel, shells, stones, and sand, and make firm the loosely aggregated particles of such a bed as this. The horse-mussels, therefore, are eminently helpful to the clam, for they afford a firm basis of attachment for the young and a foothold for the adult to maintain its position in spite of adverse currents. Some such bivalve as the horse-mussel is absolutely essential to the growth of the beds in the Forth to ensure that the fine mud does not bury the clams, and as a result kill them.

A few oysters are obtained by the boats, and near Inchkeith vast quantities of dead *Turritella* shells are brought up by the dredge. Very large *Actiniæ*, many specimens of *Alcyonium palmatum*, Zoophytes, including Hydroids and Polyzoa, a few of *Buccinum undatum*, comparatively few Ascidians, but many Sponges live alongside of the bivalves on the bed. Large numbers of *Anomia ephippium*, so often popularly mistaken for the young of the true oyster, some of the hermit crabs, an odd *Polynoe* and Nemertean, and the ubiquitous Echinoderms are there. Of the last the Ophiurids are in greatest abundance, and the common star-fish (*Uraster rubens*) is much rarer than its 12 to 15-fingered relative (*Solaster papposus*); *Cribella* and *Echinus sphæra* are also present.

The fishermen return all except clams, oysters, *Buccinum*, and sometimes the horse-mussel to the sea, and thus neglect an opportunity of lessening the enemies of the clam. The starfish, at least, ought to be destroyed, as well as such crustaceans as the hermit crabs. The latter creep with their house inside of the valves of the scallop, and I have seen cases where these soft-bodied crustaceans left their shell and clung on by their claws to and began to devour the body of the living scallop. It is, therefore, short-sighted policy of the fishermen to grant a respite to such enemies of the scallop by returning them to the sea.

Occasionally on one day as many as twenty-five to thirty boats may be seen dredging for clams. From Cockenzie alone thirteen boats follow the pursuit solely of dredging, and each boat has a crew of four or five men and boys. Each boat dredges a quantity sufficient to supply bait to two or two and a half large boats, and the daily earnings per man are about three shillings on the average. Five hundred clams are required to bait a line of ten hundred hooks (the fisherman's hundred hooks being one hundred and twenty or six score), and each clam is enough to bait one or two or sometimes three hooks. The dredgers sell the clams to the deep-sea fishermen at one shilling and sixpence per five hundred, but this sale is to boats belonging to the same fishing village as the dredger. The dredgers do not now sell clams to other places, although some years ago the North Berwick fishermen bought them.

While the men fish and dredge, their mothers, wives, daughters, and sisters carry the baskets of clams to their homes and there unshell the animal, cut the body into two or three parts, and bait the hooks with these pieces. After the men return from the fishing, the women are engaged in selling the fish or despatching them to market, and this work being accomplished, they bait the lines which are to be set next morning. The smaller fishing boats set their lines daily from Monday to Saturday, while the larger vessels generally proceed to the fishing banks on Mondays, Wednesdays, and Fridays, returning on the same days, or it may be not arriving till the following mornings. The empty shells are cast on the shore, but sometimes some lazy individual under the cover of darkness deposits them between the fisherman's house and the shore rather than carry them a few yards farther and throw them on the shore in accordance with the expressed sentiment of the community.

In some parts of America* the law prohibits the using of oyster shells (1) as manure, (2) in kilns, (3) in the manufacture of iron, (4) for road making, (5) for wharf building, and it declares where shells are to be set down. The same conditions are not exactly applicable to the scallops, either in respect of structure of shell or in adult habit, but in the one case as in the other it is necessary to have a certain amount of lime in solution in the water that the animals may construct for themselves a covering. Whether the lime would be sooner returned to the solution in the sea by a direct transference of the emptied shells to the sea, or by depositing them on the neighbouring land, especially if it were a peaty land—is a question which we have not data to determine. The crystalline form, in which the carbonate of lime present in the shells exists, is arragonite; with a copious supply of carbonic acid gas, such as might be liberated from a peaty soil, the solid arragonite would soon go into solution and be transferred by the river to the sea. It certainly would be more sensible for the fishermen to return the shells to the sea than allow them to lie on the shore, but if there be soil in the neighbourhood in which organisms are decaying it might be preferable to use them as manure

* The Maryland Oyster Report: Brooks, *Development and Protection of Oysters.* Baltimore, 1884.

either directly or after they had been calcined and have the lime returned in solution through this agency.

What is the Value of the Clam as Bait?—Fishermen in different localities would answer this question differently. Of all baits the edible mussel (*Mytilus edulis*) is that most commonly used and many, perhaps most, fishermen would declare that it is the best bait which we have. Not a few would dispute this conclusion, and among them could be reckoned the fishermen of Cockenzie and Prestonpans. In these districts the unanimous testimony is that clam is the best bait for the whole year, that in winter it is absolutely the best, and that in summer the only thing that detracts from its value is its liability to die soon after leaving the water. The tenacity of life which the mussel possesses gives it an advantage over the clam during hot weather, but at all times the clam can be more securely fastened on the hook, because of the firmer consistence of the 'adductor' and the edges of the mantle. The clam is much easier killed than either of its relatives, the mussel and oyster, these two and especially the former of them having better arrangements to keep the shells closed. Their valves fit more closely than do those of the scallop. It is rather unusual for mussels or oysters immediately after removal from the bed to be found with the valves apart and the shell open, but exactly the reverse is the case with the clam. The clam by alternate openings and closings of its shell cannot retain the fluid contained within its mantle chamber, and thus it sacrifices its life to its 'gaping.' Not only is the escape of the fluid detrimental to the life of the clam, but like the lobster it soon succumbs if placed in either a too hot or a too windy place. These conditions of weather and habits of the animal operate, therefore, against the value of the clam to localities far removed from the clam breeding and feeding grounds. Under favourable barometric and thermometric conditions the clam will remain alive in the air for two days or so, but this is about the length of the animal's life out of its native element. Thus it is valuable chiefly to fishing communities in whose vicinity the clam beds are, but the mussel is more valuable as it is more universally distributed, and it can better resist the forces destructive of marine molluscan life to which it is subjected when removed out of the sea.

The great value of the Forth beds is apparent when the value of the clams landed in this restricted area is compared with that of the mussels landed on the whole of the Scottish coasts. The Fishery Board's returns for 1887 (*vide* Appendix C.) give the following as the figures :—

Clams, [all from Forth beds], . . .	£2,320
Mussels, [from whole of Scotland], . .	15,411

Thus the value of the mussels obtained from all the mussel beds in Scotland is only six or seven times as great as that of the clams got from the Forth beds. In questions, therefore, concerning bait and the artificial or the natural propagation of it, we must not lose sight of the clam, as its great breeding and multiplying powers may indicate one way in which an increase of bait may be obtained. But in addition to its economic importance as bait the scallops may supply us with a very digestible though, perhaps, a somewhat sweet kind of food. The fishing communities strip off the mantle, gills, and all the other organs except the adductor muscle, and eat this last or 'the white part.' That is how they eat the uncooked clam, but when boiled they add butter and pepper and the dish is a substitute for fish when these are scarce. But there is no reason why a greater population should not enjoy such toothsome morsels.

According to the evidence of the fishermen who have been acquainted with the Forth beds for the last generation or two, the clams never were more plentiful nor the beds in better condition than at present. The beds have not always been in this prosperous condition, although the fishermen have never been without bait for their lines. Some few years ago, clams were scarcer, and, it is alleged, great harm was done to the beds by the indiscriminate trawling that took place in the Firth. But the beds have completely recovered, or as one man says, 'are beginning to recover,' since the prohibition of trawling inside of the waters of the Firth. The fishermen of Prestonpans, Cockenzie, and Port Seton say that if trawling had been continued they would have had to give up the fishing altogether, as their supplies of bait would be gone, and the fish would be driven from the fishing grounds. These beds have afforded the fishermen rich supplies for several decades at least, and with protection and under wise regulations, either mutually observed by the fishermen or enforced under the supervision of the fishery authorities, they are likely to become even more prolific in the future. There is no reason why these beds should not supply all the fishermen of the south-east coast of Scotland with bait during the colder months of the year, so far, at least, as the quantities of clams present on them are concerned.

How to maintain their productiveness and prevent their depletion is a subject which ought to be considered before they are harmed as the beds of the West Coast have been. Some may doubt whether it is possible to fish out the scallops from this area, but one need only point to the very valuable beds that surrounded the north and eastern parts of the island of Arran as a case in point. Thirty or forty years ago one friend tells me that he could get a barrelful of clams in Lamlash Bay in a few hauls of a small dredge; Mr Alexander Somerville, B.Sc., F.L.S., writes that at Catacol, in 1856, in a single haul in a quarter of an hour he dredged a large quantity for the table, and that the fishermen at Lochranza were able to get as many as 500 or 600 in one dredgeful; Mr William Young writes me he could have filled a boat in a short time off the Cock of Arran. In Brodick Bay large hauls could be taken in one day, but now they are scarce. These beds were destroyed by carelessness and overfishing. No physical changes have taken place within the last thirty or forty years that can account for the comparative scarcity of scallops in these and other localities in the west where they were formerly very abundant, but the want of proper regulation and supervision by a duly constituted and enlightened authority, permitted wholesale destruction of most valuable beds. What, therefore, has been done on the West Coast will be repeated in the Forth, unless a proper amount of foresight and a due appreciation of the desiderata for molluscan breeding ward off such a calamity.

Can the Forth clam beds afford any *means of relief* to those districts in Scotland where the fishing population can only obtain bait by the expenditure of large sums in the buying of mussels and in freight? Is it possible to bring the clam nearer to the fishermen in these districts? That the Forth beds may be further utilised seems likely, when we remember that in 1885 the quantities dredged were less than in 1886 when 9100 cwts. were landed as against 17,394 cwts. in 1887, and 20,974 cwts. in 1888. In order to maintain the productiveness of the beds, regular dredging will promote the prosperity of the bed rather than harm it, provided all the clams under a standard size are returned at once to the sea, along with these associated forms that are helpful to the clam, and provided its well-known enemies are killed and retained in the boat, and provided also the dredging is conducted in such a way that no particular part is depleted by over-dredging. Not only may the productiveness be maintained, so as to ensure the gradual expansion of the clam-bearing area, but, with special precautions, it may be possible to transplant clams from the bed to other localities as a nucleus for a local bait bed. The clam is a delicate shellfish, when compared with such molluscs as the cockles and mussels, and is not so easy of transport. Means could, however, I believe, be adopted whereby transportation in large quantities could be accomplished. But before clams are laid down in any locality the biological, physical, and other characteristics of the ground should be examined, and if found suitable, arrangements might be made to transplant a large quantity of the horse-mussel which lives in close association with the clam in the Forth, in Oban Bay, and elsewhere. After the horse-mussel had spun a new 'byssus' and attached itself to the surrounding objects, the transplanting of clams might take place with increased prospects of success. But it would be worse than useless to make any such experiments unless absolute protection were afforded to those conducting the experiment. The experiment would require care and attention, for it might be a few years before the clams attained a vigorous position. On the successful formation of the bed the fishermen might be permitted to dredge for bait under well-devised rules, formed and administered by the fishery authorities. Otherwise, without such administration, the fisherman might, nay, would be sure to repeat the foolish policy which ruined the beds in the Firth of Clyde, and threatened and still threatens the destruction of the valuable cockle beds in the Hebrides.

V. Conclusion.

What ought to be done to ensure to the fishermen an adequate supply of bait which will be lasting? This inquiry at once opens up the consideration of the mussel question, which is occupying not only the minds of fishermen but also of those interested in the condition of the fishermen and in the food supply. The first thing necessary is a complete survey of all the mussel and clam beds now existing, and a knowledge of the conditions under which the mussels and clams thrive. Something is already known on these subjects, but there is still much to do to fill up the blanks in our knowledge. Besides, the suitability or otherwise of different parts of our coasts to the formation of new beds is a comparatively unknown factor, and one that merits investigation. Nothing is at present done to husband the resources of such clam and cockle beds as we have; they are left to take care of themselves, and nothing is done to further their expansion. No mere spasmodic attempts at supervision will suffice, for regulation and inspection, to be valuable, must be intelligent, thorough, and continuous. Without some such systematic treatment, based on scientific principles, the crisis is bound to be accelerated, and the quantities of bait and food obtainable from molluscs lessened. Attention has been repeatedly called by different parties to the work done in this and kindred departments by the authorities of France, of Spain, and of the United States, and yet in Scotland we lag as far behind as ever. Not only have the mussel, clam, oyster, and cockle beds not been surveyed and mapped out, but, though certain parts of the coast are tolerably well known, many beds exist known to few other than local men.

The first requisite is that an exhaustive examination be made of the present beds; then an investigation into beds which existed in recent years, but are now depleted. Inquiry might be made into the causes of such destruction, whether it has been due to overfishing, or whether any climatic or local changes have taken place that might account for it. The difference in the living organisms present near the spatting grounds, and these present on the fattening grounds would give scientific corroboration or disproof of popular theories, and thus we might arrive at the biological conditions which are best fitted to further molluscan development. Then might follow a determination of the localities that are most suitable for the planting of new beds, and conveniently situated so as to be serviceable to the fishing community. These are only a few of the many questions awaiting solution. It is first of all necessary to conserve those beds which we have at present, then attempt to resuscitate those which have been depleted, and afterwards form new beds in suitable localities where the biological, physical, and other conditions are favourable.

VIII. REPORT ON BAIT EXPERIMENTS. By J. H. Fullarton, M.A., B.Sc.

These experiments were designed by Dr T. Wemyss Fulton, Secretary of the Scientific Committee, in order to ascertain the relative success of different kinds of bait, and the preference by different fish for certain baits, and to endeavour to discover a cheap substitute for the commonly used forms of bait. No similar systematic investigation had previously been made into this question, and the results are therefore of considerable interest.

The Scottish fishermen are conservative in their habits. They have used mussels for years, and have found them fairly successful. They have demonstrated in their own experience the value of mussel baits, and provided a sufficient supply can be obtained at a fair price, they seem willing to depend on the mussel. Till some equally good, equally abundant, and equally cheap bait can be obtained, they appear determined to keep to the mussel, and in this show their wisdom. When mussels are scarce or dear, they bait their lines with other animals, some of which are reckoned equal to, and even by some persons superior to the edible mussel. Of course the animal forms selected must be such that they can be easily obtained in the particular district. In the Forth, and formerly in the Clyde district, the clam, *Pecten opercularis*, L., was often used in preference to the commoner mussel. In some of the Western Isles the spout fish, *Solen siliqua*, L., is used by the ling and cod fishermen. In many places the lugworm, *Arenicola piscatorium*, Lamk., is considered to be as good killing bait as any other. The cuttlefish, *Loligo vulgaris*, Lamk., and *Sepia officinalis*, are preferred by some fishermen to all other baits. Where herrings, *Clupea harengus*, L., are obtainable they make capital bait, as also do cockles, *Cardium edule*, L. Limpets, *Patella vulgata*, L., whelks, *Buccinum undatum*, L., and horse mussels, *Mytilus modiola*, L. are secondary baits, used when any of the other first-class baits cannot be had, or when such ground feeders as the cod are sought.

Besides using most of these baits, the 'Garland' lines were baited with earthworms, garden-snails, bullock's liver, mussels preserved in boracic acid, crayfish, and various other substances, which are classed together in the tables as artificial lures.

The experiments were carried on at various parts of the Firth of Forth, in various depths of water. The line used had 1200 hooks, baited with different baits in series of 40 hooks, so that a large variety of baits were used under identical conditions, and the fish obtained by each kind of bait were carefully noted and measured. Besides the ordinary baits used by fishermen, various other animal forms were tried, such as common earth-worms and garden-snails (which were recommended to be tried by the late Mr Buckland). These two baits were fairly satisfactory, especially the garden-snail (*Helix*) which was more successful than many baits generally employed by fishermen (*vide* Table II.). The substances used as artificial baits were formed of a variety of materials, many of

CHART showing the Position and Extent of the Great Clam Beds in the Firth of Forth.

The dotted lines represent the 4-fathom line. The black lines represent the boundary of the clam beds.

Plate VIII

them being coloured by aniline dyes and subsequently well soaked in solutions of different fish extracts.

The following is a list of the artificial contrivances, with their colour and flavour appended :—

Substance.	*Colour.*	*Flavour.*
Wool,	White,	Not Flavoured.
"	Brown,	"
"	Orange,	"
"	White,	Extract of horse mussel.
"	Brown,	Extract of mussel.
"	Scarlet,	"
"	Orange,	"
"	White,	Extract of whale.
"	Brown,	"
"	Orange,	Extract of crayfish.
Sponge,	Yellow,	Not flavoured.
"	"	Extract of mussel.
"	"	Extract of horse mussel.
Sheep Skin,	White,	Not flavoured.
"	Brown,	"
"	Orange,	"
"	White,	Extract of mussel.
"	Brown,	"
"	Scarlet,	"
"	White,	Extract of whale.
"	Scarlet,	"
"	Orange,	"
"	White,	Extract of crayfish.
Tin Foil,	White Metallic,	...

The hooks were baited with these artificial baits by an experienced fisherman, but in all cases the result was the same. Not a single fish was caught, either with the unflavoured or with the flavoured baits, and even the tin foil was unsuccessful, although one might naturally have expected that, when the lines were being set or lifted, the hooks, baited with tin foil, when in motion might have caught some fish. Not only did the long line hooks with tin foil not catch any fish, but an artificial troll of 120 hooks, half of which were baited with sponge and half with tin foil, did not take a single fish, although a similar troll baited with bullock's liver and with mussels was very successful.

So far as artificial lures are concerned the results of the experiments are entirely negative, but they reveal certain interesting facts in reference to the preference by certain fish for certain baits.

The following shows the collated results of the detailed tables :—

Table I.

Showing the number of hooks baited with particular baits, and the number and kind of fish caught.

Bait.	Hooks.	Haddock.	Cod.	Whiting.	Gurnard.	Dab.	Plaice.	Total.
Mussel, . . .	10,900	302	258	119	7	119	...	805
Clam, . . .	10,000	188	244	55	4	113	...	604
Limpet, . .	6,480	102	58	12	3	60	...	235
Lugworm, . .	3,500	130	39	67	3	50	4	293
Horse Mussel,	760	2	33	...	...	7	...	42
Cuttlefish, .	400	5	2	2	...	2	...	11
Whelk, . . .	360	1	4	...	1	...	...	6
Mussel in Boracic Acid, .	300	...	...	...	...	1	...	1
Bullock's Liver,	280	1	...	1	...	3	...	5
Herring, . .	160	...	...	...	...	1	...	1
Crayfish, . .	128	1	1	...	...	...	...	2
Cockle, . . .	120	12	...	4	...	9	...	25
Snail, . . .	112	...	...	...	...	9	...	9
Earthworm, .	60	1	...	...	1	...	...	2
Artificial Lures,	2,020	...	...	...	...	...	...	...
Totals, . .	35,580	745	639	260	19	374	4	2,041

Table II.

Giving the percentages of the fish caught by the various baits.

Bait.	Hooks.	Haddock.	Cod.	Whiting.	Gurnard.	Dab.	Plaice.	Total.
Mussel, . . .	10,900	2·77	2·37	1·09	·06	1·09	...	7·38
Clam, . . .	10,000	1·88	2·44	·55	·04	1·13	...	6·04
Limpet, . .	6,480	1·58	·90	·19	·05	·93	...	3·65
Lugworm, . .	3,500	3·71	1·11	1·91	·09	1·43	·12	8·37
Horse Mussel,	760	·26	4·34	...	...	·92	...	5·52
Cuttlefish, . .	400	1·25	·5	·5	...	·5	...	2·75
Whelk, . . .	360	·28	1·11	...	·28	..	...	1·67
Mussel in Boracic Acid, .	300	...	...	...	...	·33	...	·33
Bullock's Liver,	280	·36	...	·35	...	1·07	...	1·28
Herring, . .	160	...	...	...	...	·62	...	·62
Crayfish, . .	128	·78	·78	...	...	..	...	1·56
Cockle, . . .	120	10·	...	3·33	...	7·5	...	20·83
Snail, . . .	112	...	...	...	...	8·04	...	8·04
Earthworm, .	60	1·67	...	...	1·66	...	...	3·33
Artificial Lures,	2,020	...	...	...	...	...	...	...
Totals, . .	35,580	2·09	1·79	·73	·05	1·51	·12	5·74

From the above tables it will be seen that the commoner forms of bait used by the Scottish fishermen—mussel, clam, limpet, and lugworm—were chiefly used for the lines of the 'Garland,' and it is interesting to note the results. From the limited numbers of the other kinds of bait it would be rash to generalise too hastily. This is more apparent from Table III., when the comparative results obtained on 21st September 1888 by the different baits are noted. From Table II., it will be seen that the percentage of success, 20·83 for cockles, is the highest registered for any bait, yet on the date mentioned lugworm, clam, and mussel were each more successful than the cockle. We are not therefore warranted in forming any conclusion as to cockles, which were used on only one occasion. A detailed analysis of the daily catch as recorded in Table III., might further illustrate the caution necessary to be observed in the interpretation of Table II., but it will be sufficient to give the total percentages for Station VII. (Date, 21st September 1888.)

Lugworm, ...	25	per cent.
Clam, ...	24·16	„
Mussel, ...	23·33	„
Limpet, ...	9·38	„
Cockle, ...	20·83	„
Bullock's liver, ...	·25	„
Snail, ...	11·25	„

The great numbers of mussels, clams, limpets, and lugworms used for bait between August and March will enable us to form an approximate estimate of the worth of these as baits. The best results were obtained with lugworm for all except cod.

Following in order come mussel and clam. For all practical purposes we might consider lugworms, mussels, and clams to be about equally successful baits during the greater portions of the year in the Firth of Forth district. Fishermen prefer clams during the winter, but in the summer months clams will not keep so long as mussels, and consequently are in so far not so valuable.

In the lines used the hooks were placed 30 or 32 inches apart, and the baits were grouped in series of forty. The series of different baits were arranged alternately, a series of mussels being followed in regular order by clam, limpet, lugworm, &c.

The subjoined table gives the details of which Tables I. and II. are the summaries.

TABLE III.—Showing the Results of the Bait Experiments carried on on Board the 'Garland,' 1888–89.

The baits used included the following:—

Lugworm	=*Arenicola piscatorium*, Lamk.	Clam	=*Pecten opercularis*, L.	Cockle	=*Cardium edule*, L.
Horse Mussel	=*Mytilus modiola*, L.	Limpet	=*Patella vulgata*, L.	Mussel	=*Mytilus edulis*, L.
Whelk	=*Buccinum undatum*, L.	Snail	=*Helix nemoralis*, L., and *Helix aspera*, Müll.	Cuttlefish	=*Loligo vulgaris*, Lamk.
Earthworm	=*Lumbricus terrestris*, L.			Herring	=*Clupea harengus*, L.
Crayfish	=*Nephrops norvegicus*, L.				

The fish caught were the following:—

Haddock	=*Gadus æglefinus*, L.	Cod	=*Gadus morrhua*, L.	Whiting	=*Gadus merlangus*, L.
Brassie	=*Gadus luscus*, L.	Saithe	=*Gadus virens*, L.	Gurnard	=*Trigla gurnardus*, L.
Common dab	=*Pleuronectes limanda*, L.	Lemon Dab	=*Pleuronectes microcephalus*, Flem.	Plaice	=*Pleuronectes platessa*, L.
Dragonet	=*Callionymus lyra*, L.	Ling	=*Molva vulgaris*, Flem.		

Station.*	Date and Tide.	Bait.	No. of Hooks.	Haddock.	Cod.	Whiting.	Gurnard.	Common Dab.	Plaice.	Total.	Condition of Fish.	Wind, Weather, and other Observations.
I. Firth of Forth.	30th Aug. 1888, 12.45 p.m. Ebb.	Lugworm,	400	36	8†	21‡	2	5	...	72	Small.	Wind S.W.; force 3.
		Clam,	80	4	1	1	...	...	...	6	Immature.	Dull.
		Mussel,	400	45	16	11	4	7	...	83	Quality good.	Sea smooth.
		Limpet,	320	18	8	1	1	1	...	29		Transparency disc, ¶ 7 fathoms. Depth, 29 fathoms. Bottom, stones.
		Total,	1200	103	33	34	7	13	...	190		
II. Firth of Forth.	1st Sept. 1888, 10.30 a.m. Flood.	Lugworm,	280	5	8	13	...	3	...	29	Average size.	Wind S.W. by W.; force 7.
		Clam,	320	2	10	12	1	3	...	28	Immature.	Showery.
		Mussel,	360	8	11	22	1	2	...	44	Quality good.	Sea moderate.
		Limpet,	200	...	...	...	...	1	...	1		Transparency disc, $1\frac{3}{4}$ fathoms. Depth, 13 fathoms. Bottom, shells and mud.
		Cuttle-fish (squid),	40	...	...	...	...	1	...	1		
		Total,	1200	15	29	47	2	10	...	103		

* Stations I., V., VI., and XI., were in the neighbourhood of the Isle of May. Stations VII., IX., X., XI., XVI., were in the neighbourhood of Fidra island. Station XIV., was near Granton. Stations III., VIII., and XV., were between Aberlady Bay and the Fife Coast. The other Stations were to the East and North East of Inchkeith and not far distant from it.

† Includes 1 Ling. ‡ Includes 6 Brassie. ¶ The transparency disc was a white disc, $9\frac{5}{8}$ inches in diameter.

TABLE III.—Showing the Results of the Bait Experiments carried on on Board the 'Garland,' 1888–89.—*continued.*

Station.	Date and Tide.	Bait.	No. of Hooks.	Haddock.	Cod.	Whiting.	Gurnard.	Common Dab.	Plaice.	Total.	Condition of Fish.	Wind, Weather, and other Observations.
III. Firth of Forth.	4th Sept. 1888, 11 a.m. Flood.	Lugworm,	40	4	1	...	...	3	1	9	Small. Immature. Quality good.	Wind W.; force 6. Cloudy. Sea moderate. Transparency disc, 5 fathoms. Depth, 11 fathoms. Bottom, shells.
		Clam,	440	32	2	4	1	18	...	57		
		Mussel,	440	25	3	6	1*	18	...	53		
		Limpet,	280	25	...	2	1	13	...	41		
		Total,	1200	86	6	12	3	52	1	160		
IV. Firth of Forth.	12th Sept. 1888, 12 Noon. Low water.	Lugworm,	240	2	7	3	...	1	...	13	Immature. Quality scarcely average.	Wind W. by S.; force 2; Hazy. Sea smooth. Transparency disc, 1½ fathoms. Depth, 9½ fathoms. Bottom, mud and shells.
		Clam,	240	1	15	1	...	2	...	19		
		Mussel,	240	6	14	2	...	2	...	24		
		Limpet,	160	...	1	...	...	...	...	1		
		Cuttle-fish (squid).	160	...	1	...	...	1	...	2		
		Crayfish,	128	1	1	...	...	...	...	2		
		Snail (*Helix aspera*),	32	0	...	...	...	...	...	...		
		Total,	1200	10	39	6	...	6	...	61		
V. Firth of Forth.	14th Sept. 1888, 12.35 p.m. Ebb.	Lugworm,	160	15	1	1	1	...	...	18	Immature. Quality average.	Wind E.S.E.; force 4. Hazy, fine. Sea heavy swell. Transparency disc, 5¼ fathoms. Depth, 17 fathoms. Bottom, sandy mud, shells.
		Clam,	160	9	...	...	1	...	...	10		
		Mussel,	200	16	6	1	...	...	...	23		
		Limpet,	160	3	1	...	...	...	...	4		
		Cuttle-fish (squid),	120	5	...	1	...	...	...	6		
		Whelk,	120	1	...	...	1	...	...	2		
		Bullock's liver,	80	1	...	...	...	...	...	1		
		Artificial lures,	200	...	...	...	...	...	...	...		
		Total,	1200	50	8	3	3	...	...	64		

* Dragonet.

TABLE III.—Showing the Results of the Bait Experiments carried on on Board the 'Garland,' 1888-89.—*continued.*

Station.	Date and Tide.	Bait.	No. of Hooks.	Haddock.	Cod.	Whiting.	Gurnard.	Common Dab.	Plaice.	Total.	Condition of Fish.	Wind, Weather, and other Observations.
VI. Firth of Forth.	17th Sept. 1888, 12.45 p.m. Ebb.	Clam,	120	5	...	...	...	...	..	5	Immature.	Wind W.; force 3. Hazy, fine. Sea smooth. Transparency disc, 6 fathoms. Depth, 22 fathoms. Bottom, gravel, shells, mud.
		Mussel,	320	36	17	9*	...	1	...	63		
		Limpet,	160	8	1	2	1	2	...	14		
		Whelk,	40	...	...	...	...	...	...	...		
		Earthworm,	60	1	...	...	1†	...	...	2		
		Artificial lures,	500	...	...	...	...	...	...	...		
		Total,	1200	50	18	11	2	3	...	84		
VII. Firth of Forth.	21st Sept. 1888, 11.30 a.m. Flood.	Lugworm,	200	10	1	10	...	29	...	50	Immature. Quality good.	Wind N.W.; force 2. Very hazy. Sea smooth. Transparency disc 2 fathoms. Depth, 13 fathoms. Bottom, muddy sand.
		Clam,	240	26	...	9	...	23	...	58		
		Mussel,	240	36	1	9	...	10	...	56		
		Limpet,	160	6	...	1	...	8	...	15		
		Cockle,	120	12	...	4	...	9	...	25		
		Bullock's liver,	40	...	...	1	...	...	...	1		
		Snail (*H. nemoralis*),	80	...	...	...	...	9	...	9		
		Artificial lures,	120	...	...	...	...	...	...	...		
		Total,	1200	90	2	34	...	88	...	214		
VIII. Firth of Forth.	24th Sept. 1888, 12.30 p.m. Low water.	Lugworm,	340	6	2	4	...	4	1	17	Immature. Quality below average.	Wind N.E.; force 1. Very hazy. Sea smooth Transparency disc, 1½ fathoms. Depth, 14 fathoms. Bottom, mud.
		Clam,	80	2	...	1	...	...	...	3		
		Mussels,	420	12	8	4	...	1	...	29		
		Limpet,	360	2	1	1	...	2	...	6		
		Total,	1200	22	11	14	...	7	1	55		

* Includes 1 Brassie. † Dragonet.

TABLE III.—Showing the Results of the Bait Experiments carried on on Board the 'Garland,' 1888-89—*continued.*

Station.	Date and Tide.	Bait.	No. of Hooks.	Haddock.	Cod.	Whiting.	Gurnard.	Common Dab.	Plaice.	Total.	Condition of Fish.	Wind, Weather, and other Observations.
IX. Firth of Forth.	26th Sept. 1888, 11.30 a.m. Low water.	Lugworm,	320	17	1	5	...	...	...	23	Immature. Quality very good.	Wind E.; force 3. Cloudy. Sea moderate. Transparency disc, 2¼ fathoms. Depth, 26 fathoms. Bottom, mud.
		Clam,	320	22	2	5	...	...	...	29		
		Mussel,	320	32	1	12	...	...	...	45		
		Limpet,	240	4	...	...	...	...	...	4		
		Total,	1200	75	4	22	...	...	...	101		
X. Firth of Forth.	27th Sept. 1888, 11.25 a.m. Ebb.	Lugworm,	320	9	3	6	...	...	...	18	Immature. Quality good.	Wind S.E.; force 1. Hazy. Sea smooth. Transparency disc, 3½ fathoms. Depth, 28 fathoms. Bottom, mud.
		Clam,	320	23	3	7	...	...	...	33		
		Mussel,	320	22	2	9*	...	...	...	33		
		Limpet,	240	3	...	1	...	...	...	4		
		Artificial lures,	360	...	...	...	...	...	...	...		
		Total,	1560	57	8	23	...	...	...	88		
XI. Firth of Forth.	28th Sept. 1888, 12.15 p.m. Ebb.	Lugworm,	240	22	1	2	...	4	2	31	Immature. Quality good.	Wind S.E.; force 1. Hazy. Sea smooth. Transparency disc 4½ fathoms. Depth, 19 fathoms. Bottom, muddy, sand, stones.
		Clam,	320	50	2	3	1	6†	...	62		
		Mussel,	400	51	1	4	1	2	...	59		
		Limpet,	240	16	...	...	...	3	...	19		
		Artificial lures,	360	...	...	...	...	...	...	...		
		Total,	1560	139	4	9	2	15	2	171		
XII. Firth of Forth.	2nd Oct. 1888, 11 a.m. Flood.	Lugworm,	240	2	...	1	...	...	...	3	Immature. Average quality.	Wind W.N.W.; force 5. Rainy. Sea moderate. Transparency disc, 2½ fathoms. Depth, 29 fathoms. Bottom, mud.
		Clam,	320	9	...	...	...	...	...	9		
		Mussel,	320	4	.	6	...	...	...	10		
		Limpet,	280	11	1	1	...	...	...	13		
		Artificial lures,	360	...	...	...	...	...	...	...		
		Total,	1520	26	1	8	...	...	...	35		

* Includes 1 Brassie. † Includes 1 Lemon Dab.

TABLE III.—Showing the Results of the Bait Experiments carried on on Board the 'Garland,' 1888-89—*continued.*

Station.	Date and Tide.	Bait.	No. of Hooks.	Haddock.	Cod.	Whiting.	Gurnard.	Common Dab.	Plaice.	Total.	Condition of Fish.	Wind, Weather, and other Observations.
XIII. Firth of Forth.	11th Dec. 1888, 12.20 p.m. Ebb.	Lugworm,	320	...	3	...	...	1	...	4	Quality good.	Wind S.E.; force 2. Very hazy. Sea smooth. Transparency disc, 2 fathoms. Depth, 12 fathoms. Bottom, stones and mud.
		Clam,	440	1	4	2	...	..	...	7		
		Mussel,	320	...	2	2	...	...	...	4		
		Limpet,	120	...	1	...	...	...	...	1		
		Mussel in boracic acid,	120	...	...	...	...	...	...	...		
		Bullock's liver (salt),	60	...	...	...	...	...	...	..		
		Total,	1380	1	10	4	...	1	...	16		
XIV. Firth of Forth.	12th Dec. 1888, 11.5 a.m. Ebb.	Clam,	320	...	6	...	...	11	...	17	Small. Quality good.	Wind W.; force 3. Very hazy. Sea smooth. Transparency disc, 1½ fathoms. Depth, 6½ fathoms. Bottom, mud on rocks and stones.
		Mussel,	480	...	1	2	...	21	...	24		
		Limpet,	320	...	2	1	...	5	...	8		
		Horse mussel,	80	...	1	...	...	4	...	5		
		Mussel in boracic acid,	60	...	...	...	...	1	...	1		
		Bullock's liver (salt),	60	...	...	...	...	3	...	3		
		Artificial troll of 120 hooks,	...	...	...	...	...	...	...	...		
		Total,	1320	...	10	3	...	45	...	58		
XV. Firth of Forth.	25th Dec. 1888, 10.35 a.m. Ebb.	Lugworm,	240	...	2	1	...	...	...	3		Wind S.S.E.; force 6. Clear. Sea moderate. Transparency disc, 1½ fathoms. Depth, 14 fathoms. Bottom, sandy mud.
		Clam,	360	...	5	4	...	...	...	9		
		Mussel,	280	...	10	4	...	...	...	14		
		Limpet,	200	...	2	1	...	...	...	3		
		Horse mussel,	120	...	...	...	...	...	...	...		
		Cuttle-fish (squid),	40	...	1	1	...	...	...	2		
		Mussel in boracic acid,	40	...	...	..	...	...	...	...		
		Artificial lures,	40	...	...	...	...	...	...	...		
		Total,	1320	...	20	11	...	...	...	31		

TABLE III.—Showing the Results of the Bait Experiments carried on on Board the 'Garland,' 1888–89—*continued.*

Station.	Date and Tide.	Bait.	No. of Hooks.	Haddock.	Cod.	Whiting.	Gurnard.	Common Dab.	Plaice.	Total.	Condition of Fish.	Wind, Weather, and other Observations.
XVI. Firth of Forth.	26th Dec. 1888, 10.35 a.m. Ebb.	Lugworm,	160	2	1	...	...	...	...	3	Quality very good.	Wind W. by N.; force 8. Clear. Sea rough. Transparency disc, $1\frac{1}{4}$ fathoms. Depth, 8 fathoms. Bottom, sand, shells.
		Clam,	320	1	...	1	...	1	...	3		
		Mussel,	280	9	...	2	...	...	...	11		
		Limpet,	320	4	...	...	...	...	...	4		
		Horse mussel,	120	2	2	...	...	1	...	5		
		Cuttle-fish (squid),	40	...	...	...	...	...	...	...		
		Mussel in boracic acid,	40	...	...	...	...	...	...	...		
		Artificial lures,	40	...	...	...	...	...	...	...		
		Total,	1320	18	3	3	...	2	...	26		
XVII. Firth of Forth.	27th Dec. 1888, 12.50 p.m. Ebb.	Clam,	480	...	11	1	...	1	...	13	Quality good.	Wind S.E.; force 6. Dull. Sea moderate. Transparency disc, $1\frac{1}{2}$ fathoms. Depth, 12 fathoms. Bottom, muddy sand.
		Mussel,	400	...	3	1	...	...	...	4		
		Limpet,	320	1	...	...	...	...	...	1		
		Mussel in boracic acid,	40	...	...	...	...	...	...	...		
		Bullock's liver,	40	...	...	...	...	...	...	...		
		Artificial lures,	40	...	...	...	...	...	...	...		
		Total,	1320	1	14	2	...	1	...	18		
XVIII. Firth of Forth.	15th Jan. 1889, 10.30 a.m. Flood.	Clam,	520	...	24	...	...	...	...	24	Quality good.	Wind S.S.E.; force 5. Dull. Sea smooth. Transparency disc, $1\frac{1}{2}$ fathoms. Depth, 11 fathoms.
		Mussel,	440	...	14	...	...	...	...	14		
		Limpet,	240	...	4	...	...	...	...	4		
		Total,	1200	...	42	...	...	...	...	42		

TABLE III.—Showing the Results of the Bait Experiments carried on on Board the 'Garland,' 1888–89—*continued.*

Station.	Date and Tide.	Bait.	No. of Hooks.	Haddock.	Cod.	Whiting.	Gurnard.	Common Dab.	Plaice.	Total.	Condition of Fish.	Wind, Weather, and other Observations.
XIX. Firth of Forth.	16th Jan. 1889, 10.15 a.m. Flood.	Clam,	400	...	10	...	...	2	...	12	Quality good.	Wind S.S.E.; force 3. Hazy. Sea smooth. Transparency disc, $1\frac{3}{4}$ fathoms. Depth, 8 fathoms. Bottom, mud, stones, shells.
		Mussel,	440	...	24	...	...	6	...	30		
		Limpet,	320	...	5	...	...	1	...	6		
		Herring,	120	...	...	...	...	1	...	1		
		Horse mussel,	40	...	1	...	...	...	...	1		
		Total,	1320	...	40	...	...	10	...	50		
XX. Firth of Forth.	17th Jan. 1889, 11.12 a.m. Flood.	Clam,	400	...	7	...	...	...	...	7	Quality good.	Wind W.; force 2. Hazy. Sea smooth. Transparency disc, 2 fathoms. Depth, 13 fathoms. Bottom, mud, stones, shells.
		Mussel,	480	...	5	1	...	1	...	7		
		Limpet,	240	1	2	...	...	...	...	3		
		Herring,	40	...	...	...	...	...	...	...		
		Horse mussel,	80	...	1	...	...	...	...	1		
		Whelk,	80	...	2	...	...	...	...	2		
		Total,	1320	1	17	1	...	1	...	20		
XXI. Firth of Forth.	19th Jan. 1889, 10.15 a.m. Flood.	Clam,	440	...	36	3	...	1	...	40		Wind W.; force 7. Clear. Sea moderate. Transparency disc, $\frac{3}{4}$ fathom. Depth, 11 fathoms.
		Mussel,	400	...	20	4	...	...	...	24		
		Limpet.	240	...	8	1	...	2	...	11		
		Horse mussel,	120	...	6	...	...	...	...	6		
		Whelk,	120	...	2	...	...	...	...	2		
		Total,	1320	...	72	8	...	3	...	83		

TABLE III.—Showing the Results of the Bait Experiments carried on on Board the 'Garland,' 1888–89—*continued.*

Station.	Date and Tide.	Bait.	No. of Hooks.	Haddock.	Cod.	Whiting.	Gurnard.	Common Dab.	Plaice.	Total.	Condition of Fish.	Wind, Weather, and other Observations.
XXII. Firth of Forth.	25th Jan. 1889, 10.15 a.m. Ebb.	Clam,	400	...	5	1	...	20	...	26		Wind W.S.W.; force 8. Overcast. Sea rough Transparency disc, 1½ fathoms. Depth, 7 fathoms.
		Mussel,	400	...	7	4	...	14	...	25		
		Limpet,	360	...	5	...	...	13	...	18		
		Horse mussel,	40	...	1	...	...	1	...	2		
		Total,	1200	...	18	5	...	48	...	71		
XXIII. Firth of Forth.	26th Jan. 1889, 10 a.m. Ebb.	Clam,	400	1	20	...	...	...	...	21		Wind W.; force 3. Overcast. Sea moderate. Transparency disc, 1¾ fathoms. Depth, 13 fathoms.
		Mussel,	440	...	23	...	...	1	...	24		
		Limpet,	320	...	7	...	...	...	...	7		
		Horse mussel,	40	...	5	...	...	...	...	5		
		Total,	1200	1	55	...	...	1	...	57		
XXIV. Firth of Forth.	30th Jan. 1889, 10.35 a.m. Flood.	Clam,	400	...	20	...	...	6	...	26	Good condition.	Wind W.; force 8. Overcast showery. Sea rough. Transparency disc, 1½ fathoms. Depth, 16 fathoms.
		Mussel,	400	...	13	...	...	10	...	23		
		Limpet,	400	...	8	...	...	5	...	13		
		Total,	1200	...	41	...	...	21	...	62		
XXV. Firth of Forth.	1st Feb. 1889, 11 a.m. Flood.	Clam,	360	...	11	...	...	12	...	23		Wind W.; force 8. Overcast. Sea moderate. Transparency disc, 1½ fathoms. Depth 7 fathoms.
		Mussel,	360	...	11*	...	...	15	...	26		
		Limpet,	280	...	1	...	...	4	...	5		
		Horse mussel,	120	...	16	...	...	1	...	17		
		Total,	1120	...	39	...	...	32	...	71		

* Includes 1 Saithe.

TABLE III.—SHOWING THE RESULTS OF THE BAIT EXPERIMENTS CARRIED ON ON BOARD THE 'GARLAND,' 1888–89—*continued.*

Station.	Date and Tide.	Bait.	No. of Hooks.	Haddock.	Cod.	Whiting.	Gurnard.	Common Dab.	Plaice.	Total.	Condition of Fish.	Wind, Weather, and other Observations.
XXVI. FIRTH OF FORTH.	13th Mar. 1889, 1 p.m. Ebb.	Clam,	600	...	24	...	...	1	...	25		Wind, N.N.W.; force, 4. Sunshine and cloudy. Transparency disc, 2 fathoms. Depth, 10 fathoms.
		Mussel,	600	...	18	...	...	2	...	20		
		Total,	1200	...	42	...	...	3	...	45		
XXVII. FIRTH OF FORTH.	15th Mar. 1889, 11.40 a.m. Flood.	Clam,	600	...	26	...	...	1	...	27	Quality good.	Wind, N.N.W.; force, 2. Hazy and rainy. Transparency disc, 2 fathoms. Depth, 12 fathoms.
		Mussel,	600	...	27	...	...	3	...	30		
		Total,	1200	...	53	...	...	4	...	57		
XXVIII. FIRTH OF FORTH.	16th Mar. 1889, 12.30 p.m. Flood.	Clam,	600	...	...	...	...	5	...	5	Quality fair.	Wind, W.N.W.; force, 6 to 8. Bright sunshine. Transparency disc, 2 fathoms. Depth, 10 fathoms.
		Mussel,	600	...	...	...	...	3	...	3		
		Total,	1200	...	...	...	...	8	...	8		

IX. NOTES FROM PERSONAL OBSERVATION ON THE HABITS OF THE GREENLAND WHALEBONE WHALE.

The full-grown average-sized Greenland male whale is from 52 to 53 feet in length, 36 feet round the thickest part of the body, 32 feet round in the region of the eyes, 16 to 17 feet from the nose to the eye, and 10 feet across the lower jaw. The flippers measure 7 feet long by 5 feet wide; the tail, from fluke to fluke, 20 feet across; the length of whalebone is 10 feet 6 inches; the yield of whalebone 15 cwts, with 15 tons of oil or thereby, according to the age and condition of the whale (young whales having thicker blubber than old ones), and the displacement 65 to 70 tons.

There are sometimes larger male whales caught than the above, but they never measure over 55 feet in length, and they rarely have whalebone measuring over 11 feet. Female whales have often been killed from 55 to 57 feet in length, their bone ranging from 11 to 14 feet long, and their other proportions being equally large.

Individuals have been taken in the Greenland Seas yielding 28 or 30 tons of oil, with 30 cwts of whalebone, their displacement being 70 to 80 tons. I have never taken a female whale that yielded more than 25 tons of oil, and 25 cwts of whalebone, 12 feet 6 inches in length; but I took one in Cumberland Gulf with whalebone 13 feet 6 inches, which is the longest bone I have ever taken, although it was not nearly the largest bodied whale, as it only yielded 20 tons of oil.

The probable length of the life of whales is purely a matter of conjecture, but that they attain a very great age is beyond a doubt. This is proved to a certain extent by the amount of white skin on very old animals; the young whales being quite black, excepting the white marks round the lower jaw, which are to be seen at a very early age. The older a whale grows the whiter it becomes about the fins and rump, and it is heavily scarred with white marks all over. The tail becomes entirely white. I killed a very large old female whale, and took out a harpoon embedded in its blubber that had been there for thirty-two years, as shown by the date on the harpoon. In another instance, when flensing a whale, the harpooners struck against the socket of a hand harpoon. On examination, they found the harpoon embedded in the flesh with six inches of gristly bone all round it, clearly showing that it had been there for many years, although it is impossible to say for how long.

The only way of determining how many years it takes for a whale to have whalebone 10 feet long, is by counting the notches on the outside of the whalebone, which can be done in the same way as the branches of a pine tree. These notches have been frequently counted, and it is considered that it takes twenty years for a whale to have bone 10 to 10 feet 6 inches in length. My decided opinion is that whales will live up to and over 100 years.

So far as has come under my observation, the Greenland whales have no stated period at which they bring forth their young, as I have seen them with very young calves early in May and late in July. There is a great deal still to be found out as to where old cow whales disappear to after calving, for after forty years' whaling experience in the Greenland Seas I have not seen many more than a dozen old whales accompanied by calves altogether. That they have often calves is proved beyond a doubt by the number of young whales frequently to be seen.

It has been known for many years to the Greenland whale fishers that there is a separation of the sexes for sometime in the summer season;

the old males frequenting the ice and feeding banks south from the 75° N. latitude, where occasionally an old female may be got amongst them, but not exceeding one to twelve of bull whales. For years there may be no whales found on the feeding banks off the east coast of Greenland. There are various reasons that can be given for this. The ice may not be suitable or not so much to their liking as the ice further north. It also sometimes happens that there are very rich feeding banks south of the 75°, and in other seasons little or no whales' food can be found. The ice also may occasionally lie too near the land and inside the best feeding banks. In this case the whales disappear further north for better cover. Whales will never lie on banks where there is not sufficient ice for them to find shelter in. In fact, now-a-days whales are like rabbits or rats—never to be found far away from their holes, more particularly since the introduction of steam. The old females, with the younger whales of both sexes, bury themselves in the Polar ice north of 80° after the end of June, where no ship can follow them, retreating in the autumn southwards as the ice makes in the north. This whale fishers know from seeing the same class of whales in the following spring coming up from the south, to disappear again in the Arctic ice when it opens up sufficiently to allow them breathing space and room to feed in. By this we ascertain that the Greenland whale migrates south in the autumn and north in the spring, but how far in each direction is not known.

There is very little evidence to show that whales migrate from Davis Straits to Greenland, or *vice versa.* The only instance that I know of was a small whale killed in Greenland by the 'Kate' of Peterhead in 1866, in 80° N. latitude, when an Esquimaux harpoon was found in it, which is certain proof that this whale must have been first struck in Davis Straits, there being no natives on the east coast of Greenland.

The food of the Greenland whale consists of all sorts of minute crustacea and the Medusa tribe, but their staple food without doubt is a small crustacean about a quarter of an inch long with red feelers standing out from each side of the head, which the whale fishers call 'rice food,' being exactly similar in shape and size to that grain. No doubt, whales are very particular in the quality of their food, because they are never to be got feeding where the water is dirty. They are almost invariably to be seen feeding in clean, clear, dark blue or light olive green water.

The usual way a whale feeds is to choose a spot where the food is plentiful, and swim backwards and forwards for two or three hundred yards with the nose just under the water; or sometimes, when the food is very near the surface, the nose with part of the whalebone can be seen above it. Whales when feeding invariably swim from one side of their beat back again to where they started from with their mouths open. They then close their jaws, lie quietly on the surface of the water for a short time, and swallow the food caught.

A whale's mouth is like a bag-net. The whalebone is fringed with hair inside, which represents the meshes, and which prevents the food from escaping through between the slips of bone along with the water; the whalebone being curved backwards to allow the water to flow freely out of the sides of the mouth while the whale is moving. Whales will go on in this way constantly feeding for an hour or more at a time; after that they will disappear under the nearest ice, and sleep there until they come out again for exercise or for another meal. Sometimes, if the weather is fine and the sun warm, they will fall asleep on the surface of the water near where they have been feeding, and will lie quite motionless for hours at a time.

Whales, unlike other warm-blooded animals do not require to breathe through their nostrils while asleep, and they do not do so. Whales can sleep as well under water as they can do on the surface, as I have often seen them disappear under solid ice and remain there for many hours at a time. Sometimes they also fall asleep with their heads down, with only the tail standing out of the water. They have often been observed in this attitude for several hours without moving.

When a Greenland whale is harpooned, its instinct is to dive straight down until it reaches a depth of from 600 to 700 fathoms, and it remains under the water from half an hour to forty minutes. When it comes to the surface again it is evidently very much exhausted. The other boats, observing the motions of the fast boat, place themselves near about where the whale may be expected to reappear, immediately shooting a second or third harpoon, or striking in their hand harpoons, also plying the whale with lances until it bleeds to death. If a whale when harpooned has any chance of reaching pack ice or a honeycombed floe, it invariably attempts to reach such shelter. In these circumstances, it is very difficult to capture, and is often lost through lines breaking or the harpoon drawing. Whales, after the shock and fear through getting the first harpoon, if not immediately struck again on reappearing on the surface, very soon recover their strength, and cause great difficulty before being finally captured.

After a whale has once broken loose, when harpooned a second time it never sounds or dives, no matter how long a time may have passed before it is again struck, even although years may elapse before it is again harpooned. Whenever a whale is seen to run along the surface after it is harpooned instead of sounding, we at once know that it has been previously harpooned; and if we succeed in capturing it we invariably find an old harpoon or a healed scar where the animal had been previously wounded.

A whale struck a second time is always more difficult to capture than one which has never been previously struck. I could give many instances to prove this fact, but one or two will suffice.

In 1872, my boats got fast on a whale. It immediately swam rapidly along the surface, so fast that none of the boats could overtake it, until the fast boat came against some ice, when the lines at once slackened. On handing them in I found the line cut as if by a knife, showing that there had been a harpoon sticking in the whale's back. The same season farther south one of my boats struck another whale. It immediately took rapidly to windward on the surface, so fast that the fast boat could hardly be seen for spray. Fortunately the boat came against a large piece of ice, whereby the harpooner was enabled to check the speed. The whale, feeling this, immediately stopped, turned round, and came to leeward again, when the other boats now getting up killed it. When flensing we found a harpoon embedded in the body, with part of a whale line attached, belonging to the 'Alibi' of Peterhead, and ascertained on our return that the whale had been struck by that vessel the previous year. Whales, like all other inhabitants of the sea, are very much influenced by the tides. This is very marked in fishing inshore in Davis Straits, and particularly in Cumberland Gulf, where during the neaps there is hardly a whale to be seen, whereas in spring tides they are much more numerous. I have also seen the same fact very well illustrated in the Greenland ice, when whaling in very deep water where one would suppose the influence of the tides could not be felt. One year in particular, where I fished in one place the whole season, from early in June until the middle of August, the whales invariably made their appearance three days before the full and change of the moon, and entirely disappeared again three days thereafter.

I have no doubt in my own mind that these whales were in the neighbourhood during the whole of the neaps, but how they passed their time or how they hid themselves I cannot tell.

The scarcity of whales now in not so much owing to the number killed in Greenland and Davis Straits, although no doubt there has been a vast number captured from first to last. It is more owing to the way in which the earlier whale fishers conducted their business in killing off the young whales before they are able to reproduce. In this way a large proportion of the mature whales died out, and no young ones were left to take their place. In proof of this I give the following figures:—In 1814 the 'Resolution' killed forty-four whales, averaging only five tons; in 1845 the 'Joseph Green' killed in Ponds Bay forty whales, averaging only four tons. Many other vessels were also killing this same class of whales. I have heard that the 'John' of Greenock killed twenty-two suckers before the crew rested, and I know the 'Eclipse' in 1838 killed fifteen small whales in the same way.

D. G., Peterhead.

X. ON THE SAPROLEGNIA OF SALMON DISEASE AND ALLIED FORMS.

By Alexander Edington, M.B., C.M., Lecturer in Bacteriology, Edinburgh, and Assistant to the Professor of Surgery, University of Edinburgh.

(*From the Bacteriological Laboratory of the Surgical Department, University of Edinburgh.*)

Preliminary Paper.

In the Fourth and Fifth Annual Reports, Appendices F, xi. p. 177, and F. xii. p. 331, there is detailed by Professor Greenfield reports upon the quantitative and qualitative estimation of bacteria, present in the water of several of our rivers. The work which it was then proposed to do, and to which the reports referred are valuable and able contributions, was as follows:—

1. The enumeration of the number of organisms in river waters under various conditions.
2. The study and the identification of the various bacteria and other nearly allied fungi.
3. The study of higher microscopic fungi.
4. Observations upon the mode of growth and cultivation of the Saprolegnia, and the manner in which it invades and affects salmon.

The present report, which must be considered of a purely preliminary kind, is a direct continuation of the work then begun and so far carried out.

A consideration of the work previously done brings home to us very clearly the fact, that little indeed is known of the nature of the bacteria and higher fungi found in our river waters. We find that, under certain little-understood conditions, the numbers and qualities of the bacteria found therein are subject to considerable variation. A knowledge then of these and allied forms must be of great importance, as it is more than probable, that certain kinds may be directly prejudicial to fish by setting up disease; or indirectly, by rendering them more susceptible to the attacks of other diseases, of which latter we know very little. In the reports already noted, the work accomplished consisted in the enumeration and description of certain forms found in the waters of the rivers examined. In the present report it has been thought advisable to depart, in some measure, from the course already followed, and rather to attempt an investigation of certain fungi found in fish affected by disease; to endeavour to work out their life-history and inter-relationship; and thence to utilise the knowledge gained by subsequent determinate investigation of the forms found in river water in various situations and at different times of the year. Bacteria are, for the most part, true fungi living as parasites upon decaying vegetable and animal tissues, which by their agency are decomposed and rendered subservient for further use. They are further, to a certain extent, in many cases interdependent upon each other; thus while certain forms can exist upon a certain soil, others would find such a substratum unsuitable for them, but after the former had subsisted upon it for some time, they by their decomposing action might make it suitable for other forms for which it previously was not so.

As an instance of this I need only cite the well-known fact, that torulæ find a condition perfectly suited to their wants in certain saccharine solutions, but after a time they either, by using up the materials contained in it, or by forming as a result of their decomposing action certain compounds directly inimical to their own welfare, cease to grow. When this has happened however, we find certain other bacterial forms stepping in and flourishing luxuriantly. This is an instance of a natural law, and capable of almost universal application, but as yet it has only been applied to a very few series of organisms. A knowledge of the manner in which it obtains in river-water fish-disease must, it is evident, be of the utmost practical importance.

It is a widely-known fact that for many years certain of our rivers have been at various times infested with fish affected with salmon disease, and in Professor Huxley's report for the year 1881 there is given a historical account of several of our most severe epidemics, in which tremendous numbers of salmon were destroyed by the fungus.

Attention was strongly drawn to it first in the year 1877, when the Esk and Nith, two rivers which flow towards the Solway Firth, were seen to have diseased salmon present. Following this it passed to the Eden, and in 1879 it was observed to be present in the Tweed, shortly assuming an epidemic form, so that in 1880 a special commission was appointed to investigate it. At this period it was found to have extended to the Nith, Annan, Esk, Eden, Cree, and Dee, all rivers which flow into the Solway Firth; to the Doon, and the Ayr in Ayrshire; the Derwent in Cumberland; and to the Lune in Lancashire. Since then outbreaks have been noticed in North Wales, occurring in the Severn, the Ogwen, and the Conway; also in the Tay and North and South Esk in Scotland.

I am informed by Sir Thomas Brady that disease has been reported as existing in the upper waters of the River Slaney in Ireland, but he has not himself seen distinct evidence of the disease in question. Mr Speedie of Perth has written me to the effect that there is no disease in the western or northern rivers of Sutherlandshire this year, while on the east the Helmsdale and Brora are very bad, but that so far the average take of salmon has not been affected by it. He also states that he has seen 'plenty 'of diseased fish in Stockholm and also in New York,' and that he 'saw 'one day in Fulton Market about fifty salmon affected with fungus in 'the same manner as they are here.' In the Fifth Report of the Fishery Board for Scotland, there is a report by Mr Joseph Fraser—concerning the salmon disease in South Esk, in which he states that in the month of August 1886 he found one dead sea-trout in the Kinnaird water, to all appearance dead with the fungus. Until the September following the disease prospered but little, but towards the end of October in the same year great quantities of salmon lying in the pools below Brechin were badly marked with it. He considers that the disease usually gets less toward the latter end of January and at this time clean spring fish passing up the river are seldom touched with the fungus. He further notes that the practice of 'sniggering,' adopted by certain people, by which process a hook is allowed to sink into a pool in which fish are collected and then dragged about forcibly with the intent to foul-hook fish, is well calculated to promote the extension of the disease. He bases this theory on the fact that many of the diseased fish obtained by him were marked by cuts, which might have been thus inflicted. The South Esk is this year almost entirely free from salmon disease and the same applies, but in a less degree, to the North Esk. The lessees attribute the freedom from disease to the fact that the river has throughout had plenty of water.

As far as we can learn the earliest recorded observations of such a disease affecting fish are those of Unger's,* who described a fungoid disease which occurred among some carp, confined in a pond in the Botanical Gardens at Gratz. The fungus in question has been styled by him as the *Achyla prolifera*, but there seems to be little doubt, from his description, that it is a Saprolegnia. It must, however, remain questionable whether or not it is really the *S. ferax.* In one of Mr Stirling's papers† he gives a very interesting account of a disease which occurred at Ightham, in Kent, affecting dace, roach, gudgeon, small perch, and small pike, in which, however, the direct cause of death seemed to be suffocation from the fungus clogging up the gill openings. Ulceration here was not a marked feature, but when it occurred it was found to be in those situations most densely covered with the fungus. The eels present in the moat and ponds always escaped the disease, although living in the midst of the diseased fish. I have had numerous accounts given me of a disease somewhat similar, if not absolutely identical, occurring among fish kept in aquaria. There seems little doubt, as is noted by Professor Huxley, but that salmon disease occurs frequently in a sporadic form in many rivers, but it is still questionable whether like fungoid diseases attacking other fish are exactly identical with *S. ferax.*

Fish affected with the disease in question are easily recognised while in the water, as the patches of disease have a white or greyish appearance, which contrasts most markedly with the dark skin on the rest of the body. So much so is this the case, that one approaching the river side where a diseased fish is lying, usually detects the presence of the animal in the first instance by the appearance of the white diseased patches. The earlier symptoms of disease are usually better marked while the fish is still in the water, than when it has been taken out of it, and consists in the appearance of small greyish patches, which if small are usually almost completely circular. The first patches generally make their appearance about the head, and frequently upon the snout, but other cases frequently present themselves in which a patch may be seen first on the adipose fin and about the tail, and I have even seen it confined to the extreme tip of one of the pectoral fins. Mr Stirling believed that the principal cause of the localisation of diseased patches on and about the head lay in the fact that fish usually lie with their heads up stream, and as the skin in this situation is liberally supplied with mucus, spores coming down stream tend to adhere in this situation and there germinate.

* 'Sur l'Achyla prolifera,' *Ann. d. Sci. Nat. Bot.*, 1844.

† 'Additional Observations on Fungus Disease of Salmon and other Fish,' *Proc. Roy. Soc. Edin.*, vol. x. 1879.

This however, is an erroneous theory, because certain gastro-intestinal conditions which are always followed by a diminution of mucus secretion tend to make the fish more susceptible to fungus growth.

Fish sometimes present a most disgusting appearance when the disease is much advanced, the flesh being almost entirely rubbed off in certain situations, as over the nose, crown of the head, opercula, and skin covering the fins. I have seen a fin almost entirely denuded, with the rays standing out quite separate from each other.

If one examines a fish in the early stage of the disease the patches have a peculiar appearance, as the fungus falls when the fish is removed from the water. On close inspection such a patch appears as if denuded of scales, but a little gentle rubbing removes the fungus, and it is then seen that the scales are so far intact.

On parts naturally devoid of scales, the diseased areas look as if they were produced by injury, and are not at all unlike as if due to bruises, having a somewhat darker colour than the healthy skin. Here also by gently rubbing one may manage, in some cases where the disease is slight, to completely remove all visible signs of the fungus. It has been already remarked that the very early patches are usually almost completely circular, but, as the diseased areas extend, new foci are formed and the patches become irregular, and still later by the blending of several previously discrete patches, the irregularity is made worse. On attempting to rub off the fungus covering an older patch, it may be found that the epidermis below has completely disappeared, and an ulcerating or granulating sore is left. The appearance presented by a young patch when examined in water is rather pretty than otherwise, as the fungus can be observed standing up like wheat in a field; but in the older, the threads of the fungus become intertwined, and enclose in their meshes bacteria, diatoms, particles of dirt, &c.*

After a diseased patch has once appeared it extends for a day or more and then frequently many other patches make their appearance, and the disease then progresses rapidly.

In advanced cases, not only may the bones of the head and fins be denuded of skin, but blindness † may, in some cases, ensue from the fungus attacking the eyes. I have not, however, seen such a case; contrarily I have observed in the case of a char, disease progress from the snout to the regions beyond the eyes, but leave the pupil quite untouched, although it was adherent to the skin all around it. Probably, in this case, it might have extended to the eye, but the fish died at this period. Even after death, however, in this specimen, as also in the case of a gold fish and a minnow, the pupil remained quite unaffected. Frequently the fungus extends into the mouth and forms a tangled mass over the teeth, and usually also affects the membrane covering the floor and roof of the mouth itself, more especially that in the floor, forming, in this way, a decided obstacle to respiration. I have only in one case observed the gills affected, and in this case there were present several parasites adhering to the gills and being themselves affected by the fungus.

Fish soon after becoming affected show many evident signs of irritation, rushing about in a most erratic manner and leaping out of the water. They may also be seen to rub themselves against rocks, as if attempting to effect the removal of the parasite. Probably this accounts for much of the injuries one finds on such fish, which may thus be held to be self-

* Annual Report of Scottish Fishery Board, 1886.

† Bacteria are also found inside the tubules of the fungus itself, but this seems in most cases to be due to degeneration taking place in the particular hypha, as they are not usually seen in healthy hyphæ.

inflicted. With regard to this, Mr Stirling quoted the following passage from a letter written to the *Field*, on 25th May 1878, by Commander Duncan Stewart, R.N.:—'In regard to the disease from which salmon 'are suffering in some of our rivers, it may be of advantage that I should 'mention what I observed in a small river at the head of Castrie's Bay in 'Siberia. I found the river rather low, but with plenty of clear running 'water. But what astonished me was to see thousands of salmon in all 'stages of disease and death, some darting away, but soon stopping to rub 'the side on the bottom or on a rock; others were constantly rubbing, 'others unable to rub. In those last cases large sores, from the size of a 'shilling to that of a half-crown, of a most filthy appearance, were always 'present. Fish on which scales had been rubbed off would try to get 'out of my way, but I could kill them with a stick; those with the skin 'gone would rub themselves against my trousers.' After a fish has been for some time affected, and the disease progressed so as to form large patches upon it, the irritability seems to disappear in great measure. This sluggishness so distinctly manifested by such a fish cannot always be held as due to its being in a dying condition, as in many cases one finds it possessed even then of considerable muscular power, as may be well seen if an attempt is made to drag it out of the water, and further, I have had ample evidence of this from having had affected fish under my observation, when I have noticed such a manifestation of sluggishness thirty-six hours before death.

One of the bailiffs on the South Esk informs me that he has observed that fresh fish coming up from the sea if they get slightly affected by the disease, much sooner become sluggish or 'sick' than those fish which have been long in the river do, although the latter may be much diseased.

So far, we have not been able to observe any distinctly pathological appearances in the viscera, with the sole exception of evident congestion of the spleen, which, however, did not show any marked evidence of enlargement. However, the number of specimens examined preclude the assertion that even this condition is always present. On subjecting a portion of the furry fungus-covering to close examination, it is seen to present a peculiar appearance aptly designated by Professor Huxley as 'wet-paper' like. This appearance, however, is only manifested when it is examined out of the water. If a fish dead of the disease be left in water for a little time the filaments of the 'wet-paper' like mass unfold themselves partially and then it is seen to have a greyish woolly appearance.

If a portion of the mass be removed and placed under the microscope, it is seen to be composed of very long tubes having very thin and delicate walls, consisting for the most part of cellulose.

The diameter of the tubes varies greatly, but the average may be stated as 10μ ($1\mu = \frac{1}{25000}$ of an inch) but they may be so narrow as only to have a diameter of 8μ or even less, while others are found in which the diameter may be 40μ.

The tubes are lined by a layer of fine colourless protoplasm, and within this there is usually included a variable amount of granular protoplasm irregularly disposed among a large mass of fluid. The granules of protoplasm are themselves irregular in form, and many vary in size from 5μ up to that of masses 6μ in diameter. In some cases the filaments seem absolutely empty, and when so are difficult to define being absolutely colourless. The filaments are, for the most part, unbranched, but at wide intervals lateral branches are given off.

If a filament be traced upward it may be found to taper slightly to its termination, containing here no granular protoplasm and ending blindly in a rounded and tapering extremity. This is usually the rule during the first day or two; but later, however, we find curious currents set up spontaneously in the tubes and the granules begin thus to be congregated in or near the blind extremity. Later, this terminal portion becomes packed closely with the granular protoplasm, and then at some little distance from the top a septum makes its appearance which shuts off a quantity of the granular material from the rest of the tube, and in this isolated terminal portion spore formation begins.

The granular matter here accumlated now takes up a central position with reference to the portion of the tube within which it is included, and is surrounded by a regularly disposed layer of clear protoplasm, like that which is found within the rest of the tube. Growth now manifests itself in the central granular area; so that, as a result of this, the shut-off portion begins to swell and assume a somewhat pyriform aspect. By-and-by the granular matter begins to undergo a process of division, so that rounded masses are formed, and this progresses until this pyriform shut-off portion is seen to be filled with round shot-like granular bodies, which react to staining agents in the same way as does the granular material found throughout the tube. This division of the protoplasm is not affected simultaneously as certain observers have supposed, but is a gradual change, first obtaining in the more central parts and then progressing outwards. After the process just described has come to an end, the free end of the closed sac ruptures and the enclosed spherical bodies escape. After the case has become emptied of its contained spores, it does not drop off at once as might be expected, but a new case is seen to push its way upward and through it from the common tube behind. This peculiarity is characteristic of the genus of fungi known to botanists as Saprolegniæ. Before proceeding further, however, a word or two may not be amiss by way of properly defining the various structures which have just been described.

The collection of long tubes of which the fungus mass is composed is known as 'mycelium' and the individual tube units are known as 'hyphæ.' To each of the terminal portions, which have become shut off and filled with spores, is applied the name of 'sporangium,' while the contents are known as spores. It happens, however, that in some cases these spores when they escape are endowed with the power of locomotion, which is effected by means of long excessively delicate hair-like bodies attached to them and termed cilia. When such is the case the spores are called 'zoospores' and the case or sporangium enclosing them a 'zoosporangium.'

It may be noticed that the spores contained in the sporangium when nearly ripe assume, as a result of mutual pressure, a somewhat hexagonal appearance; but I have never seen them assume a spindle shape as has been described by certain previous observers. After the spores are discharged they sink to the bottom and begin to germinate. This process is seen to consist in the extrusion from the spore of a young mycelial shoot or hypha. In some cases two shoots appear, while in others the single shoot may be seen to branch almost as soon as formed. As soon as this has occurred, the spore by means of its young shoot, may bore its way into any suitable soil within reach. In several cases in cultivations of this fungus I have seen the young hyphæ penetrate the wall of an unopened sporangium.

As the result of the observations of numerous workers, of whom may be mentioned Pringsheim,* Cornu,† De Bary,‡ Brefeld,§ and others,—

* 'Die Entwickelungs-geschichte der Achyla prolifera,' *Nova Acta*, 1851, p. 397–480; *Jahr. f. Wiss. Bot.*, i. 1857, ii. 1860, ix. 1874.

† 'Monographie,' *Ann. de Sci. Nat. Botan.*, 1872.

‡ De Bary and Woronin 'Unters über die Peronosporein und Saprolegnien,' 1881.

§ Botanische Untersuchungen, Hft. iv. 1881.

and of late, more particularly, the able report of Professor Huxley * a considerable advance in the knowledge of Saprolegnia has been made. We thus learn that Saprolegniæ may be considered as aquatic saprophytes, which obtain their nourishment at the expense of decaying animal or vegetable matter.

In the Report of the Inspectors of Fisheries (England), Professor Huxley details the result of producing Pringsheim's experiment, *i.e.*, of placing dead flies into water wherein Saprolegnia was growing. The spores on reaching the fly germinate, sending inward through the cuticle the young hyphæ which permeate it in every direction, corresponding in this way to roots; while from the free surface shoots are sent out, so that latterly the insect is surrounded by a delicate white aureole of hyphæ. Fructification proceeded with the formation of zoosporangia and subsequent liberation of the zoospores; whose life-history may best be detailed in his own words :—'Each zoospore, as it leaves the zoosporangium, is usually in active motion, being propelled by the rapid lashing of two vibratile cilia, which are attached to one point of its surface. After a few minutes it becomes quiescent and surrounds itself with an extremely delicate transparent coat. But this repose is of very short duration, as it soon emerges from its envelope and moves about even more actively than before. It has now an elongated oval shape, and has two cilia which proceed from one side of the oval. This second state may last for a day, or perhaps two; and it is obvious that, from the activity of the motion of the zoospores to say nothing of accidental currents, they may thus be carried a long way from the parent stock. Sooner or later, however, they again come to a state of rest, which is final, and they then usually germinate. That is to say, one, or perhaps two, delicate filaments grow out and represent the primitive hyphæ of a new Saprolegnia.'

Somewhere about the fourth or fifth day dictyosporangia were formed. These are ordinary sporangia in which, however, liberation of the spores, from some reason, is inhibited, and as a result of this they germinate, penetrating the enclosing capsule with their young hyphæ. So far the method of reproduction detailed is of an asexual type, but under certain not well understood conditions, a form of sexual reproduction, though of a low type obtains. In these cases the terminal shoot is not converted into a sporangium of the type already described, but assumes a form more nearly approaching a sphere, and within this the contained protoplasm, by a process of division, is converted into a number of oospores, this kind of sporangium being termed an oosporangium. Even this method of reproduction may be asexual, the oospores being simply emitted, but in other cases, a slender twig may arise by branching from the stalk beneath the oosporangium or from a neighbouring stalk, and its terminal portion slightly enlarging applies itself to the oosporangium. This having been effected, a partition forms behind this terminal portion of the stalk just as if it were about to be converted into a sporangium in the ordinary way, when a condensation of its contained protoplasm occurs, and we have what is known as an antheridium, corresponding to the male element formed in higher plants. On the completion of this stage, a portion of the antheridium penetrates the oogonium or female element, and then breaks up into as many branches as there are oospores, to each of which a branch is applied. Whatever be the conditions under which oospores are formed, we know that they are true resting spores, and as such capable of being exposed to various conditions which would be absolutely detrimental to the young fungus or the ordinary zoospores. They are

* Reports of Inspectors of Fisheries (England), 1881–1886.

believed to remain at rest for a very long time, even months before germinating.

The oosporangium may, however, by immediate rupture set free the oospores, which may at once germinate without passing through a resting period. When an oosporangium is ripe it may discharge its within contained brood, or may drop off and fall to the bottom while still containing the oospores, just as we find with many of our fruits; the seeds may be found scattered on the ground or the capsule may be found with the seeds still contained within them. The capsule, therefore, of the oosporangium has no function after the oospores have attained their maturity. When, however, their period of rest comes to an end, and this may perhaps be decided by the onset of conditions favourable not merely for their germination but also for successful aftergrowth, they may proceed in one or other of the following ways:—

(1.) The ripe oospores may have their contained protoplasm by a process of division formed into a number of zoospores, which by subsequent rupture are set free.

(2.) The whole oospore may proceed in somewhat the same manner as an ordinary spore, sending out a hypha of mycelium, which later may give rise at its summit to the formation of a sporangium, but, in this case, it is not necessary for the oospore to become attached to a nutrient soil as is the case with ordinary spores. Here then the oospore is somewhat analogous to those seeds of higher plants, which contain a store of suitable nourishment, to meet the requirements of the young growing embryo.

(3.) The oospore may proceed in exactly the same way as an ordinary spore, becoming attached to a dead insect or other material, into which it sends a hypha which then branches into an ordinary mycelium in the usual way.

While, therefore, there is here indicated, as far as we at present know, the whole series of events possible in the Saprolegnia as a genus, we must note that in certain of the species variations may occur, but it is very difficult to define the species accurately, for reasons which will afterwards appear.

The definition of the species of Saprolegnia, depends upon the recognition of certain characteristics, as for instance, the forms assumed by the sporangia, the forms and manner of emission of the ripe spores, and the presence of antheridia.

In certain forms the sporangium approaches in shape more nearly to the spherical, and there may be instead of a single terminal one a succession of such bodies, assuming a somewhat necklace-like arrangement. Such a peculiarity obtains in *S. torulosa*, and as such has been described as a different species from the more common variety of Saprolegnia known as *S. ferax*. However, Pringsheim and De Bary both consider that not only this species but several others, as *S. thureti* and *S. monoica* are but varieties of the *S. ferax*.

It seems to be pretty certain that oosporangia are very rarely found in salmon afflicted with the fungus, as Mr Stirling speaks of having only observed it on four occasions during the whole course of his investigations, and Mr Huxley, in his report for the year 1881, states that not a single one was seen in any of the fish examined during the course of the previous four months. Up to the present moment I have only had an opportunity of examining nine salmon, specially for this purpose, and in none of these did I find any oosporangia, although I made a very careful examination in each case. *S. ferax* is supposed by many to be identical with the fungus known as *Achyla prolifera* affecting flies, and Pringsheim considered Achyla so plentiful that, if one wishes a cultivation of it, he believed all that is necessary is to place a dead fly for a day or two in rain water, when it will soon become enveloped in it. This experiment has been performed by Mr Stirling, Mr Murray, and latterly by myself, but in each case our experiments have been unsuccessful.

In my case, flies have only been obtained with difficulty owing to the season of the year, and the specimens used were those which I managed to discover lying in odd corners, so that when they gave rise to cultivations of common moulds I have not been much surprised; still, however, the same result seems to have attended the experiments of the previous observers noted. Prof. Huxley and Mr George Murray have, however, easily infected dead flies by rubbing them over diseased fish and even by placing them in water in which Saprolegnia was placed. The exact procedure adopted in their case was to insert a glass tube into a wide glass vessel, in such a way that the bottom of the glass tube did not quite reach the bottom of the glass vessel. Flies were then allowed to float on the surface of the water in the glass vessel, but outside the tube, while in the tube itself an already infected fly was placed. The flies then in the outer vessel becoming infected, showed that the spores liberated from the fungus affecting the fly in the central tube must have passed first toward the bottom of the tube and then out of it, before they could be able to rise in the outer part and infect the dead healthy flies. This experiment demonstrates that a very considerable power of locomotion must be possessed by the liberated spores.

Mr Stirling attempted to infect healthy minnows by placing a piece of skin, with fungus adhering to it taken from a salmon smolt, in a glass vessel filled with water in which the minnows were placed along with it, but found that 'In three days they had eaten up both skin and fungus and remained unaffected.' Considering that possibly the fungus was dead, he procured fresh pieces of skin with fungus which had been removed from fish at the water side and immediately placed in bottles of water. These fresh pieces were then emptied into the glass vessel containing the minnows and the water left unchanged for three days. At the end of this time the water was changed, and subsequently renewed every second day. Here, again, a like result attended his experiment, as the minnows devoured every morsel of skin and fungus and remained alive and healthy for two months afterwards, when they were last observed. I am inclined to attach a certain measure of importance to this experiment for reasons which will appear later. In 1882–3 Mr G. Murray, at Professor Huxley's request, made a series of experiments with fungus cultivated on the bodies of dead flies, with somewhat varying results.

Receiving from Professor Huxley on the 2nd February cultivations of fungus derived from a diseased Conway salmon, he proceeded to keep up fresh cultivations on flies, and in the July immediately following he attempted inoculation of two healthy specimens of trout and two healthy dace, by rubbing them with fungus, making in addition a slight abrasion of the epidermis in one trout by rubbing it with fine sand. No result attended this experiment which had been made with fungus on which no oospores were present. This experiment was then repeated at a later date with fungus bearing oospores and zoosporangia, but in this case the site of inoculation was changed, the left side of the fish being now chosen. This time the experiment was quite successful, and it was inferred that the success was due either to the presence of oospores in the fungus or to its being applied to the new site. In order to test this, two dace were rubbed on the sides with fungus in which no oospores were present, but on which there were to be found a plentful growth of ripe zoosporangia. This experiment resulted in complete success, and he states that 'on both fishes, contrary to my expectation, oospores were more numerous than in those individuals which had been inoculated with oospore-bearing material.' It is rather to be regretted that proof was not then made manifest at this time by a further experiment, whether or not the change of site was the principal factor in determining successful infection. In the following year Mr Murray again prosecuted like experiments. On February 1st, he applied to the head, by gently rubbing, fungus derived from flies as before, on which few oospores were present, and in four days the disease appeared in the region rubbed, and the fish, as usual, showed signs of irritation followed by languor, and died on the fourteenth day following the inoculation. On the 12th February the experiment was again repeated, but this time with fungus bearing very few ripe zoosporangia but many oospores. No result was obtained when examined eight days later, but it was found to be extremely diseased when seen on the twenty-second day after inoculation. Mr Murray infers from other observations that the infection was due to the oospores which might have germinated in about fourteen days after inoculation.

In the Fisheries' Exhibition in London, the disease appeared and destroyed a considerable number of fish, and as this coincided with the fact that at the same period the tank water contained much lime, owing to the presence of this substance in the rockwork which had been but newly built, Mr Murray, at the suggestion of Professor Huxley, devised and prosecuted a series of experiments in order to determine whether or not the presence of lime in the water conduced in any way to the onset of the disease. His experiments consisted in inoculating a double series of fish, one of which was kept in ordinary water while the other was supplied with water containing one-half per cent. of lime. In one set of experiments, he succeeded in getting the fish inoculated, both those in the ordinary as also those in the lime water, when it was found that death overtook the latter at an earlier period of the disease than it did those in the former case.

From the wide-spread occurrence of this fearful disease, sometimes in a sporadic, at other times in an epidemic form, the popular mind has been much exercised, particularly of late years, as to the cause of this curious condition, and as a result of this all sorts of views have been promulgated regarding its causation.

The pollution of rivers as a cause found favour with many persons, but is easily met and refuted by the fact that in many cases the disease occurs in rivers and ponds entirely free from the slightest suspicion of pollution. There can be no doubt whatever that the prime cause lies in fungus, and that without its presence no disease can appear, but when we consider that the presence of fungus on a few fish in a river will result in a few days' time in affording a plentiful harvest of spore germs, *sufficient to infect every fish in the river*, the question then arises, why it is that so very many fish escape. Do healthy fish possess an immunity? This seems scarcely likely in view of Professor Huxley's report, but, on the other hand, they do not seem so easily infected as one might suppose, and therefore, there arose another theory that a previous injury was requisite in order that the fish should take the disease. That a mechanical injury is unnecessary is pretty well proved by observations of fish taking the disease, while in situations remote from any chance of injury, as in aquaria, etc., and still further by Mr Murray's success in infecting fish while in a healthy state. We must, however, note that it is possible for a fish to be in an abnormal condition of health, without giving visible evidence of it, and further, of the diseases peculiar to fish we have only the most meagre conception. We find that at the Howietoun fisheries, there always occurs a few cases of fungussy fish after an east wind has been blowing, more especially if the fish have been previously fed. Such fish always are somewhat dry to the touch after the exposure of the pond to the wind, and show signs of gastro-intestinal disturbance. That the wind has something to do with this has been proved by putting up a screen at the side of certain ponds and leaving others unscreened, when fish only became fungussy in those unprotected by screen.

In other cases there seems to be pretty evident signs that certain sexual conditions of ill health predispose to the fungus growing. From such considerations, it seems possible to infer that the fungus is a secondary condition, only attacking fish which are out of health; but while this may be applicable to the sporadic cases, it is scarcely credible that it can apply to the epidemic cases. The point which calls for investigation is, I think, this. Is the fungus which is thus found in sporadic cases identical with that which is found in epidemics among river salmon? The theory of overstocking of fish has been advanced as the principal cause favouring the onset of the disease, and this is probably an efficient factor in determining an epidemic. We are well aware of the fact that when certain diseases of an infectious type, such as typhus fever, affect a large city, it is most deadly and spreads most rapidly in those parts where there is overcrowding of the inhabitants.

Mr Stirling cited as an argument against overcrowding, the following experiment conducted by the Tweed Commissioners in 1874. They 'constructed a small pond for experimental purposes, which measured '36 feet by 16 feet, on the side of a small stream called 'Carham Burn, from which a run of water was supplied to the 'pond by a drain pipe. On 7th May 1874, 130 sea-trout smolts, 'the average length of each being 8 inches, were taken from the Tweed 'and placed in this pond. After an interval of two years they were 'specially examined, weighed, and measured on the 25th May 1876. 'Seventy fish were found in the pond, the average length of each was 12½ 'inches, they were now in the whitling stage, and in fine condition. 'After another interval of two years, there was another examination . . . 'when sixty-six sea-trout of the average length of 14⅝ inches were found 'in the pond. They were kept here free from fungus for a further 'period, making in all five years, during which time they were kept 'cribbed, cabined, and confined, in a pond no larger than an ordinary 'dining-room, and remained in health during that period without 'exhibiting any sign of fungus disease, and this although the pond 'is situated within a few hundred yards of the Tweed—an affected 'river.' This experiment proves certainly that in a crowded pond the disease cannot occur spontaneously, and is thus an argument, if that is needed, against 'spontaneous generation,' but nothing further. This experiment might with considerable advantage to our knowledge, have been carried further by their putting into the pond a fish of the same kind, but already affected with the disease. In this way it would have been well determined whether or not overcrowding is the principal factor in determining the spread of the disease, from a sporadic case, in an epidemic form. The disease, however, may attack fish although there is no predisposing cause in the form of overcrowding, and an instance of that has lately come under my own observation. We have had a fine specimen of a char living in a tank alone, and supplied with 200 gallons of water since the 25th February. On Monday, the 11th March, a few patches of fungus were noticed on the snout, and it died two days later. On examination after death, I found the snout covered with the fungus, which extended up to the eyes, and leaving them untouched, passed for an inch beyond on either side. Large patches existed at the posterior border of the opercula, and passed thence to the posterior insertion of first dorsal fin over which it extended half way to its tip. The upper half of the tail had an extensive growth, and there existed a small single patch on the tip of the right pectoral fin. On opening the mouth the fungus was seen to form a close-felted mass over the teeth, and passing thence to the lining membrane of the mouth, which it affected to a distance of one inch beyond the teeth, but extending a little further in the mesial line of the lower jaw. Both gills were slightly affected, and here there were found several parasites, which were themselves diseased. The viscera showed no visible signs of disease, with the exception of the spleen which was congested, but not much enlarged. The fungus was somewhat similar to the common *S. ferax*, and as the mass in the mouth contained growing zoosporangia, I endeavoured to obtain cultivation from the contents of the intestinal canal, and have at length succeeded. Here then we have a case of infection occurring without any suspicion of overcrowding. I have traced the origin of the disease in this case, either to a hatching box suspended near the tank, and from which several young embryos were removed several days before, affected with the disease, and it is possible that when cleaning this box some material was allowed to fall into the larger tank, thus determining the infection of this fish; or to there having been disease in this tank during a previous year. The problem as regards infection of river salmon is somewhat difficult to solve. The disease exists while salmon are in the water, and disappears on their departure. Thus it would seem that they bring it with them, but I have the reliable observation of Mr Johnston, the lessee of the Esk fishings, to show that the disease always first makes its appearance in the higher reaches of the river and subsequently comes down. This would indicate that the infection is met with in the higher parts of the river, and that the fish are healthy when they leave the sea. This is somewhat emphasised by the experiments made by Mr List, for Mr Stirling and later for Professor Huxley, and by those of Mr Armistead of the Solway fishing, Dumfries, and by that of Mr Johnston of Montrose. In all these experiments it has been found that if diseased fish are placed in salt water they tend to recover, and their sores, if there be any present, to heal, indicating that it is improbable that the disease is brought from the sea. Further Sir James Maitland informs me that at the Howietoun fisheries the fungus can always be controlled by the addition of rock salt to the water in the upper ponds.

If then we assume that the disease is contracted by the fish in the higher reaches of the river, where does it remain during those months when no salmon are in the river? It may be said that it attacks trout, and that therefore we should find it during the summer affecting them. I do not know, however, that it is a well-ascertained fact that trout are generally liable, and farther we do not possess reliable evidence to show that the fungus attacking trout in summer is the true *S. ferax.*

Having obtained, by the kindness of Mr Johnston of Montrose, a fine salmon heavily coated with the fungus, I determined to attempt the infection with it of some healthy gold-fish, as from multifold observation, such fish seem to have acquired it naturally when kept in aquaria. For this purpose large portions of the fungus, in which a plentiful growth of sporangia was present, were placed in a large glass vessel of water in which three gold-fish were present. In another vessel the same procedure was adopted, but here, in addition to the gold-fish, three minnows were also placed. In neither case, however, did any successful result accrue, while in the case of the minnows I found that they devoured the fungus greedily, ejecting the remains of the empty tubules, however, from the mouth after a period of time, which varied from half-an-hour to three hours.

I now determined to attempt a renewal of this experiment, but in this case to effect a slight abrasion of the epidermal covering and then to apply the fungus by slight rubbing. However, in this experiment, I was fated to have an able assistant in the shape of a pet domestic cat, which overnight amused himself with the fish to such advantage that next morning the gold-fish were almost entirely scaleless, although otherwise they seemed perfectly healthy. I therefore rubbed them all over with the fungus, but as before no result whatever accrued. Various other experiments of the same nature were also attempted, with this difference that abrasion was effected by forcible but gentle removal of scales from the sides of the fish, and now instead of as before keeping up a constant supply of fresh tap water, it was left unchanged in the vessels for periods varying between a day and a week. In these cases, although the water became so filthy as to be quite milky, and large masses of bacteria clung to the sides of the fish, no result followed. In one case, however, one gold-fish died and was left in the water for three days, the others being removed, when it was seen to have a fine growth of the fungus covering it in twenty-four hours, and which in two days had completely surrounded it, the filaments being on an average about $\frac{3}{4}$ of an inch in length.

The other fish, having now been given a plentiful supply of fresh water every two days, seemed to return to their normal state, but six weeks from the time of attempted infection, one minnow was seen to have a slight furry appearance on one side and died within six hours after this observation had been noted. Being now left in the glass vessel with two other minnows, the fungus was seen to form upon it most luxuriantly, and looking very much of the same nature as that which occurred upon the gold-fish. Up to this time I had been working with two glass vessels A and B. In A were the three gold-fishes alone, while in B there were three gold-fish and three minnows. The infected gold-fish died in A, and afterwards, I placed one of the minnows from B into A, and it was this minnow which died, and on which the fungus appeared. So that it might be inferred that the infection had been derived from the gold-fish which had died in A. The dead minnow remained in A twenty-four hours when I determined that I would on the following morning, after the completion of forty-eight hours remove it to B and see if infection of the other two minnows would follow. However, over night a curious incident happened in that a special bacterium had gained access to vessel B, and in the morning the water was quite milky, and in this way contrasted with the clear water in A in which the dead minnow and two gold-fishes were, and which might have been expected to be in a worse state than the others, on account of the presence of the dead minnow. In B the fish were holding to the surface of the water and almost one might think trying to put their heads out of it, and all died in the course of the forenoon with the sole exception of one gold-fish which lived till the evening. The stench emanating from the water in vessel B was so overpowering, that it could be felt throughout the whole house, and I was thus forced to get rid of it. I mention this incident, as it clearly indicates the effect that certain bacteria may exert on fish through the medium of the water. The dead fish have been carefully preserved and I hope later to see whether or not the internal organs have been affected.

On microscopic examination the fungus affecting the minnow which died presented an altogether different appearance in its method of fructification from that of the ordinary *S. ferax* got from the salmon and that found on the dead minnow, and agrees somewhat with the form known as

S. torulosa. A photograph of it may be seen in Plate IX. fig. 4. Here, instead of the terminal portions of the hyphæ being surmounted by a single sporangium, we have a necklace-like arrangement of sporangia, some being almost completely spherical, others broadly ovate, while others approach the form found in *S. ferax.*

Further, we find here the non-terminal sporangia in some cases throwing out buds or branches into which the granular matter is continued.

At an early period of my investigation I determined to attempt artificial pure cultivation on previously sterilized media. For this purpose I had prepared small flasks containing a small quantity of finely divided bread to which a small amount of water was added, sufficient to make the mass coherent, and the flasks being then plugged with cotton wool and efficiently sterilized by boiling in a steam sterilizer, were on cooling ready for use. Portions of the fungus were then removed from the fish by means of a platinum needle and inserted into the flasks, which were then left for some days to await further results. I have found, in the case of fungus derived from salmon, that it, when pure, *i.e.*, when not intermixed with bacteria and other fungi, grows luxuriantly and forms masses exactly like pure cotton wool, forming masses which may almost fill the flask and of which the terminal parts may be as much as two inches removed from the source of nutriment. On examination, microscopically, I find the hyphæ to be much narrower (see Plate IX. fig. 2) than the fungus growing in water, and not so far possessing sporangia. On the other hand, however, I have found, present, though so far somewhat sparingly, bodies similar to oosporangia, and which indeed I regard as such (see Plate IX. fig. 5). On taking such a cultivation and placing it in water it is found that the hyphæ rapidly swell, becoming eventually in all respects identical with the fungus found in the salmon, and developing terminal sporangia exactly similar (see Plate IX. figs. 6, 7).

I have attempted, with such cultivation, to infect minnows and gold-fish, but without success. Although I may mention that one gold-fish, which died without showing signs of it during life, developed a plentiful growth immediately after death, I am not able to prove conclusively that its infection was due to my inoculation. My reasons for this lies in the peculiar fact that artificial cultivations of fungi, on bread material, derived from salmon, minnow, and char each show to the naked eye absolutely different appearances in their forms of growth, and this conveys to me a slight suspicion of there possibly being different varieties of Saprolegnia affecting different kinds of fish. In any case, if Saprolegnia can grow in air in a laboratory, and still further develop bodies similar to oospores, it follows that we may with perfect right infer that there is probably a *terrestrial* form of Saprolegnia, although it has not yet been discovered. We may anticipate that careful investigations carried out in this way may lead to an important accession of knowledge.

Description of Figures, which have been reproduced from Photographs taken by Mr Edington.

Fig. 1. Mycelium of cultivation on bread paste, derived from salmon fungus. × 45 diameter.

Fig. 2. A portion of the same, more highly magnified, showing the pseudo-dichotomous branching. × 80 diameter.

Fig. 3. Fungus growing on a char, showing sporangia of the common form. × 45 diameter.

Fig. 4. Fungus growing on minnow, showing the successive formation of sporangia, many of which are of a spherical form. × 45 diameter.

Fig. 5. Same as figs. 1 and 2, but more highly magnified, and showing the oosporangium-like body. × 320 diameter.

Fig. 6. Same fungus as figs. 1, 2, and 5, but showing the condition assumed after thirty-six hours growth in water. Sporangia are here seen, some having discharged their spores, and in the centre a new sporangium may be seen growing up into the case of a sporangium just emptied. × 80 diameter.

Fig. 7. A ripe sporangium from same cultivation, more highly magnified. × 160 diameter.

XI. NOTE ON THE INTERCROSSING OF MEMBERS OF THE GENUS *SALMO*.

The complex and interesting subject of hybridism has received in recent years a large amount of attention. It used to be generally held that the production of fertile hybrids from the intercrossing of parents specifically distinct could not occur, and that if fertile progeny resulted from a cross between apparently distinct species it was in reality a proof of specific identity. The supposed invariable sterility of hybrids was looked upon as a provision to guard against the promiscuous intermingling of species, and no point has been more insisted upon as a distinction between species than the incapacity to produce mutually fertile offspring. The further investigation has proceeded into the instances of hybridism, and the more extended the observations made, the more it has been rendered evident that this distinction of mutual sterility is not an invariable rule. It has been conclusively proved that hybrids are not invariably sterile, but that their reproductive capacity may vary from complete sterility to complete fertility.

Among fishes there are two cases recorded of hybrids having been produced between species belonging to different families, namely, between the brook trout and burbolt,* and between a female of the herring family (*Clupea* or *Alosa*) and a male striped bass (*Roccus lineatus*); † but doubt has subsequently been cast upon both these cases. The fact, however, that fish belonging to different families may be mutually fertile has been recently shown by some experiments of Mr Thomas Scott, one of the naturalists of the Fishery Board for Scotland. In May last, on board the 'Garland,' he fertilised the ova of the common gurnard (*Trigla gurnardus*) belonging to the family Cottidæ with the milt of the whiting (*Gadus merlangus*) belonging to the family Gadidæ.‡ Development went on for 1½ days, when the ova were found to have begun to sink, and they subsequently died; apparently from the want of fresh sea-water, when the vessel was lying over Sunday in harbour. Mr Scott in June last also fertilised the ova of the lemon sole (*Pleuronectes microcephalus*) with the milt of the turbot (*Rhombus maximus*), fish belonging to different divisions of the Pleuronectidæ.§ The eggs were unfortunately killed by dust getting into the water 3½ days after impregnation, but development had been rapid, the embryo was well formed, and hatching would probably have taken place on the seventh or eighth day. These experi-

* Day, British and Irish Salmondiæ, p. 47.
† *Bull. U.S. Fish Commission*, vol. ii. p. 187, 1882.
‡ *Nature*, vol. xl. p. 163. § *Nature*, vol. xl. p. 253.

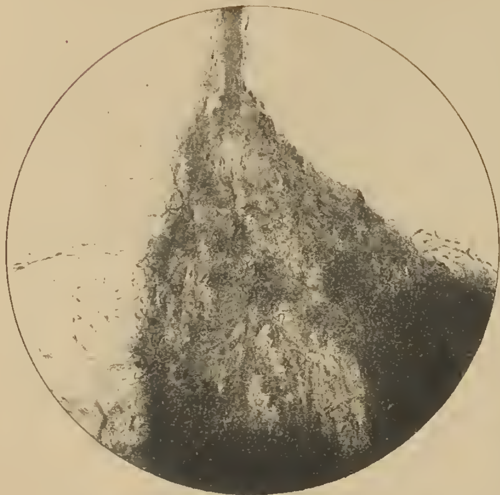


Fig. I X 45 dia.

Fig. II. X 80 dia.

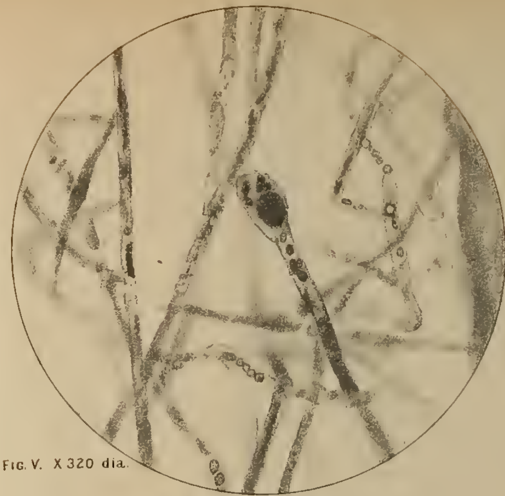


Fig. V. X 320 dia.

Fig. VI. X 80 dia.

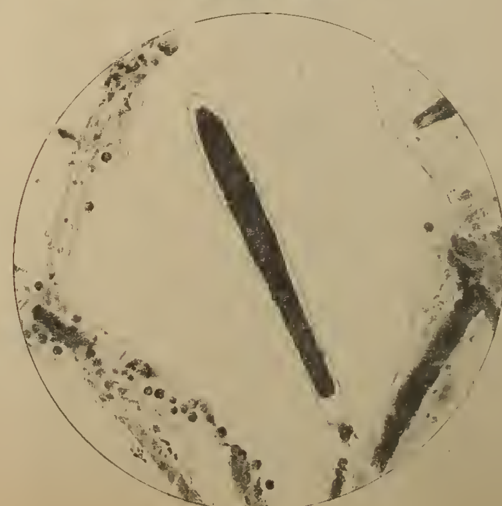


Fig. VII. X 160 dia.

Fig. III X 45 dia.

Fig. IV. X 45 dia.

A. E. Photo

ments at least show that the range of mutual fertility between widely separated species is greater than has been generally supposed.

Hybrids are also recorded as having been produced between the herring and the pilchard, the turbot and the brill, the flounder and plaice, between different species of carp, between the roach and the bream, between the chub and the bleak, &c. In these cases, however, there is little more than the record of the occurrence of hybrids. Among the Salmonidæ, more extensive evidence is found as to hybridisation, since the members of this group have received special attention, and are now largely reared artificially, and therefore under close observation. Even here, however, the experiments made have generally not been extensive or prolonged, and it is necessary for definite results that the influence of intercrossing should be tested throughout several successive generations. At the fish-culture establishment at Howietoun special attention has been given for a number of years past to the intercrossing of various members of the genus *Salmo*, and a brief description of some of these is given below. Such experiments are of value, not merely in their relation to many profound biological problems, but also in regard to the probability of promoting the inland fisheries by producing more vigorous and valuable breeds.

Hybrids between Lochleven Trout and Salmon.

On the 27th December 1884, 7000 ova of an adult specimen of *Salmo salar*, taken from the Teith, were milted from a Lochleven trout. On March 11, 1885, about 5000 of these hatched. There was considerable mortality among them from the time they were a month old, continuing up to the time of feeding. On June 30, 1885, about 2000 were placed in pond 4. Nearly two years later about 1000 remained, one which was measured being 5½ inches in length. On March 1st, 787 were transferred to pond 7. At this time the largest was between 7 and 8 inches long. On May 22, 1889, they numbered in the Botanical pond about 200, the larger specimens being about 12 inches in length.

On November 11, 1884, about 12,000 ova from a Lochleven trout were milted from three young Howietoun (land-locked) grilse. In this case above 2000 of the eggs escaped fertilisation, but the remainder hatched out on January 28, 1885. A considerable number died subsequently. On June 19th, about 5000 of the hybrids were placed in pond 1. On July 26, 1886, 1260 of them were transferred to pond 8. On October 12, one which was measured was 5¼ inches long. On July 5, 1887, a specimen landed measured 10 inches. On May 22, 1889, there were above 500 in pond 16, the larger measuring about 14 inches in length.

Hybrids between Californian Trout (Salmo irideus) and Salmo fario.

In April 1885, 3000 ova of the Californian trout were received at Howietoun. They hatched out in May. In March 1889, the females were ripe, and about 3000 of the ova were milted from *S. fario*.

Of the fry of *S. irideus* there is now about 30,000 (pure).

It may be mentioned here that in March 1884 a number of eggs of the land-locked Sabago Salmon from Maine, U.S., were received at Howietoun, and hatched in April. On the 22nd May 1889 they were in fairly good health, with an average weight of about 2 lbs.

Cross between Lochleven Trout and Hybrid of S. salar (male), and Lochleven Trout (female).

On November 6, 1886, 3000 ova from a Lochleven trout (which was hatched in 1876) were milted from a hybrid between a male salmon, from the Teith, and a female Lochleven trout, hatched in 1879. The progeny (in pond 7) on May 22, 1889, were about fifty in number, 11 inches in length, and very deep in the body.

Hybrid between Lochleven Trout, and Hybrid of Howietoun Salmon par and Lochleven Trout.

On November 23, 1886, 1000 eggs were obtained from a hybrid female (the result of a cross on November 23, 1883, between a female Lochleven trout and a Howietoun salmon par) and milted from a three year old Lochleven trout. About 700 hatched on February 10, 1887. At the last count in June 1888, there were about 600 of these, and all looked well.

Hybrid from Hybrid Parents.

In pond 7, there were on the 22nd May 1889 several specimens of a hybrid, spawned in November 1886, and hatched in January of the following year. The parents of these hybrids were three years of age, and both half-blood, being the product of a cross between the female of the American char, *Salmo fontinalis*, and a male Loch Rannoch char.

J. R. G. M.

XII. NOTES ON CONTEMPORARY WORK RELATING TO FISHERIES IN THIS AND OTHER COUNTRIES. By T. Wemyss Fulton, M.B., and J. H. Fullarton, M.A., B.Sc.

In the following pages will be found an account of the contemporary fishery work in progress in this and other countries. Much of the information has been obtained from reports, memoirs and other publications received in exchange for the Annual Report of the Board, and we have to thank Lieut. Drechsel, Dr Petersen, Captain Dannevig, His Highness Prince Albert of Monaco, Professor Pouchet, Professor Marion, Dr Sauvage, M. Raveret Wattel, Dr P. P. C. Hoek, Mr Gilbert C. Bourne, Professor Herdman, and others, for information which will be found embodied below. We have also to thank Mr W. Anderson Smith, Ledaig, and Mr H. A. Webster, Librarian, University of Edinburgh, for translations of several of the foreign memoirs and pamphlets.

GREAT BRITAIN.

In a paper 'On the Cranial Nerves of Elasmobranch Fishes,' read before the Royal Society,* Professor Cossar Ewart describes in detail the anatomical arrangement of the cranial nerves of *Laemargus* and of *Raia batis*. The arrangement of these nerves in both fishes is illustrated by woodcuts. The author states that a comparison of the arrangement of the cranial nerves of *Laemargus* and *Raia* with those of *Petromyzon*, *Scyllium*, *Galeus*, and other familiar forms, renders it impossible to accept many of the statements hitherto made as to the nature, distribution, and segmental value of the cranial nerves of vertebrates. A comparison between the

* *Proc. Roy. Soc.*, vol. xlv. p. 524, 1889.

nerves of *Laemargus* and other Elasmobranchs, and the consideration of the segmental value and the more important modifications of the cranial nerves in the chief sub-divisions of the vertebrate group, are reserved for a future paper.

Mr W. Anderson Smith, in Mr Harvie Brown's recently published work on the Vertebrate Fauna of the West of Scotland, gives an account of the fishes which are found on the West Coast to the north of the Mull of Cantyre. This account includes the fishes recorded in previous books and papers dealing with the subject, as well as those obtained by the author, and forms the fullest list yet published.

Dr Philip J. White recently read a paper before the Royal Society 'On the Skull and Visceral Skeleton of the Greenland Shark (*Lœmargus microcephalus*).' It is shown that in the carnio-vertebral connection, the anterior portion of the first vertebra is wedged in at the hinder part of the occipital region; that the mesial portion of its centrum is continuous with the cranium, while the lateral parts of the centrum, although firmly bound to the skull, are distinct from it; and lastly that the neural arch of this vertebra enters freely within the foramen magnum. The various regions of the cranial and visceral skeleton are described, the cartilage being soft, as in *Hexanchus*.

Mr Bourne states that at the Marine Biological Laboratory at Plymouth, which has now been completed, Mr J. T. Cunningham, the resident naturalist, has been chiefly engaged in studying the common sole, and is collecting material for a monograph of that species, which will probably be published at the end of this year. The spawning of the sole occurs in March and April, but while in 1888 the spawning period extended into May, it this year practically terminated at the beginning of April. It is suggested that these variations are connected with differences in the temperature. Mr Cunningham has had the greatest difficulty in fertilising the ova of the sole, and has, so far, been unsuccessful in rearing the ova fertilised.

Mr W. Bateson is engaged on researches on the physiology of the sense organs of teleostean fishes, and particularly on the action of odorous and sapid substances on the olfactory organ, with the view of supplying, if possible, an artificial bait to be used during the scarcity of the natural baits commonly in use. Mr W. F. R. Weldon is preparing for the press an account of the decapod crustacea of Plymouth, with especial reference to their larval life, and has made many new and original observations on the subject, which will be embodied in his memoir to be read before the Royal Society. Mr Weldon is also collecting material for a monograph on the craw-fish, *Palinurus vulgaris*, and in June and July will continue his experiments on the artificial cultivation of this species, and of the common lobster.

Mr Harmer has worked at the anatomy and development of *Dinophilus metameroides*, and has also studied the different larvæ of several species of polyzoa; and Mr P. C. Mitchell has studied the histology of the endostyle of simple and compound ascidians; Mr W. Garstang, assistant to the director, is continuing his researches on the compound ascidians of the Plymouth district; while Mr W. Hardy has been engaged in the study of the Physiology of *Myriothela phrygia*.

Mr Bourne, Director of the Association, has prepared a report on the pelagic copepoda of the Channel, and is engaged in a general comparative study of the pelagic life in the sea contiguous to Plymouth, its distribution, seasonal variation, quantity, relation to temperature, &c. Mr Bourne is also elaborating a method for computing more exactly the amount of pelagic organisms contained in a given volume of sea water. An important addition to the fauna of Plymouth has recently been made by the discovery of *Amphioxus lanceolatus* in the neighbourhood.

In the last number of the Journal of the Marine Biological Association, Mr J. T. Cunningham has a long paper on the 'Reproduction and Development of Teleostean Fishes occurring in the neighbourhood of Plymouth.'* This paper contains an account of the breeding, under natural and artificial conditions of the ova of various fishes, including the boar or cuckoo-fish, red gurnard, lemon-sole, common-sole, mackerel, butterfly blenny, dragonet, and a variety of others taken in the tow-net. A great portion of the paper is taken up with the development of the lemon-sole, common-sole, and mackerel. Ova were chiefly obtained by means of trawlers going to sea from Plymouth. On these voyages either Mr Cunningham or the fisherman of the station usually accompanied the trawler, but sometimes the ova were obtained and fertilised by the fishermen themselves. In this way fertilised ova of the lemon-sole were obtained in April and May, thus showing that the spawning period for this species at Plymouth is during these months. The ova, in their homogeneous yolk and small perivitelline space, resemble those of other species of *Pleuronectes* and many species of *Gadus*. The progress of development showed complete segmentation at the end of the first day, extension of the blastoderm over the yolk at the end of the second day, mesoblastic somites and optic vesicles at the end of the third day, and lenses, auditory vesicles and pigment at the end of the fourth day. The specific gravity of the ovum of the lemon-sole is 1·024, while that of the ovum of the common-sole is between 1·026 and 1·027. The distinguishing features of the ovum of the sole are a great number of minute oil globules arranged in groups of irregular size near the edge of the blastoderm, and a layer of yolk segments, forming a superficial layer over the whole surface of the yolk. *Mullus* and *Solea* are the only genera whose ova undoubtedly have the peripheral layer of yolk segments. It is pointed out that in *Solea* and *Mullus* the central yolk is fused into one mass, while the peripheral layer is segmented, and that this is an intermediate condition between adhesive non-pelagic ova, where the yolk is made up of a number of minute yolk spheres, and the continuous homogeneous single yolk sphere of pelagic ova. From May 24th to July 17th a continuous supply of mackerel ova were obtained, and Mr Cunningham thinks that the process of spawning among such migratory fish as the mackerel is approximately simultaneous in all specimens in a given locality. The specific gravity of mackerel ova was ascertained to range between 1·0259 and 1·0265. There is a large oil globule in the ovum, and it moves with perfect freedom at the surface of the yolk, proving thereby that the yolk is a liquid with a very slight tenacity. In floating ova the blastoderm is at the lowest pole and the yolk at the uppermost. The yolk is described as a liquid enclosed by a layer of protoplasm which is continuous with the blastoderm. After a description of certain buoyant clupeoid ova, notes are given of ova, supposed to be those of the plaice, whiting, pouting and rockling. A connection between the presence of oil globules in the yolk and the normal quantity of oil in the body of the parent fish leads the author to a hypothesis that the excess of oil in the tissues of the parents extends into the ovum, and during the development of the latter supplies the embryo with an abundance of fat necessary to its growth. Mr Cunningham also gives the results of his observations on the development of the vascular system and cœlom in the pelagic ova of teleostean fishes.

In the same number there is also a paper on some 'Animal Colouring Matters examined at the Plymouth Marine Biological Laboratory,' by

* New Ser., No. 1, p. 10, 1889.

Dr C. A. MacMunn. This paper, which is only an abstract of the results of Dr MacMunn's researches, describes the pigments present in a large number of invertebrata belonging to different groups.

Mr Gilbert C. Bourne, the Resident Director, describes a *Tornaria*, the pelagic larva of *Balanoglossus*, taken in the neighbourhood of Plymouth, and the first specimens found in British seas, and gives an account of its anatomy, illustrated by two plates. There are also short papers in the same journal on 'The Marine Oligochæta of Plymouth,' by Mr F. E. Beddard; on 'The Mackerel Fishery in the West of England,' by R. J. Ridge, and an account of 'The Scientific Work of the Fishery Board for Scotland,' by Dr T. Wemyss Fulton.

The marine fauna of the south west of Ireland has recently been the subject of special investigation. In the *Proceedings of the Royal Irish Academy*,* Professor A. C. Haddon gives the general results of the Dredging Expedition of the Committee of the Academy, and the Rev. W. S. Green describes the equipment and apparatus employed. A new species of *Edwardsia* and the erect variety of *Epizoanthus papillosus*, with an associated *Pagurus*, were taken. The latter replaces the mollusc's shell on which it settles, so that the carcinœcium is formed entirely by the soft tissues of the actinian. *Holothuria tremula* and a new British addition *Chitonactis richardi* were met with. *Cassidaria tyrrhenea* was obtained in 265 fathoms. This expedition affords another evidence of the interdigitation of northern and southern forms on the south-west coast of Ireland.

Professor W. C. M'Intosh has recently given an account of the development of the common mussel (*Mytilus edulis*).† Some of the older mussels found at the Eden are covered with *Gonothyrœa*, which affords a resting place for the spat from the ripe molluscs. The young mussels fix themselves in situations where oxygen is abundant, and where there is a plentiful supply of food. The mussels on settling were from $\frac{1}{21}$ to $\frac{1}{71}$ inch in length, and the number of gill papillæ which were developed at this stage ranged between 3 and 13. Professor M'Intosh holds that mussels can leave their situations and fix themselves anew. Accordingly the measure of growth of the mollusc found on such objects in the sea as pier-supports or ships' bottoms, is not necessarily represented by the size of the mussels on these objects since the objects were last cleaned.

The Puffin Island Biological Station‡ offers an opportunity to young biologists of becoming acquainted with marine animals and plants, and it affords a supply of specimens to the specialists at work on the flora and fauna of Liverpool Bay. In crustacea several species new to science have been found in the past year. In regard to the young of molluscs, instances of *Hydrobia ulvae* depositing their eggs on the shells of the same species occur, and all projecting objects on the shore at certain spots are black with the young of the common mussel, which, however, never come to maturity. The suggestion that their disappearance is because they are eaten by larger animals must be received with reserve. The three days' dredging excursion, by the Liverpool Marine Biological Committee to the Isle of Man, was occupied in collecting specimens by dredging and otherwise, but the chief interest centred in the experiments made with the electric light. A 60 candle power Edison-Swan incandescent lamp was placed at the mouth of a tow-net. Two tow-nets—one on either side

* *Proc. R. Irish Acad.*, vol. i. pp. 29–86, 1888.
† *Ann. and Mag. Nat. Hist.*, vol. ii. pp. 467–9, 1888.
‡ *Second Annual Report on the Puffin Island Biological Station.* Liverpool, 1889.

of the ship—were let down after dark, one of the nets containing the incandescent lamp. It was found that in the illuminated net there was an abundant gathering of crustaceans, while in the dark net there was practically nothing.

In connection with the work carried on at the Puffin Island Biological Station, Mr Isaac C. Thompson has very completely investigated the copepoda, and has published several papers in the *Proceedings of the Liverpool Biological Society* on this group of organisms. Mr Thompson's observations have resulted in adding a number of species new to Britain and new to science,—the most remarkable addition being probably *Cymbasoma herdmani*, a previously described species of this genus, *C. rigidum*, discovered by Mr Thompson at Teneriffe, having necessitated the constitution of a new family for its reception, the Cymbasomatidæ. Mr Thompson, in a report on the copepoda of the Maltese Seas,* has described 68 species, 3 of which are new to science.

Dr Day, after an interval of ten years since the publication of his 'Fishes of India,' now issues a supplement† to that great work, so as to make it as complete as possible. Many new forms have been obtained from the seas and inland waters of India, and these Dr Day has described in a supplement of about 40 pages, which includes a very full index to the genera and species described. Dr Day adds to his former work the sub-class Leptocardii, and notes that one or more species of *Amphioxus* are common to India, Burmah, Ceylon, and the Andaman Islands. By this work Dr Day makes all interested in pisciculture more than ever indebted to his patient and painstaking researches.

THE UNITED STATES.

The Report of the United States Fish Commissioner for 1886 has not yet come to hand ; but we have received four volumes, in continuation of those previously published, on the Fishery Industries of the United States. This elaborate work has been prepared by Professor Brown Goode, assistant secretary of the Smithsonian Institution, and a staff of associates, through the co-operation of the Commissioner of Fisheries. Sections III. and IV. are published in the same volume. Section III. contains a most extensive and elaborate account of the Fishing Grounds of North America,—the location, character and the productiveness of the numerous grounds resorted to by the fishermen of the United States being described. These extend from Greenland to Mexico, from Lower California to Alaska. The text is illustrated by 49 charts, showing the position of the grounds, depth of water, &c. ; and is accompanied by an appendix on the ocean temperatures of the eastern coast of the United States, with 32 graphic charts. This section contains also an account by Dr S. Jordan of the geographical distribution of fresh-water food fishes in the several hydrographic basins of the United States. Section IV. deals with 'The Fishermen of the United States,' and is profusely illustrated. The men engaged in the various fisheries, at different parts of the coast, their life, &c. are described, an account being, as a rule, given of their economic and social condition. There are also chapters on the dangers of the fisheries and on the management of the vessels.

Section V., which is published in two volumes, deals with the History and Methods of the Fisheries, and is illustrated by an atlas of 255 plates. Each of the fisheries is described with a wealth of details not often found in fishery works published in this country,—for instance, 119 pages are

* *Proc. Biol. Soc., Liverpool*, vol. ii. p. 137.
† *Supplement to the Fishes of India.* By Francis Day, London, 1888.

devoted to a description of the halibut fishings, and nearly 300 pages to the whale fishery. There can be little doubt that these volumes constitute the most elaborate account of fisheries which have ever been published.

FRANCE.

In France there is a comparatively large number of marine laboratories where researches in connection with fisheries are carried on, and they are largely subsidized by the State.

Concarneau.—We are indebted to Professor Pouchet for most of our information in regard to the well-known laboratory at Concarneau, of which he is director, the pioneer of so many other similar institutions. This laboratory took origin in 1857 from the labours of Coste, the distinguished Professor of Comparative Embryology in the College of France. The work carried on was at first purely that of scientific inquiries, but Coste soon applied himself to establish what he termed a zoological observatory, where scientific observations might be conjoined with practical work on the artificial culture and rearing of economic species, which formed his dominant study. The persistence and eminent scientific authority of Coste ultimately induced the Government to grant the means necessary to erect a large, thoroughly equipped building for the work, and this forms the laboratory at the present day. After Coste's death the laboratory remained for some time without a scientific director, and was left to the commercial exploitation of a keeper, but in 1881 Professor Robin associated himself with Professor Pouchet in the endeavour to restore the laboratory to its former position as a place of scientific research. Since that period the laboratory has been in regular operation, under the energetic direction of Professors Robin and Pouchet, and the scientific operations have been simply but completely established in accordance with the requirements of modern science. An assistant resident director was also appointed.

The laboratory at Concarneau consists of a large granite building, situated on the shore at the level of the tides. On the land side is a garden leading to the first floor towards the sea. There are 8 extensive tanks of granite, having a total superficies of about 500 square metres, communicating with the sea by sluices. The first floor, which is entirely devoted to scientific work, is divided into 7 compartments or cabinets for research, each capable of accommodating two workers, and also includes a large room for experiments, a library and a workshop. The latter contains a gas-engine to furnish the motive power necessary for the work, and for the circulation of the water supplying the aquaria, when the wind fails; for the latter task is usually accomplished by means of a windmill placed on the roof and acting on a pump. On a level with the ground-floor, at the side of the sea, are placed the aquaria supplied by 3 large reservoirs, and comprise 60 tanks or basins, the forge and the photographic room. Four of the outside tanks are set apart for the use of the laboratory, the other 4 having been granted by the Government to the previous keeper of the laboratory, who utilises them in keeping turbot, lobsters and cray-fish in them.

For the past ten years the State has placed at the service of the laboratory a steam vessel and a whaling boat manned by a crew of 6 sailors, thus allowing scientific excursions to be made,—dredgings, to the depth of from 100 to 150 fathoms, and tow-netting being regularly carried on. By these means naturalists have been enabled to study the fauna of the Bay of Concarneau.

An old dismantled fort on one of the Glenan Islands is annexed to the laboratory, furnishing the conveniences necessary for zoological researches into the extremely rich fauna of the archipelago.

An annual sum is given by the Government to the laboratory; part of this goes to pay in certain cases the travelling expenses of workers. Independently of the individual work done by naturalists visiting the laboratory, a series of systematic investigations are carried on under the guidance of the director during most or part of the year. The records of meteorogical observations, made by means of self-recording apparatus, are supplied to the central meteorological office. The director furnishes to the Government an annual report for publication, containing an account of the work done at the laboratory. The site of the laboratory, placed as it is in the midst of the district where the French sardine fishery is carried on, has made it a natural centre for the study of this fish, which forms the great object of a large industry. The report for 1887, by Professor Pouchet, describes the recent work done at the laboratory.*

The publications of the work at the laboratory include articles on the colour of the sea and in fishes, contributions to the embryology and teratology of the simple ascidians, a catalogue of the crustaceans (Malacostraca) of the Bay of Concarneau, and a variety of papers on the sardine, their food and the instruments for capturing them. In 1887 the chief work of the laboratory was an investigation into the food of the sardines of the French coast, and of the Bay of Concarneau in particular, and the comparison of these with the sardines of the Azores. Besides this question of food, the work of the laboratory also embraced an investigation into the ripeness of the reproductive organs; the migration of the fish, and the superficial and bottom temperatures of the water of the bay. It has been demonstrated that the sardine is on the coast simultaneously with the presence of small crustacea, molluscs and pelagic plants, and an extraordinary abundance of sardines was noted in the season of 1887. Another table gives the average number of sardines caught by each boat in Concarneau from 1855 to 1886, and a comparison is drawn between the numbers got at Sables-d'-Olonne. A valuable table, giving the numbers of various specimens, the date on which they were caught, their weight, length, and the exact measurements and conditions of ovary and testes, closes an interesting report.

Boulogne-sur-Mer.—Dr H. E. Sauvage, the director of the Marine Station at Boulogne-sur-Mer, publishes yearly in the *Bulletin du Ministré de l'Agriculture*, reports of the work carried on in connection with fish and fishing. The workers deal with practical fishery questions, especially questions in regard to the herring fishery (which is the great industry of Boulogne), such as an analysis of the nutritive value of herrings. The utilisation of star-fish and of the residue of herrings, and the employment of the products of these in agriculture engage the energies of the workers. Besides these are also studied at the station such practical questions as the best kinds of material to use for fishing-line, and how best to preserve this material, and the composition of the different kinds of salt used to preserve fish. The director has published a note on the fishing grounds for herrings in the North Sea, and he has constructed charts of the fishing ground of the mackerel on the south coast of Ireland. Besides articles on the food of different kinds of fish, and on the food of the sardines of the coast of Boulogne, a catalogue of fishes observed on the coast of Boulogne has been printed. The workers are also turning their attention to the capture and destruction of young flat-fish, and to

* *Rapport sur le fonctionnement du laboratoire de Concarneau*, par M. G. Pouchet. Paris, 1888.

salmon disease. M. Martin is working at the subject of fish parasites, both trematodes and nematodes, and great quantities of material from the Boulogne shore are being collected, which may be useful in the subsequent investigations.

The following are abstracts of some of the more interesting of the recent reports from the station.

Dr Sauvage was commissioned by the Minister of Agriculture to visit the principal fishing ports of the east of England, and ascertain the fishery organisation of these places.* Accordingly, Lowestoft and Yarmouth were selected as the seats of the herring fishing, while Hull and Grimsby were visited as ports from which trawlers fished, and the results of the Commissioner's observations are given in his Report. The first portion of the Report deals with various questions in regard to the fishing. The organisation for rapid and economical transport of fish from these ports is described in detail, and Dr Sauvage considers that the facilities and management are admirable. The equipment for trawling at Hull and Grimsby is given, and attention is called to the advantages of this kind of fishing, especially by steam vessels, in the North Sea. The fact that steam trawlers are at work during the whole year is noted, and the relative advantages of steam trawlers *versus* sailing trawlers, with attendant steamers as fish carriers, are mentioned. The fishing places in the North Sea, from the English coast to Jutland and Schleswig and from the coast of Hanover to Kinnaird Head, embracing the Dogger Bank, the Eastern Mudhole, the Great and Little Fishing Banks, the Jutland Bank, the Great Silver Pit, and other fishing areas are given, and the positions of these, their depths, and the best seasons for fishing them, supply an amount of information which will be equally useful to French and other fishermen.

The oyster beds at the south-east of the Dogger Bank, at the Outer Silver Pit, twenty-five miles east of Botney Cut, are noted, and it is stated, on the authority of Mr Olsen of Grimsby, that a single boat on the last mentioned bank secured thousands of oysters in four hours. The parts of the English coast at which shrimping is carried on are mentioned generally. In the cod fishing the Grimsby fishermen prefer to bait their lines with lampreys; and the arrangements for keeping the cod alive in the smacks for despatch to Billingsgate are described. The particulars of the herring fisheries are taken from the Reports of the Fishery Board for Scotland, and the season and apparatus for the mackerel fishery of Lowestoft and Penzance are given.

The second part of the Report deals with the preparation of the white fish for the market and the utilisation of fish refuse. Attention is directed to the preservation of herrings fresh in ice, and as 'bloaters' and 'kippers,' and to the smoking of haddocks, as well as to the boracic acid method of preserving.

The concluding portion of the Report is restricted to questions connected with transport, the service of trains on the Great Eastern route being detailed, as well as the rate of carriage for different kinds of fish. Statistics of the export trade of Scottish herrings and the values of barrels of herring at Stettin are given.

Dr Sauvage concludes a valuable Report, which shows that France means to profit by as full and perfect an acquaintance with what is being done in fishery matters in Great Britain, as it is possible for a special Commissioner to obtain, by impressing on his countrymen the necessity of cheap means of transit to ensure the development of French fisheries.

* *Rapport sur la peche dans les principaux ports de l'est de l'Angleterre, par* M. le Dr H. E. Sauvage. Paris, 1889.

The Marine Station, Marseilles.—The scientific committee is indebted to Professor Marion, Director of the Marine Zoological Station of Marseilles, for copies of the *Annales du Museé d'Histoire naturelle de Marseille.* These magnificent volumes afford evidence of the good zoological work done at this marine laboratory in recent years. The sketch of the 'Topographical Zoology of the Gulf of Marseilles,' and the 'Monograph on the Bottom Fauna of the Mediterranean,' by Professor Marion, are illustrated by a chart of the neighbouring waters, with the different regions differently coloured. Naturally, as one might expect, the molluscs come in for a large share of attention, but the other groups, such as worms, and echinoderms, are not neglected.

Embryology bulks largely, Professor Kowalévsky of Odessa having worked out, with the wealth of detail and accuracy that also characterise his numerous other larval researches, the Embryogeny of the Alcyonarians, of Chiton and of Dentalium. In the Monograph of the Alcyonarians his co-worker was Professor Marion. The all-round character of the work done at this station is also shown by Jourdan's Researches on the Histology of the Ascidians, Kœhler's on the Echinids of the Coast of Provence, Roule's on the Simple Ascidians, Gourret's on the Peridinians, and Vayssiere's Anatomical and Zoological Work on the Opisthobranch Molluscs of the Gulf of Marseilles. All these contain very valuable morphological results, and the topographical work has been continued by Gourret, who treats of the pelagic fauna of the Gulf of Marseilles, and describes a new member of the chætognatha, viz., *Spadella Marioni.*

These tomes are not the only product of the activity of Professor Marion and his coadjutors. The Molluscan fauna of the brackish Pond de Berre has been described by Professor Marion, who distinguishes four stations,—first, the littoral zone, with *Mytilus galloprovincialis*, Lamk., and other forms; second, a sandy beach, with *Cyclonassa;* third, the plain of *Zostera marina;* and fourth, the depths beyond the last region. This paper and that on the sardine of the Marseilles coast, are tokens of activity in another direction.

Marine Station, Arcachon.—The annual bulletin of the zoological station for the year 1888, besides containing the report of the director of the station, gives a *résumé* of the work performed in the laboratory by Messrs Burdon Sanderson, Gotch, Ferré, Jolyet, Lagatu, Petit, De Boury, Fischer, Dollfus, and others. The first two gentlemen studied the electric properties of the torpedo by the aid of the galvanometer, and the results of their research have been communicated to the Royal Society of London. De Boury has investigated the distribution, both geographical and bathymetrical, of the molluscan life, and has chronicled more than 30 species new to the coast of the Gironde. He has also pointed out the occurrence of northern forms along with Mediterranean species. Dr Fischer has found at Arcachon a number of interesting actiniæ, among which is *Paranthus rugosus*, which till now was regarded as peculiarly Mediterranean, and a *Bunodes* new to science.

M. Dollfus gives a list of crustacea. The list of species new to the department of the Gironde, which have been recorded during the year 1885–8, include 7 cœlenterates, 3 echinoderms, 2 worms, 31 crustacea, 12 molluscs, and 2 tunicates.

We are indebted to Mr W. Anderson Smith for translations of extracts from the 'Journal Officiel,' which were forwarded from the Foreign Office through the Secretary for Scotland.

*On the Sale and Consumption of Mussels in France.**—This note

* F. Hermegny, member of Consulting Committee on Marine Fishes, *Journal Officiel*, 26th May 1889.

contains an account of the poisonous properties of mussels. It appears that the consumption of oysters did not cause more frequent accidents at the period of spawning than away from the time of reproduction, poisoning arising only from those which have undergone a chemical change, or have lived in waters made filthy by organic matters in course of decomposition. The more frequent poisoning by mussels has been attributed to a variety of causes, (1) to a small crab (*Pinnotheres pisum*) which often lives within the mussel shell; (2) the presence of the spawn of starfishes; (3) the presence of copper, Bouchardat having shown that mussels taken from copper-bottomed ships contained this metal; (4) to an idiosyncrasy of the individual poisoned. The first two explanations have been shown to be unfounded; and although copper is often present in mussels growing on old hulks, &c., it has been shown experimentally that mussels living in water containing copper in solution die before they accumulate sufficient of the metal to make them poisonous.

On 17th October 1885, the workmen of the Arsenal of Wilhelmshaven ate mussels attached to the wooden keel of two vessels sunk in the port. Nineteen of them were attacked seriously, and four died in some hours. The swallowing of 5 or 6 mussels was sufficient to cause grave symptoms of poisoning. Animals which had eaten equally of these mussels succumbed like the men, very quickly. These mussels were eaten quite fresh from the water, but they exhaled a nauseous smell. MM. Brieger and Schmidtmann analysed them, and obtained from them a very active alcoholic extract, which would be a ptomaine developed under the influence of a special microbe. According to M. Wolff, the principal poison would be seated exclusively in the liver. M. Salkowski has discovered that the alcoholic extract became inactive when treated with carbonate of soda; in the same way mussels cooked for ten minutes with carbonate of soda had lost their intoxicating property! Professor Virchow also made an interesting experiment with these mussels; he kept some alive during two months in an aquarium, and proved that they had ceased to be dangerous. According to MM. Lohmayer and Kobelt, the poisonous mussel of Wilhelmshaven belongs to a variety introduced from England, probably by ships that carried it fixed to their keels: this would be *Mytilus edulis*, var. *pellucidus*. However this may be, M. Schmidtmann has shown that the same mussel taken in the outer port was non-injurious, but that it became poisonous after a sojourn of a fortnight in the docks; it is the same with the star-fishes, which, according to M. Wolff, become poisonous and produce the same symptoms as the mussels, when they live in stagnant waters. In England sailors will not eat mussels from non-flowing waters and those polluted by docks and ports. Recently M. Lustij has studied, comparatively from the point of view of their action on the animal economy, mussels taken in the open sea at Trieste and Genoa, and those taken from stagnant waters of the canals and ports. In the first he has not found any microbe; from the second he has obtained by cultivation two microbes, the one inoffensive, the other pathogenic; this last, introduced into the digestive tube of animals, causes death in one or two days.

It appears then that the poisonous property of mussels is due to the presence principally in the liver of a volatile organic alkaloid (Mytilotoxine of Brieger) developed under the influence of a particular microbe. Almost all authors agree in acknowledging that poisonous mussels are only found in stagnant waters or the filthy waters of ports, docks or canals, and that the accidents caused by eating these shell-fish can be noted at all seasons outside the period of reproduction, as the case of poisoning at Wilhelmshaven proves. The consulting Committee on Marine Fisheries, considering that mussel parks are commonly placed where the water is constantly renewed, and consequently free from unfavourable conditions that would make them poisonous, that on the other hand the protection of the natural beds assures, to an extent, the reproduction of these mollusca, is prepared to permit the sale at all times, in the markets of the coast, of mussels from the parks, a sale at present prevented during the months of May and June by the application of article 53 of the decree of 4th July, 1883.

Injury to Fisheries by Porpoises.—The Prefect of the Var forwarded to the Minister of Marine on 10th December 1888, a resolution of council of the municipality of Saint Nazaire, desiring that competent commissioners be appointed to study the question of porpoises and point out the proper measures to be taken to destroy them or at least drive them from the coast during the fishing season. The efforts made consisted in the offer of premiums for their destruction, ranging from 5 to 15 francs, directions to the fishermen to continue their nets and drag them ashore, and the payment of injuries done to nets by the porpoises. The premiums produced no result; the porpoises leaped over the nets when they found themselves enclosed, and when a vessel sought to cannonade them off the fishing grounds they drove the fish off likewise, and stopped all fishing for more than a week.

The conclusions arrived at are:—1. That the use of artillery against porpoises is without useful effect. 2. That the offering of premiums for the destruction of these animals has always been without result. 3. That it remains only to encourage the fishermen who complain of the abundance of porpoises to unite either to join chase to these animals, or to protect themselves by a sort of mutual assurance against their depredations. Meantime the Department of Marine might continue to indemnify, in a certain degree, proprietors of nets who may have suffered serious losses.

*Shrimp Fisheries.**—M. Giard and M. Roussin have addressed a paper to the Minister of Marine on the employment of certain machines for the capture of shrimps.

It has been proposed to absolutely prohibit shrimp trawling on the coast of France, and as the machine described is considered far superior, the reporters advise its adoption in certain centres, with a view to its general adoption throughout French waters.

The Committee who drew up the proposed bye-law had in view to check the diminution of fish, and particularly flat-fish, in the shores where the trawl is in use, 'this destructive machine, gathering at each draw 'considerable quantities of small specimens of those species which, even 'when immediately returned to the sea, do not survive this rough usage, 'and are wholly lost.' At Croisie particularly, where decked boats made fifteen years ago very good fishing at some miles from land in less than 50 metres depth, fish are no longer found, except at 30 to 40 miles off, about Belle Ile, in depths of 110 to 130 metres (60 fathoms!). The same is found all around the littoral, especially by the fishermen of Sables d'Olonne and Groix, who are found to trawl in depths of more than 100 metres. The shrimp trawl having, by general agreement, been a principal agent in this destruction, it was prohibited and the prohibition enforced energetically.

The machine that is to take its place in the capture of shrimps is on the principle of a lobster or crab-pot, but barrel shaped, 75 centimetres

* *Journal Officiel,* 21st Mai 1889.

long, covered with netting of meshes of 10 millemetres, with entries at the ends to the suspended bait (fragments of fish). The framework has stones tied to it, and the cage or pot is furnished with 40 metres of line and a cork at the end. Each owner has at least 25 or 30 pots which he places in favourable reaches, at depths of 15 to 30 metres more or less distant from the coast, preferably on muddy bottoms where vegetation grows. The use of these pots or cages is prohibited between 1st November and 1st May. A hundred boats with 300 fishermen pursue the fishing. The mean product is 80,000 kilogrammes annually, of a gross value of 220,000 francs, and *net* 200,000 francs, giving 2000 francs per boat. Another mode in use in the north of France, near Cherbourg, is to employ a machine more like a lobster pot, and very open. It is more productive than the last, but as the shrimps can easily escape, the fishermen are obliged to remain with their boats over night drawing and resetting the traps.

Yet another system is employed on the littoral of La Vendée, where a conical net 40 to 60 centimetres deep, with 10 millemetre meshes, is fixed to an iron circle of 80 centimentres to a metre, like a very open butterfly net. The bait is laid on the bottom of the net, the bridle kept clear of it by a light float, and with 10 to 20 of these per boat they are lifted every ten minutes. They are most destructive where there are sandy stretches between rocks where trawls could not go.

The consulting Committee of Maritime Fisheries submit the following conclusions:—

1. The adoption of the measure already proposed, which consists in interdicting, at all times and in every place, the use of the shrimp trawl; the promptest possible notification of this decision; the fixing, for applying this interdict, a delay of a year, starting from the day of the notification.

2. To popularise the system, other than the trawl, employed for the capture of the shrimps by boat, by distributing descriptions of these appliances, particularly of those in use at Croisie and Saint-Gilles-sur-Vic; gratuitous distribution of a certain number of samples of the machines employed in order to make the model known and so encourage its trial.

3. The substitution of steam vessels in place of the coastguard ships actually charged with supervision of the coast fisheries.

Prince Albert of Monaco has been good enough to send a number of pamphlets, giving some of the results of four scientific cruises in his yacht 'Hirondelle.' They contain discussions on the currents of the Atlantic, which have been investigated in a thoroughly practical manner. The Prince, in order to determine the direction of the currents, set numbers of floating objects adrift, with directions to the finder where they were to be forwarded to. By a careful system of number, dates, &c. a vast amount of data is gradually being accumulated on the subject of ocean circulation.

Various kinds of apparatus have been made for facilitating marine researches, such as the capture of animals in certain kinds of traps, and the attraction of marine animals by means of the illumination by electricity of the deep water. He has described the sperm-whale of the Azores, and two specimens of *Orthagoriscus mola*, taken during the voyages in 1886 and 1887. During the second voyage he obtained, off the Spanish coast, *Julis vulgaris* Cuv. et. Val., *Labrus bergylta*, Asc., *Conger vulgaris*, Cuv., and *Gadus luscus*, L. Prince Albert describes a self registering thermometer which he employed for taking temperatures at great depths, and in the paper on his third voyage he gives a note of the appliances which were used to capture surface forms and animals from great depths.

The statistical tables on the French fisheries, published by the French Minister of Marine and the Colonies, are valuable as showing the general and detailed results of the French fishings.* The number of seamen liable to naval duty engaged in the fishing was 82,156, and the number of men, women and children additionally employed in the fisheries was 53,032. The value of the fish, &c. caught in 1886, by all these, was upwards of 80 millions of francs. Elaborate results of the produce of different kinds of fishings are given.

SPAIN.

A résumé of the Official Reports from 1868–85, *in five volumes.*†
Prepared by W. Anderson Smith, Esq.

The Fisheries of Spain are in charge of a permanent Commission of Fisheries, under the Ministry of Marine, local committees having again charge of the various districts. Their Reports are carefully drawn up and liberally distributed, 250 copies being printed on superior paper for distribution in Foreign centres, for High State Departments, Royal Academies, &c.; while of the edition of 1250, half are for distribution amongst the periodical press, the different corporations, and persons likely to be benefited. The Reports range from 1868 to 1885, in five large volumes, and contain a very full and most instructive account of the fisheries of Spain. It is to be specially noted that a species of trawling that is carried on out to very great depths by means of two vessels with a net between them, and known as *Arte del Bou* has greatly concerned the Commission, from its reputed injury to fisheries. Generally speaking steam vessels are not permitted in this fishery, except as carriers; but in Cadiz, owing to the stoppage of a steamship line, an exception is made. The total value of the boats and establishments pursuing this industry in Spain reached in 1868 about £400,000, and the annual value of the fish taken £412,000;—they employ 4458 people. The Commission considers the size of the mesh of little consequence, as the tension is so great that no fish, small or great, can pass through the nets, and those taken are all dead. In the Gulf of Valencia, at a depth of about 50 fathoms, there is an extensive zone in which the bottom is covered with the zoophyte *Funiculina tetragona*, and commonly *Canamizar*, 'which serves for a refuge, and for food to 'all classes of fish, but which to-day is found destroyed, and has almost 'disappeared owing to the fishery *del Bou*' (trawl). They propose to prohibit the use of the trawl over this ground. Other systems of trawling—more or less resembling that of Tarbert, Lochfyne—abound in Spain. 'The Commission declares, demonstrating it in a conclusive manner, that 'the trawling (*pesca de arrastre*) is one of the principal causes of the decay 'of the industry, by the dispersion of the fish which formerly abounded 'on the southern coasts of Spain. It has not proposed, however, the 'immediate prohibition of this disastrous fishery, but regulation, which, 'without violence, and by successive restrictions, will produce its entire 'cessation.' Again, the Fish Commission of Palamos met to consider the petition of certain fishermen, and decided 'that the *Boliche de roda*

* *Statistique des Pêches Maritimes et de Ostréiculture pour l'anée* 1886, *France et Algerie.* Paris, 1888.

† These Reports were obtained by the Secretary for Scotland through the Foreign Office.

'(another class of draw-net), so-called from its being used with the help 'of windlasses, is even more injurious than that of *El Bou*, on account of 'the greater contraction of the mesh, and because drawing it directly on 'to the shore it kills all the young fish taken.'

A great sweep-net called *Jabega real*, originally of Arabic origin, is in use over the southern coasts of Spain, and is not included in the general objection to such nets, because they are mainly dedicated to the capture of species of fish, such as the sardine, the *Sparus boops*, &c., which appear periodically on the coast. These nets are also drawn upon special ground, free of obstructions and of vegetation, and consequently only capture the migrating shoals. Much information is given throughout the volumes as to the *Almadabras*, or great tunny nets, and as to the cause of the decay of the tunny fishery. They conclude that this fish is not local, but is passing the coast of Spain on the way to the further waters of the Mediterranean, and that it is well to capture as many as possible, as otherwise they merely pass into the hands of the competitors of Spain.

A curious discussion is raised upon the subject of small lines, called *Los enemigos* (the enemies). 'The instrument called the enemies is an 'arrangement of small hooks, so skilfully prepared with silkworm-gut that 'it takes all kinds of fish, however small they may be, and destroys the 'young, clearing them even from their nurseries without their being able to 'reach maturity.' The Commission decided not to interfere, except to define the size of the hooks to be used—No. 9.

Important papers on many local fisheries are supplied, amongst the most interesting being those on the *Mar Menor* (smaller sea), the name given to a lagoon in the vicinity of Cape Palos, 4 leagues from Cartagena. The main fish in the lagoon is the mullet, of several species, and in ordinary years it is calculated that 50,000 arrobas, or 558 tons weight, of these fish are taken. *The females taken far exceed the males.*

At the mouth of the Ebro the shoals formerly supplied fair encouragement to fishermen, but the cultivation of rice and the establishment of Saladeros (salt-pans) have done great injury. It was found that the complication of Government Departments—those of Agriculture, Marine, and Fisheries—was also injurious, and fresh regulations were accordingly issued. It is important to note the progress of Norway here. By royal decree of November 1867, the cities of Bergen and Drontheim were admitted as *Fishery Ports.* 'In Great Britain the islands of the Orkneys, the Hebrides, and those of Shetland; in Denmark, Iceland; in the United Kingdom of Norway and Sweden, the Ports of Aalesund, Christiansand, Molde, and all those comprised in the departments of Norland and Finmark.' Cargoes of dried cod from all other ports may be proceeded against if landed.

In 1869 the Commission proposed to close half the oyster grounds of Spain for several years.

In 1870–74, 655 vessels with 45 carriers, 700 in all, employed in the *Arte del Bou*, were calculated to capture 1,041,450 arrobas, or 13 thousand tons of fish annually, at a first cost 12 million pesetas £500,000. The cost of a *pareja con su arte* (pair of boats with engine) is under 15,000 pesetas £625; the average take is 17,000 kilos £708; the owners share 15 parts, or 4500 pesetas £187 10s.,—more than 25 per cent.

Much attention was paid at this time to oyster culture, and sixteen natural beds were reserved, a scientific memoir by Dr Graells published, and regulations issued for the protection of shell fish. This is of value from what it covers, including such molluscs as Pholas, Solen, Psammobia, Scrobicularia, Tapes, Pecten, &c., many of them never utilised either for food or bait in this country.

1880.—Official statistics for five years show the following losses in the fisheries of Spain 1874–79 :—

Department of Cartagena	. .	63 men	25 boats.
,, Cadiz	. . . .	32 ,,	11 ,,
,, Ferrol (north)	. .	520 ,,	84 ,,
		615 men and	120 boats.

So far as can be ascertained in 1878, in the Fisheries of Spain there were employed 78,184 men; 66,242 afloat, and 11,942 in fishery and curing establishments. The total value of all the material is calculated at 22,342,319 pesetas (say £931,000), of which 7,149,278 are in the establishments and curing places, and 15,193,041 in the boats and gear, including in the last those in the service of the establishments.

Congers.—In the district of Corunna the conger eels taken were so very small that it was proposed to limit the size of the hooks; but it was finally decided that this would interfere too much with the fishery, and so they prohibit the capture or sale of any conger less than 50 centimetres long. They are taken up to 100 kilos and 2 metres in length in the ocean, but generally they run from 15 to 20 kilos.

Bait.—Conger bait used in Galicia; sardine in Cantabria as in France (pulpo, la gibia, el calamar), 3 species of Cephalopods; the great earthworm, of which like the eel the conger is extremely fond; also young of the sole, of the flounder and small fish; and above all *de la esquilla* (*Cancer squilla*, L.) is a bait which is appetising; also shell-fish, particularly the mussel, and even crabs of whatever species.

This year they acknowledge the little progress made with oyster culture, and assert the necessity of means to apply the stringent rules made in the different localities, as the shell fish merchants pay no attention to them. A chart of the Model Oyster Farm is given, with the result of the first spatting season added.

A proposal to use fire-arms in the pursuit of the dolphin produces a curious discussion. These cetacea come in such multitudes in the pursuit of the sardine in the north of Spain, that it was proposed to kill them with fire-arms, arming special vessels for the purpose. But it was decided that the use of fire-arms would be most prejudicial to the sardine fishery, these fish being readily alarmed; and that the dolphins were not themselves altogether injurious, as their assaults drove the sardines into the mouths of the rivers. Fire-arms were consequently entirely prohibited.

1885 (from 1879–84).—The Prologue deplores continued decadence of Spanish fisheries, the non-success of the prohibitions of small mesh-net in the *Mar Menor* in order to save the young of the mullet—as it also saved a small fish which mainly preyed upon these young, and so the fishing did not recuperate—and continues to deplore want of proper police. Many of the oyster banks, for which grants have been made, are doing well and selling quantities. A very exhaustive statement and description of the various draw-nets in use in Spain, and the comparative injury caused by them, is given, from which we should have wished to quote extensively, had our space permitted. The great net called *Arte del Bou*, that fishes with two vessels to a depth of 120 fathoms on the coasts of Morocco and off Valencia, is looked upon as the most injurious, and being so, 'it falls 'to place more restrictions on its use, prohibiting it in certain places, 'establishing and enforcing the seasons of close time, and reducing the zones 'in which it may work; but, while imposing severe penalties on trans-'gressors, by no means absolutely prohibiting the fishery.' This modifies the former entire denunciation.

Crustaceans.—The destructive fishery of the lobster on the coasts of Galicia, and the excessive exportation by foreign craft, determined the Government to issue regulations and establish *viveros* (floating). Four floating lobster *viveros* have already been conceded.

In January 1881 a decree was issued establishing a close time for fishing crustaceans, and drawing up regulations to be observed. The whole range of edible—and to us absolutely useless—crustaceans are included in these regulations.

A species of draw-net used in the sardine fishery was the subject of investigation. It is called *Encesa* (candle), also *Boliche de la encesa*, greatly resembling the destructive *Boliche* draw-net, for which reason it had been prohibited. A fresh investigation led to the belief that it was not specially injurious where used, as, although a drag-net, it was not possible to reach the bottom with the sole rope, however weighted; that the heavy weights employed kept the meshes apart, and the use of a light in the leading boat kept the fishes on the surface, so that the short depth of the net was not material. The Commission add the recommendation that the use of the light to attract fishes should not be prohibited for legal nets.

Submarine Light (Faro submarino).—Under this name a new light for attracting fish under water desired recognition from the authorities. 'As to the apparatus, it consists of a receiver of glass in the form of a 'truncated cone, protected by circles or wires of iron, in whose interior are 'placed five lamps, fed with petroleum. This species of bell is adapted to 'the keel of a small vessel, in such a manner that, receiving the required 'air for combustion, the submerged light illumines a considerable area, 'giving an intense and constant light with little fuel. The boat sets out 'and crosses over the ground frequented by the fish, so as to attract their 'attention and bring them within range of the light. When they have 'collected a quantity, they steer the vessel towards a floating engine of 'capture, made of nets of large meshes at the entrance, and which go on 'steadily reducing their dimensions until they measure a centimetre in the 'last, or *Matador*, kept in place by corks and by three anchors, ending in 'a trap, and watched over by the *Matadero* in a small boat.'

The apparatus was permitted *pro tem.* as an experiment.

Sardines.—The value of the sardine fishery of Spain is upwards of £400,000, and there are about 500 factories in connection with it.

Throughout these Reports there are admirable Piscicultural Bibliographies, accounts of the donations to the National Fisheries Museum in Madrid, and numerous investigations of much special interest. The last includes an admirable 'Ichthyology of the Cadiz littoral,' a summary by Don Juan Antonio de Vera y Chilier, with the names of the fishes, molluscs and crustaceans, the ground on which they are taken, the mode of capture, the time of spawning, time of capturing, and general observations upon each—all also tabulated in a handy form. Altogether we may learn much as to method and direction of investigation by an examination of these careful Reports.

THE FISHERIES OF HOLLAND.*

The French Ministry of Agriculture sent Dr Sauvage to study the fisheries of Holland, their engines and their methods of fishing, in the interests of the fishings of the north coast of France, and, as a result, a very valuable and full report has been written on the subject. The report is divided into two parts,—the first treating of the equipment and

**Rapport sur la pêche en Holland, par* M. H. E. Sauvage, Paris.

appliances peculiar to Holland, the second dealing with every kind of fish caught, a description of the engines employed, the selling price, and the general statistics of the fisheries. The Dutch fisheries till 1857 were subject to repressive regulations, but in that year the Government considering liberty synonymous with commercial progress, swept away the hurtful restrictions, and the value of the herring fisheries rose from 630,000 florins in 1857 to 1,879,880 florins in 1880.

By the first article of the new law complete liberty was ensured to every fisherman to carry on his calling as he thought best. A second article abolished the prohibition to import salted herrings in kegs, but temporarily forbade the importation of salted herrings in bulk. Regulations as to fishing boats were enacted and measures were taken to conserve and develop the marine fisheries. A State Committee of fifteen members was entrusted with the management of the fisheries,—including a lawyer as president, an ichthyologist, two university professors of zoology, an expert in oyster culture, a member of the States-General, the director of a society of fisheries, a naval officer, five shipowners, and two citizens, one of Rotterdam, and one of Harderwijk. This committee has consultative and administrative powers, superintends the enforcement of the regulations, nominates the functionaries who are charged with fishery inspection, advises the ministry in cases of litigation, makes known desirable reforms, presents an annual report and publishes practical manuals on the fisheries. Dr P. P. C. Hoek was a year or two ago appointed the Scientific Adviser in fishery matters.

The first division of the report gives in detail an account of the different kinds of boats employed and the fish tanks in these. The coast fishermen are then described. The principal species of fish taken are turbot, brill, sole, plaice, dab, skate, and cod. The different kinds of gear, nets and lines and the means taken to preserve these, and a detailed description of the working of nets and gear, and the distribution of profits among boat, sailors, &c. are given. Questions in regard to salt and transport precede a short notice of the Committee's Zoological Station, which ends the first division of the report.

The second half includes an interesting account of starfish, oysters, mussels, shrimps, sturgeons, skate, eels, cod, sprats, salmon, herring and other fish. Britain received 764,000 kilos of oysters in 1881, being a half of the whole produce of oysters of the Netherlands, and that, too, when it might be possible for Britain to rear most of its own oysters if the subject were courageously, intelligently and systematically grappled with. The saving of the great sums annually spent on imported oysters, and the cultivation of oysters on the most improved principles, would warrant more attention and time being devoted to this subject. The chief conclusions which Dr Sauvage impresses on the ministry as having learned from his various journeys to fishing ports, and which are fitted to foster the fishing industries of France, are the abolition of certain restrictive salt dues, the reduction of rates of carriage, and the more careful preservation of herrings. Valuable tables relating to the quantities of herrings caught and the market prices obtained for these bring a most interesting and valuable report to a conclusion.

Dr Sauvage also has a lengthy report on the fishery apparatus and fishery products of the countries represented at the Fisheries Exhibition, held in London in 1883.* It deals with the fishery industry in a very exhaustive manner, and is likely to be of great service to the fishermen of the coasts of France.

* *Rapport sur exposition internationale à Londres en* 1883, *des Products et engines de Pêche, par* M. H. E. Sauvage. Paris, 1884.

Dr Sauvage is always practical, and insists on the development of more rapid steam communication, the diminution of the rate for the carriage of fish, proportional rates, and the introduction of more serviceable fish-train service. He does not neglect to insist on the better management of fishery ports, and the perfection of fishery organisation,—especially in reference to improved forms of fishery apparatus. The educative value of an international exhibition in the principal French fishing ports, to permit the French fishermen to see the great progress made in other fishing countries, both as regards fish products and engines for capturing fish, is recommended.

ITALY.

Beam trawling.—It appears, from a recent publication by the Italian Government, kindly forwarded by Professor Giglioli,* that attention has lately been directed in Italy to the question of beam trawling. At the meeting of the Commission on October 22, 1888, Professor Giglioli, in the course of a discussion on beam trawling, made a long and elaborate statement on the subject. At the beginning of 1887, fishermen of the Gulf of Naples applied to the Minister of Agriculture for the complete prohibition of the use of the trawl-net. When the authorities were consulted, some demanded prohibition (which was formerly in force), while others recommended that the waters should be closed from April 1st to the end of October, and opened during the other months within 3 kilometres of the shore. The report refers to the question of beam trawling in the territorial waters of other states, and makes special reference to the work of the Scientific Department of the Fishery Board having determined several important points in connection with beam trawling in territorial waters, and points out that it is only by such investigations that the necessary data can be obtained for reaching a true knowledge of the question.

In number 7 of the *Bollettino di Notizie Agrarie*, published under the direction of the Italian Minister of Agriculture, Industry and Commerce, there is a report by Dr Fed. Raffaele on the floating fish ova of the Gulf of Naples and their relation to trawl fishing.† Dr Raffaele, after pointing out that until quite recently it was believed that all fishes deposited their eggs on the bottom, like the herring, and referring to previous observations of Sars and others, shows that in the Gulf of Naples, about forty species, comprising those that are economically important, have buoyant eggs. Some species have free eggs which sink to the bottom, but these are in general deposited not far from shore, and belong to small unimportant littoral species. While the majority of pelagic eggs float on the surface, many may be found at depths down to 100 or more metres, the descent depending on the density of the water, the surface disturbance, &c. Pelagic eggs develop, as a rule, more rapidly than eggs attached to the bottom, and their rate of development depends largely upon temperature, some that hatch in two or three days in the waters of the Gulf of Naples taking eight or ten days in northern seas. It was found possible by Dr Raffaele in most cases to distinguish the ripe floating eggs of different species by their appearance and character. Artificial fertilisation and the comparison of the eggs caught by the tow-net with those obtained from ripe fish were often resorted to. Dr Raffaele

* *Annali di Agricoltura*, 1888. *Atti della commissione consultiva per la pesca.* Roma, 1889.

† '*Le uova galleggianti nel golfo di Napoli e la pesca delle paranze*,' p. 344, March, 1888.

also made use of the species that are kept in the tanks at the Naples Zoological Station, and was thus able to determine the eggs of various species.

The following are the conclusions of the author:—(1) Almost all the important food fishes of the Gulf of Naples have eggs which either (and generally) float at the surface, or are suspended at varying depths; (2) the development of these eggs is very rapid, requiring from two to (rarely) twelve days; (3) eggs are found floating in the Gulf of Naples in all the months of the year, but they are most abundant and represent a greater variety of species in spring and the beginning of summer; (4) the ova of a given species are not spawned all at one time, but at various intervals during a longer or shorter period; (5) the ova are, for the most part, spawned during the night; (6) 'bottom' eggs belong, as a rule, to small species of little value; (7) beam trawling cannot have an injurious effect on most fish eggs. A list is given of the floating eggs found in the gulf, with the months when they were obtained.

In relation to the above report, Dr Raffaele has published a long and elaborate paper on 'The Floating Ova and Larvæ of Teleosteans of the Gulf of Naples,'* which may be considered one of the most important contributions to this department of marine research in recent years. In the introductory portions Dr Raffaele reviews previous inquiries, and discusses general points, such as the influence of temperature, &c., and then deals *seriatim* with the embryos of many teleosteans. Probably its chief interest for a fishery department consists in its description of the ova and larval stages of the flat-fishes and of the clupeidæ. Dr Raffaele states that the ovum of the sole exhibits, as Mr Cunningham has also pointed out, groups of minute fatty globules. These groups are scattered on the surface of the vitellus, especially on the ventral side of the embryo. There is a peripheral zone of the vitellus, which is vesicular in character. Pigment is rather abundant both on the body, and on the vitellus, and is black and an intense or a light yellow. In the larva the pigment becomes darker. In the turbot an abundant yellowish-brown pigment is present in the ovum in large stellate cells over the whole body of the embryo and on the vitellus. In the larva the yellowish pigment is spread over the whole of the anterior part of the body, and there is a large zone under the tail. The black pigment cells are few. The clupeoid ova have a large pervitelline space, one oil globule, and the nutritive vitellus is vesicular. The larvae are slender, the vitellus ellipsoid and the oil drop is situated posteriorly. The paper is illustrated by five large plates.

NORWAY.

A report on the work done in 1888 by Captain G. M. Dannevig, at the well known fish hatching establishment at Flödevig near Arendal, was published a few months ago.† It appears that besides the annual subsidy given by the Norwegian Government to this hatchery, an additional sum to extend it has now been granted, large enough to enable operations to be conducted on a much larger scale than hitherto. The mechanical and natural difficulties which were first encountered when Mr Dannevig began hatching operations were overcome by devising a method of keeping the eggs in motion, and getting rid of the impurities that fouled the hatching apparatus.

* *Mittheilungen aus d. Zool. Station zu Neapel, Band* viii. 1 Heft., pp. 1–84, 1888.

† *Beretning om Flödevigens Udklækningsanstalts Virksomhed, i Femaaret* 1883–1888. Arendal, 1889.

Captain Dannevig has been so successful in his operations for the artificial hatching of sea fish that it is worth while giving an account of the exact method adopted. When the cod are ripe so much milt is introduced into a small tub containing a few pints of sea water (*sp. gr.* 1·024) as to render the contents slightly milky. The spawn of the ripe females is then allowed to run into the tub, the water being occasionally stirred by the hand. The fish examined or used are transferred to another tank, and the process is repeated every two or three days for a couple of months. The next step is to stir the impregnated spawn in fresh sea water to get rid of the excess of milt, after which it is poured into a glass receiver, 18 inches high, half full of clear sea water. In a few minutes the serviceable spawn separates to form a compact layer near the surface, while dead ova and impurities sink to the bottom. With a perforated ladle the living spawn is removed and placed in a smaller glass used as a measure, which, by careful counting and weighing of the ova, has been found to contain 60,000 eggs. From the measure the spawn is poured directly into the hatching apparatus. These are 8 feet long, 2 feet wide and contain each 10 small boxes, able collectively to accommodate 3,000,000 eggs, *i.e.*, 300,000 in each box. The spawn lies in these boxes, through which a steady current flows, for two or three days, when it is removed to allow the apparatus to be cleaned; and after a fresh sorting and separation of the living from the dead as before, the living ova are returned to the apparatus. This process is repeated every two or three days until the spawn is ripe; live spawn is perfectly translucent, dead spawn is light grey in colour and opaque. A few days before the embryo is ready to burst its shell, the apparatus and spawn are cleansed for the last time, and note is made of the quantity of spawn remaining.

The loss may vary between 20 and 70 per cent., and depends chiefly upon the degree of saltness of the water during the hatching, which varies from time to time according to the prevailing wind, and the presence of Baltic currents.

Captain Dannevig then discusses the influence of salinity generally, and the position of the micropyle in fish ova. He shows that the specific gravity of ripe cod spawn being 1,022, that of sea water 1,025 and that of fresh water 1000, if cod spawn is blown or carried to the mouth of an estuary, when the specific gravity of the surface water is reduced by admixture with fresh water, the ova will sink until they reach a layer of specific gravity sufficient to keep them in equipoise, and thus pass under the fresh water altogether.

The lobster fry thrive in salt water, but immediately die on being transferred to fresh water. While the milt of the male salmon is shed on the ova over which the male swims, in the case of the cod the male fish swims underneath the female, the difference in either being due to the presence of the micropyle on the upper or lower surface respectively. In the hatchery the facts which nature teaches are made use of, and water is only pumped from the sea to the large pond or reservoir on those days when the sea is sufficiently salt to float the fish-eggs, and in the intervals when the salinity of the sea is not high enough, the water which has already passed through the apparatus is again made use of by being repumped into the pond. The aeration of the water in the pond is ensured by the indraught of the pumped water carrying with it air from holes bored in the suction pipe.

The difficulty of getting water of a sufficiently high temperature is obviated by heating the pond water by the waste steam, and if necessary steam from the engine is also passed into a tank through which the suction pipe travels.

The average specific gravity of the water in the apparatus was found to be:—

1884	1·0217	Average for 4 years 1·023
1885	1·0252	
1886	1·023	
1887	1·0247	

The maximum specific gravity was 1·027, and the minimum 1·0154, the proportion of favourable to unfavourable days being 3 to 1.

During the four years' existence of the hatchery 101½ millions of fish fry have been hatched.

The Rearing of Cod.—Having successfully hatched the ova Mr Dannevig experimented on the vitality of the fry artificially hatched, to see whether these possessed the necessary vital powers for further development in confinement. The fry when liberated are only 6 days old, 3 to 4 mm. in length, and comparatively helpless. To keep these longer and to develop them further, more nourishment must be given to them than is to be found in the filtered water of the hatching apparatus. The first and principal condition for successful rearing is that the water to which the fry is introduced should be of such specific gravity that the fry may, without difficulty, be able to keep clear of the bottom,—the other chief conditions being that the temperature of the water be not too high, that sufficient nourishment be present, and that frequent renewal of the water take place. Accordingly a large basin was built on the shore into which water from a great depth was pumped by a steam engine. Fry of cod, herring and flounders were introduced into this basin in 1886 to the number of half a million, and the rate of growth of cod, as determined, was as follows:—

Date.	Age.	Size in mm.
April 26	0 days	3
May 3	6 ,,	5
,, 16	19 ,,	7
,, 18	21 ,,	8
,, 21	24 ,,	9
,, 31	1 month 5 ,,	10
June 3	1 ,, 8 ,,	12
,, 6	1 ,, 11 ,,	15
July 12	2 ,, 15 ,,	55
Aug. 12	3 ,, 15 ,,	70
Sept. 12	4 ,, 15 ,,	85
Oct. 12	5 ,, 15 ,,	115

The greatest rate of increase was between June 6th and July, when the young fish began to eat the food thrown into them several times a day.

The fish have steadily increased in size. The numbers were greatly reduced, owing to the death-rate being great in the very severe winter of 1887–8, the ice in the basin being as much as 20 inches thick. At the end of 2½ years their sizes ranged from 9 to 18 inches.

Three distinct varieties of cod are distinguished by Mr Dannevig—(1) *Light Grey Cod* taken in deep water, frequenting a sandy bottom and having white milt and light grey ova; (2) *Red Cod* of the shallow alga region round the coast, with yellowish milt and deep orange ova; (3) *Dark Grey Cod* on grassy bottoms of fjords, with light yellowish grey ova and milt. The larvæ in the first stages are of the same colour as the developing eggs. Mr Dannevig holds that the colouring of the cod is inherited and constant and not due to the colour of its surroundings, and brings forward as proof the colours of the fry reared in the basin. If the colour were due to their surroundings, then all the fry should be the same colour, whereas the colours of the fry reared follow the colours of the parent fish from which the eggs and milt were taken. That greyish cod frequent sandy banks he holds to be due to the instinct of the fish leading it to ground where it will have greater immunity from its enemies. He states that the fjord cod offers to the hatcher the best guarantee for the success of his labours.

Hatching of Flat Fish.—The eggs of the flounder, which are heavier than those of the cod, were hatched, and in three years attained a size of 7 to 8 inches in length. Plaice are nearly exterminated, so specimens cannot be obtained near Arendal for hatching, and it is difficult to get soles.

Hatching of Lobsters.—Mr Dannevig has succeeded in hatching lobster ova detached from the mother, and reckons that it is much cheaper to detach the ova and hatch them in artificial apparatus than to keep the female lobsters in confinement and feed them till the embryos are liberated, and pay for the extra labour involved in tending the adults.

He is of opinion that a rational trial of rearing lobster fry in quantity, which he has demonstrated to be possible on a small scale, ought to be made, though he doubts whether the number reared will be at first proportionate to the expense.

Mr Dannevig is strongly impressed with the absolute necessity of restrictions being imposed to prevent the threatened destruction of lobster fishing, and to combat the gradual decrease of many sea fish, and for recuperating declining fisheries is convinced of the beneficial results obtained by artificial hatching, the utility of which has been so markedly shown by the labours of the U.S. Fish Commission. He instances the destruction of the oyster beds of Norway, which have, unfortunately, a parallel in Scotland, and shows how, within the last twenty years, the value of lobsters landed in Norway has decreased to the extent of £30,000 annually. Only good is likely to result from the projected visit of Mr Dannevig to the hatching ponds for lobsters that are being erected by the Fishery Board for Scotland.

SWEDEN.

Dr Rudolf Lundberg, Fishery Superintendent at the Royal Agricultural Academy, Stockholm, who is already known for his report on the Swedish Fisheries prepared for the Berlin Exhibition, has published a second part of his *Meddelanden rörande Sveriges Fiskerier.* The volume contains a paper on the influence of the debris from the 'lumberwaks' on the river fishing in Sweden. It appears that in many rivers the accumulations of floating rubbish are extremely injurious. A second paper gives a sketch of the progress of Swedish fishery legislation, and a third reports some investigations into the natural conditions of the middle portions of the rocks and islands near Stockholm in 1885–86. A large number of temperature observations are given, and the various species of fish, molluscs, &c. are registered. The rest of the volume is occupied with statistical matter relating to the Swedish fisheries.

DENMARK.*

In Denmark the fisheries are placed under the Home Department, the superintendent and adviser in fishery matters being at present Lieutenant

* We are indebted chiefly to Lieutenant Drechsel and Dr C. G. Joh. Petersen, for publications and information relating to the Danish fisheries.

C. F. Drechsel, of the Royal Danish Navy. Two gun-boats, one in the Cattegat and the other in the North Sea, are set apart for the superintendence and inspection of the fisheries; and since the 1st January this year, when the new law relating to the fisheries came into operation, two sub-inspectors, each with a small steamer under his control, and three assistants in charge of sailing boats, have been appointed to aid in carrying out the provisions of the law. These are chiefly (1) the prohibition of seine or other trawling; (2) the prohibition of selling fish under a certain size; (3) the establishment of close times; (4) the closing of certain waters.

The income derived from the Danish oyster fishery belongs to the State, and falls within the province of the Minister of Finance.

The oyster fisheries are, however, at present closed by law, owing to the threatened exhaustion of the beds from over-fishing in recent years, especially in the Limfjord.

The Danish Fishery Association, the president of which is Count Moltke-Bregentved, was founded by private individuals, but is supported by the State. The association has in every way endeavoured to promote the interests of the fisheries, as by the formation of a fishery museum, the establishment of signalling stations on the west coast of Jutland and the institution of an insurance system for fishing boats. A *Fishery Gazette* is published by the secretary, Mr A. Feddersen.

In recent years the scientific inquiries in connection with the Danish fisheries have been considerably extended and developed. By the direction of the Home Department and the Ministry of Naval Affairs, Dr Petersen, zoologist to the fisheries since 1883, has investigated the invertebrate fauna of the fishing ground in the Cattegat. The preliminary results of Dr Petersen's inquiries have been recently published,* together with an illustrative atlas. The Southern Cattegat has many more Arctic 'Baltic' species than the Northern Cattegat, which is richer in southern forms. His investigations are still going on in reference to the laws that rule the distribution and migrations of the invertebrate organisms and of fishes in the sea. During 1887–8, Dr Petersen was engaged purely on ichthyological work on board the gun-boat 'Hauch,' especially as to the life-history and the season and mode of spawning. During his cruises he has examined the surface fauna by means of the tow-net, and has found 6 new species of Diatoms, which at certain seasons are present in great quantity in the Cattegat.

The determination of the migration of the plaice has been attempted by the affixing of marked labels to liberated specimens, as is done by the 'Garland' in Scotland.

The Danish Government has now 2 steamers engaged on fishery investigations, and £2225 has been devoted to the construction of a biological station (which will be open in October or November), so that more accurate knowledge of Danish food fishes may be obtained.

The Danish fisheries are now regulated by the law of 8th August 1888, which was passed in accordance with the recommendations of a fishery commission appointed to consider regulations for the conservation and development of the fisheries.

The English beam-trawl has not been much employed in Danish waters, and its use was made illegal in 1872. Small seine trawls have been used (those of the Cattegat being called Snurrevaad), and are worked by 2 boats, 1 anchored and the other propelled by oars or sail, in much the same manner apparently as the seine or circle-net is used in the

* *Devidenskabelige Udbytte af Kanonbaaden* '*Hauchs*' *Togter.*, *I. Echinodermata.* Copenhagen, 1889.

Lochfyne fishing. These nets were dragged in the southern waters between the island 'Vale Drivaad.' Though these drag-nets are like the beam-trawl, the waters in which they are used are so shallow that the effect of their use on the fishing is important.

The Commission of 1873, whose work formed the basis of the New Fishery Law, proposed the prohibition of every kind of drag-net in the southern waters of Denmark. This proposal was strongly resisted by some, because it was alleged that excellent results had been obtained by seine fishing. The opinion of most of the fishermen is that this mode of fishing has done great harm. Though fishermen do not agree as to the diminution of the quantity of eels, yet it is a fact that these are much smaller than formerly, and besides the mesh of the net is now much smaller than it was at the beginning of this mode of fishing.

It is likewise believed that it has been detrimental in southern waters by setting the whole mass of eggs and fry in the shallow depths in motion. The great development of the different methods of fishing, by seine net and fixed engine, has caused a diminution in the quality as well as in the quantity of fish, but this deterioration is specially due to the drag-nets.

In the Cattegat it is somewhat different. There the plaice trawl-fishing in the eastern waters has diminished very considerably, the plaice and soles caught at certain seasons being fewer in number than hitherto, and the valuable fish which are caught being very small. Nevertheless, in the autumn, the fishing at times is very productive, probably because of the migration of the fish that seek the shallower seas at this season.

The following statistics show the average catch of plaice (in scores) per day by 20 boats fishing in Aarborg Bay.

1888	1881	1882	1883	1884	1885	1886	1887
61	63	79	76	85	62	52	35

The seine trawl fishing was begun in 1881, and till 1883 it was productive. Since the latter date it has diminished.

Most of the fishermen agree that the lines and nets do not catch so many as the seine does, but they say that the quality of the plaice caught by the first is superior to that of those obtained by the seine, and the quantities are more constant. Consequently they desire restrictions on seine-fishing, but a great part of the Cattegat is outside of the territorial waters, to which the law can only be applied. Custom alone maintains the continuation of seine-trawling in the Cattegat, as the price received for trawled fish is very low, and custom prevents other methods of fishing, till there is a general agreement among fishermen on the question.

Practically, till now seine-trawling has been carried on without any restriction (save in the Limfjord), and it is not yet absolutely forbidden. The law of 5th August 1888 contains only the most necessary restrictions, and prohibits in southern waters the use of trawls during March, April and May, *i.e.*, the time when most of the fish are ripe. In the Cattegat it is prohibited from 1st June till 15th August, when the smaller plaice are found in the shallow water.

The Danish authorities believe that the fisheries have suffered much up to the present time because of the want of proper regulations, and they point in proof to the Limfjord, where restrictions have been in force for 200 years, and where the fishing has been conserved and remains productive. The law contains a number of other regulations on points which are less interesting for the Scottish fisheries, such as the regulations for Danish and Swedish subjects entitled to fish in certain localities, the right of individuals to have certain ground marked off by buoys, mutual regulations as regards drag-nets and fixed engines, the right of proprietors on the coast to fish by means of eel-pots, and the right of fishermen to ground for repairing and drying their gear. Special exemptions by the minister who has charge of the fisheries are provided for.

In the Cattegat, the flounder fishing is chiefly affected by the close time from 1st June to 15th August, and eel, shrimp and pike-fishing by the close time in southern waters.

RUSSIA.

The knowledge in this country of the fisheries of Russia is very meagre. A publication by Wilhelm Därr refers to the first Russian Exhibition of the Russian Union for fishing and fish breeding. The objects of the Exhibition were:—(1) To make clear the present position of the Russian fisheries; (2) to make known to merchants and consumers the various fishery products; (3) to show the usual method of fish breeding and the preparation of the products of the fisheries in the different parts of the empire; (4) to awaken a general interest in skilful methods of fishing and economical pond management. The pamphlet also contains an account of the exhibits interspersed with some information on the fisheries of the different parts of Russia. In the waters of Russia—river, fresh and salt water lakes, and the sea—there are, according to Dr O. A. Grimm's *Fishing and Hunting on Russian Waters*, 288 different species of fish, including species of sturgeons, salmon, mackerel, pike, eel, herrings (Caspian Sea herring, Black Sea herring, Baltic or genuine herring), sardines, anchovies, pilchards, &c. In 1887, 239,487,830 Caspian herrings were landed, and in 1888, 153,289,800. From Astrachan there is exported annually upwards of 17 million Russian lbs. of fish and fish products. From the Caspian, Ural, and Lower Volga the yearly product is 28 million Russian lbs. of fish, worth 35 million roubles. The Azov Sea produces annually 6 million Russian lbs.; the Black Sea 100,000 roubles worth; the White Sea 1,400,000 Russian lbs.; the Baltic 1 million roubles worth. The Inland Seas yield 7 million lbs. The yearly produce of the Russian European fishery can be reckoned at not less than 40 million Russian lbs. A congress, extending over six days, was held to discuss fishery questions, at which delegates from the Volga, Ural, Don, Azov Sea, Oral Sea, and Black Sea took part.

In view of the frequent occurrence in Russia of cases of fish poisoning from the using of raw fish for food, and the fatal results of those cases, especially frequent among the population living on the banks of the fishing rivers, a sum of 5000 roubles is offered as a prize for an investigation of this subject. The following points must be investigated:—(1) To determine, by means of accurate experiment, the physical and chemical nature of fish poison; (2) to investigate, experimentally, on living subjects, the effects of fish poison on the heart, the circulation the digestive organs, and the nervous system; (3) to determine the rate of the absorption of the poison in the digestive system; (4) to discover and describe the signs by which it is possible to distinguish bad from wholesome fish; (5) to determine the means of preserving fish from the development in them of poisonous matter; (6) to determine antidotes and the means of giving medical assistance to those suffering from the effects of fish poison. The period for the solving of the problems is fixed at five years.

SECTION C.

REPORT ON OBSERVATIONS RELATING TO THE PHYSICS AND CHEMISTRY OF THE NORTH SEA DURING 1888 AND 1889, AND INCLUDING A REVIEW OF THE ANALYTICAL WORK HITHERTO UNDERTAKEN FOR THE FISHERY BOARD FOR SCOTLAND. By John Gibson, Ph.D.

Introductory.

Having undertaken in July 1888, at the request of the Fishery Board for Scotland, the general supervision of the physical work which they desired to have carried on in connection with the scientific inquiries then in progress relating to the Fisheries, it became my duty to draw up a scheme of work for the remainder of the current year. I accordingly laid before the Committee of Scientific Investigations a scheme of work, a principal feature of which was the proposal to send an expedition during the month of September to investigate some of the more important physical and chemical characters of the waters of the North Sea generally. In making this proposal I was guided by the following considerations :—

The physical investigations undertaken hitherto in connection with the Fishery Board had their beginning in the short expedition to the Moray Firth in the summer of 1883. The results of the physical observations made during this expedition were given in a paper published in the Annual Report of the Board for 1885, in which also the lines were laid down of a method for the accurate examination of sea water, intended to lead to the detection of any local differences in the waters along the coasts, and more especially in the Firths and Estuaries. These preliminary investigations were followed up in the summer of 1886 by a more extended series of observations in the same locality, namely, the Moray and adjoining Firths, the results of which were embodied in a paper by Dr H. R. Mill and myself conjointly, and published in the Report of the Board for 1887. Dr Mill also contributed a paper to the Report for 1886, giving an account of an elaborate series of physical observations carried on by him in the region of the Firths of Forth and Tay in connection with the Scottish Marine Station. As these investigations were practically confined to the waters of the Firths and Estuaries of the East Coast of Scotland, that is to say, of the north-western boundary of the North Sea, it appeared very desirable to extend these investigations over a wider area.

Such extension was indeed necessary in order to arrive at a better understanding of the true bearings of the data which had accumulated, and more especially to account for the very remarkable, puzzling, and apparently contradictory results arrived at by the examination in the Chemical Laboratory of the University of Edinburgh, of the large number of samples of water collected in the Moray and adjoining Firths in 1883 and 1886 respectively.

It is a somewhat surprising fact that so little should have been done by this country towards the investigation of the region of the North Sea, from which so large a proportion of our fish supply is obtained. As a matter of fact, the greater part of our scientific knowledge of this region is derived from foreign sources, and especially from the labours of the German Ministerial Commission zur wissenshaftlichen Untersuchung der deutschen Meere, in Kiel, which was appointed in 1870. Under the direction of this Commission the 'Pommerania' expedition was sent in the summer of 1872 to investigate the physical, chemical, and biological characters of the North Sea. The account of this expedition, published in 1875, contains a mass of the most valuable information, and remains to this day the standard source of information on the subject.

A most important feature in the system of investigation carried on by the Commission has been the establishment of fixed observing stations along the German coasts in the North Sea and in the Baltic. The number of stations in 1873 was 14, 10 of which were at points on the Baltic, and 4 on the North Sea coasts. Since then the number has been increased to 17. The daily observations made and recorded are published quarterly, and from 1873 onwards the Commission have published an uninterrupted series of these observations.

The value of such observations obviously increases in proportion to the area over which they extend, and the Kiel Commission have repeatedly expressed the hope that their system, or a similar system of regular observations at fixed stations, would be adopted by this and other countries along the North Sea littoral.

So far this appeal has not met with the response which the importance of the subject deserves, except in Denmark, where, since 1880, observations have been made and recorded at 21 stations, only 2 of which are, however, on the North Sea.

A great advantage hoped to be gained from the proposed expedition was, therefore, the establishment of direct communications with the Members of the German Commission at Kiel, and with the Directors of the Danish Meteorological Institute at Copenhagen, under whose direction the Danish observations are carried on. It was also proposed to pay a visit to Bergen, the chief centre of the Norwegian fisheries.

The Fishery Board having given their consent to the expedition, permission was obtained from the Admiralty for the employment of H.M.S. 'Jackal' during September and the early part of October for the purposes of the expedition.

The General Character of the North Sea.

The following brief sketch of the outstanding features of the North Sea is based on Dr Meyer's Report on the Physical Observations made during the 'Pommerania' Expedition in the summer of 1872, and though necessarily incomplete, will, I hope, serve the purpose of bringing the bearing of the series of observations detailed in the following tables into clearer light. Dr Meyer's report has unfortunately not been published in English as yet.

In the chart of the North Sea, Plate X., accompanying this report the varying depth is indicated by different degrees of shading, the darkest shading corresponding to the greatest depth. Absence of shading indicates that the depth does not exceed 20 fathoms.

A reference to this chart will show that broadly speaking, the North Sea is naturally divided into two areas by the Dogger Bank. A line running along the northern edge of the Dogger Bank and extended to a point in the Skagerack midway between the Skaw and Norwegian Coast may, with a fair approach to accuracy, be regarded as cutting off the two areas from each other.

The northern and greater area is characterised by a gradual shelving of the bottom from south to north, the depth of water increasing from less than 50 fathoms immediately to the north of the Dogger Bank to between 60 fathoms and 90 fathoms at about 61° north latitude.

A remarkable and important feature of the northern area is the deep and narrow furrow or channel which runs along the coast of Norway, bending ultimately in a north-easterly direction into the Skagerack, where it abruptly terminates.

The depth of the southern and smaller division of the North Sea is comparatively slight. A band of shallow water, less than 20 fathoms deep, and varying in breadth from about 30–60 miles, extends the whole way along the coast from Calais to the Skaw. From the Straits of Dover a channel of somewhat deeper water runs in a northerly direction for about 130 miles between the shallow waters off the English coast and those of the Belgian and Dutch coasts. To the north of this the water is shallow from coast to coast, deepening gradually however to the north-east and north-west on either side of the Dogger Bank, to the south of which a band of deeper water, broken up, however, by a series of sandbanks and shallows, forms a connecting link between the deeper waters of the northern and southern areas.

The great influence which the Dogger Bank has on the distribution of temperature in the North Sea is very clearly shown by Dr Meyer's analysis of the temperatures observed during the 'Pommerania' Expedition.

In the northern area a layer of cold water, of variable thickness was generally found during the 'Pommerania' Expedition underlying a layer of distinctly warmer water, from which it was separated by a comparatively thin intermediate layer. The temperature of the colder layer was frequently found lower than 46°·5 F. (8° C.), while that of the warmer and upper layer ranged from about 54° to 57° F. (12° to 14° C.).

The passage southwards of the cold bottom water is arrested by the Dogger Bank.

The temperature of the southern and shallow area was found to be markedly higher than that of the northern area at corresponding depths. The vertical distribution of temperature in the southern area was found to be very uniform, there being no great and abrupt differences of temperature between the upper and lower layers of water as were generally met with in the northern area. Thus in the western portion of the southern area the mean range of temperature observed between surface and bottom was from 60°·0 to 59°·5 F. (16°·7 to 15°·3 C.), and even this difference may be attributed to the inflow of colder water from the north, for in the region lying more to the east, and where the inflow of colder water from the north is more completely checked by the barrier of the Dogger Bank, the range in temperature between surface and bottom was only from 64°·6 to 63°·3 F. (18°·1 to 17°·4 C.). The relatively higher temperatures of the southern area as compared with those found at similar depths in the northern area were attributed to an inflow of warm surface Atlantic water through the English Channel, and the uniformity of temperature from surface to bottom to the more complete mixing of the shallow waters by wind and currents. The comparatively low temperature of the northern area on the other hand was attributed to the presence of a mass of cold water of northern or Arctic origin in which the warm Atlantic water flowing in to the north of Scotland is soon lost.

To these two waters there must be added a third, viz., the outflow from the Baltic, the presence of which, although also indicated by the thermometer, was still more clearly recognised by the hydrometer. The specific gravity of the open waters of the North Sea is, generally speaking, not much lower than that of ocean water, and as a general rule the influence of fresh water from the land only becomes marked near the mouths of rivers and in narrow estuaries.

The most striking instance of the influence of land water in modifying the specific gravity of open sea water was found in the surface water along the Norwegian coasts, which had a uniformly lower specific gravity than that found off the Scottish and English coasts. As Dr Meyer points out, this marked lowering of the specific gravity of the surface waters along the Norwegian coasts could not be attributed to the comparatively small supply of fresh land water contributed by Norway itself, but was evidently chiefly due to the outflow from the Baltic.

In this connection the observations made during the 'Pommerania' Expedition as to the direction of currents at different depths are specially interesting and important. As has been stated above, the southern area of the North Sea was filled for the most part from surface to bottom with warm Atlantic water, this warmer water being cut off from the colder northern area by the Dogger Bank.

The outflow from the southern area of this warmer water was traced as a current which sets in along the coasts of Schleswig-Holstein and Jutland, in an easterly direction, that is to say, into the Skagerack, where it bent round and followed the line of the Norwegian coast in a northerly direction. The outflow of fresh or brackish water from the Baltic follows the same course out of the Skagerack, and was distinctly traced along the Norwegian coast as a shallow surface current only about 4 fathoms deep superposed on the heavier water flowing in the same direction and coming from the southern area of the North Sea, and originally therefore from the Atlantic. The temperature of the shallow surface current was found to be markedly higher than that of the salter water underneath. It must be remembered that all the 'Pommerania' observations were made during summer. During winter the temperature of the outflowing waters from the Baltic is of course much lower.

In one instance in which a perfectly satisfactory observation was made of the direction of the flow of the waters in the Norwegian furrow or channel, distinct indication was obtained of a third current flowing along the bottom in an opposite direction to the two upper currents, that is to say, along the line of the Norwegian coast towards the Skagerack. The presence of this third and lower current was also rendered probable by the low temperature of the lower layer of water, separated by a thin intermediate layer from the warmer waters above.

The Cruise of H.M.S. 'Jackal' in the North Sea during September and the early part of October 1888.

In consideration of the large area over which it was proposed to extend observations, and of the necessity for completing these observations within a comparatively short period, it was decided to limit the work to be undertaken during the expedition almost entirely to physical and chemical investigations. To assist me in carrying out this part of the work, I was accompanied by Dr C. Hunter Stewart and Mr F. M. Gibson, B.Sc. I have much pleasure in stating that to the able and constant assistance of these gentlemen, the successful carrying out of a very great part of the scientific work of the expedition is due. I have also much pleasure in acknowledging the hearty and kindly manner in which the officers and crew of the 'Jackal' did everything in their power to further the work of the expedition. I am especially indebted to Lieutenant Farquhar, Commander, for the valuable advice and support which he gave throughout the cruise, and to Lieutenant Dundas for the determination of the exact times and places at which the various observations were made. Thomas Mortimore, chief petty officer, gave constant assistance throughout the cruise, during which much extra work was undertaken by him. His previous experience in similar observational work enabled him to render very valuable service.

The course taken by the 'Jackal' during the cruise, and the *stations* or points at which observations were made, are given in the annexed Chart of the North Sea.

The nature and order of the work done at each *station* or point at which observations were made was in general pretty much as follows:—

1. The determination of the depth by means of a sounding line marked in fathoms. This was frequently supplemented by Sir William Thomson's sounding apparatus. The depths in fathoms as determined by this apparatus are given in Table I. column XII., alongside of the depths determined by means of the sounding line. Every care was taken to ascertain the depth as accurately as possible, but the accuracy in each case depends to a great extent on the absence of currents. At Station XXVIII. special difficulties were experienced owing to this cause.

2. The determination of the temperature of the sea water at the surface and bottom, and at every 10 fathoms measured from the surface. In some cases the temperatures at every 5 fathoms were observed. The thermometers used in these determinations were, as on former occasions, Negretti and Zambra's reversing thermometers, fitted in Scottish Marine Station frames.

The thermometers were carefully compared on September 1st and again on October 19th with a Kew standard thermometer, kindly lent by Professor Tait. Between 0° C and 20° C the agreement was very satisfactory.

I have not applied any corrections to the observed temperatures, as I much doubt the propriety of making corrections of less than a tenth of a degree centigrade on observations made with these instruments. Throughout the cruise these instruments worked admirably, and no loss or breakage occurred.

3. The collection of samples of water from the surface and bottom, meaning by surface about 2 feet below the true surface, and by bottom about 4 feet above the true bottom.

4. The determination, when the conditions were favourable, of the depth at which a white enamelled circular disk just ceased to be visible.

5. The recording of the data given in Table I. columns I. to X. inclusive.

During the intervals between one station and the other, and while lying at the different ports, the following work was undertaken:—

1. The determination of the alkalinity of the samples collected.

2. The boiling out and collecting in hermetically-sealed glass tubes of the gases from these samples.

3. The determination, by means of a 'Challenger' type hydrometer (No. 19), of the specific gravity of the samples.

4. The careful preservation, in the manner described in a previous report, of samples of the waters collected.

Abridged Diary of the Cruise.

Saturday, September 1.—The work of the expedition began by the conveyance on board and setting up of the various instruments and laboratory fittings. It will be readily understood that apparatus employed on such expeditions requires very careful adaptation to the peculiar conditions which obtain on board ship.

Monday, September 3.—A trial trip was made in the Forth to a point a little beyond Inchkeith, where the instruments were tested, and the methods of investigation rehearsed. Professor W. Dittmar, at my request kindly took part in this trial trip, in order that we might have the benefit of his great experience in all matters connected with the chemical and physical investigation of sea water. The fitting up of part of the deck-house as a little laboratory was this day completed. The various apparatus were found to work very well on board ship, one or two slight modifications being however found necessary.

Tuesday, September 4.—A second trial trip was made in order to test more thoroughly some modifications in the mode of working which resulted from the previous day's experience.

The trials made on this day were very satisfactory, so that although it was necessary for me to be in Edinburgh on the 5th and 6th September, I arranged with Lieutenant Farquhar that the 'Jackal' should proceed on the morning of the 5th to Broughty Ferry, *en route* for Aberdeen. During my absence the conduct of the physical observations was entrusted to Mr F. M. Gibson, who had had considerable previous experience in similar investigations. I left with him instructions for a series of observations to be made in the Firth of Tay, and at two points along the coast between Broughty Ferry and Aberdeen. Mr William Boyd, of the Committee of Scientific Investigations, accompanied the expedition from Granton to Aberdeen, at which place I rejoined the expedition on the 8th September.

Monday, September 10.—In the afternoon the 'Jackal' left Aberdeen and proceeded to Peterhead, off which place a very short stay was made, during which I was able to confer with Mr Boyd on some points relating to the observations to be carried on.

Tuesday, September 11.—About 8 o'clock in the morning, some observations were made between the Sutors near Cromarty and samples of water collected (Stations XIII. and XIV.). No further stay was made before reaching Kirkwall, Station XV., where a series of observations were made at various states of the tide from the evening of September 11th to the morning of September 13th.

Thursday, September 13.—Observations were made at Stations XVI., XVII., and XVIII. in Stronsa Firth. In the afternoon the 'Jackal' anchored in Viera Sound, opposite Trumland, Brousay, Station XIX., where another series of observations and analytical operations were carried on.

Saturday, September 15.—We proceeded to Lerwick, stopping at Station XX. in Eda Sound. The 'Jackal,' after experiencing a somewhat rough passage, passed Sumburgh Head at 2.10 P.M., and came to about 4 P.M. the same afternoon in Lerwick Harbour, where she remained over the two next days. Here again serial temperature observations were made at regular intervals (Station XXI.), and a number of analytical operations gone through.

Tuesday, September 18.—Observations were made at Station XXII., off Noss Head, and Station XXIII., off the Out Skerrie Lighthouse on the way to Balta Sound, Station XXIV., where the 'Jackal' remained at anchor over night. Here also serial temperature observations, &c., were made.

Wednesday, September 19.—At about noon the 'Jackal' weighed anchor and proceeded in a direct line eastwards across the North Sea Favoured by splendid weather, a very successful series of observations were made at Stations XXV., XXVI., XXVII., and XXVIII.

Thursday, September 20.—From Station XXVIII., situated about 20 miles off the coast of Norway, the course taken was up Fieosen, past the entrance of Hielte Fiord, through Herlo Fiord, and By Fiord to Bergen. Observations were made off the entrance to Hielte Fiorde and in By Fiord (Station XXIX. and Station XXX.) At about 4 P.M. the 'Jackal' anchored off Bergen where she remained three days.

Monday, September 24.—Mr Buch and Dr Bronchurst accompanied the expedition on a visit to the oyster nursery at Tysnösoen (Station XXXI.). From Tysnösoen the 'Jackal' proceeded through Hardanger Fiord, and through Hangesund to Höre Varde anchorage, in Karm Sund, where Mr Buch and Dr Bronchurst left.

Tuesday, September 25.—In the early morning, the 'Jackal' left Karm Sund, and proceeded along the coast on her way to Copenhagen, observations being made off Ekero and the Naze (Stations XXXIII. and XXXIV.).

Wednesday, September 26.—The Skagerack having been crossed during the night, observations were made in the Cattegat between the Little and Great Middle Ground and in the Sound off Trekröner, where we anchored for the night, not having permission to enter the harbour at Copenhagen. Next morning we were allowed to proceed, anchoring ultimately just outside the inner harbour.

Monday, October 1.—In the morning the 'Jackal' proceeded through the Sound towards Kiel. Observations were made in the Sound near Drogden Lightship, one of the Danish observing stations. The lightship was visited by Mr F. M. Gibson, and the instruments and records of observations inspected. During these two days I was not on board, having remained behind in Copenhagen in order to prosecute my inquiries, which were not completed, leaving, however, on Monday night, *via* Korsör for Kiel, where I arrived early on the 2nd of October. I was therefore able, through the British Consul, to have the necessary arrangements made for the berthing of the 'Jackal.' The 'Jackal' arrived at Kiel about 5.30 P.M. the same afternoon. Mr F. M. Gibson left on October 5th, his place being taken by Mr Andrew King.

Saturday, October 6.—The 'Jackal' left Kiel for Granton, where she arrived on the afternoon of the 9th. A successful series of observations were made at Stations XLII., XLIII., and XLIV. during the passage across the North Sea, from the Skaw to May Island.

TABLE I.

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Sea.	VI. Wind.	VII. Weather.	VIII. Tide.	IX. Barometer.	X. Air Temperature.	XI. Transparency of Water.	XII Depth in Fathoms. T.S.A.	XII Depth in Fathoms. S-L.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15 \cdot 56}$	XIX. $_{17 \cdot 5}S_{17 \cdot 5}$	XX. Salinity.
1888 Sept. 4	1.55 p.m.	I.	Inchkeith Lighthouse, W., $4\frac{3}{4}$ miles.	Smooth	W., 4	B.C.	ebb.	29·74	58·9	4	$19\frac{1}{2}$	...	$3\frac{1}{2}$ $8\frac{1}{2}$ $13\frac{1}{2}$ $18\frac{1}{2}$	53·8 51·9 50·9 50·7	12·10 11·05 10·50 10·40	5 2 7 1				
,,	2.16 p.m.	II.	Inchkeith Lighthouse, W., $5\frac{1}{4}$ miles.	,,	W., 4	B.C.	ebb.	29·74	58·9	4	...	15	0 14	53·9 50·8	12·15 10·45	2 5				
,,	3.33 p.m.	III.	Inchkeith Lighthouse, W. $\frac{3}{4}$ N., $\frac{8}{10}$ mile.	,	W., 5	B.C.	$3\frac{3}{4}$ h. eb.	29·76	59·7	$1\frac{3}{4}$	...	$7\frac{1}{4}$	0 6	52·9 52·4	11·60 11·35	5 2				
Sept. 5	11.55 a.m.	IV.	May Island Lighthouse, N. 80° E., $\frac{3}{4}$ mile.	Slight	W., 5	B.C.	$4\frac{1}{4}$ h. fl.	29·79	58	7	...	20	0 8 13 18	53·0 52·7 50·0 50·0	11·65 11·50 10·00 10·00	5 2 7 1				
,,	5.12 p.m.	V.	At anchor off Broughty Ferry.	Smooth	W.	B.C.	3 h. eb.	29·84	58·0	...	...	$9\frac{1}{2}$	0	55·2	12·90					
,,	9.17 p.m.	,,	,,	,,	N.W., 4	B.C.M.	1 h. fl.	29·88	55·3	..	...	$9\frac{1}{2}$	0 $8\frac{1}{2}$	56·0 55·3	13·35 12·95	2 1				
Sept. 6	11 a.m.	VI.	Taymouth Low Lighthouse, N. 64° E., $\frac{7}{10}$ mile.	,,	S.W. by S., 6	B.C., Cu.-Ni.	$2\frac{3}{4}$ h. fl.	29·70	53·0	...	...	$6\frac{1}{2}$	0 6	53·3 53·3	11·85 11·85	1 2				
,,	11.43 a.m.	VII.	No. 2 Buoy Taymouth, N. 52° E., $\frac{3}{10}$ mile.	Slight	S.W. by S., 5	B.C.Q.	$3\frac{1}{2}$ h. fl.	29·67	54·8	...	...	$7\frac{1}{2}$	0 7	53·2 52·1	11·75 11·15	1 2				

TABLE I.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Sea.	VI. Wind.	VII. Weather.	VIII. Tide.	IX. Barometer.	X. Air Temperature.	XI. Transparency of Water.	XII. Depth in Fathoms. T.S.A.	XII. Depth in Fathoms. S-L.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15 \cdot 56}$	XIX. $_{17 \cdot 5}S_{17 \cdot 5}$	XX. Salinity.
1888 Sept. 6	1.4 p.m.	VIII.	Bell Rock Lighthouse, N. 60° W., $\frac{3}{10}$ mile.	Slight	S.W. by S., 5	O.C.	5 h. fl.	29·65	54·5	7½	...	21	0 10 20	52·7 52·4 52·0	11·50 11·35 11·10	5 2 1				
,,	2.2 p.m.	IX.	Bell Rock Lighthouse, S. 65° E., 5 miles.		W.S.W., 6	B.C.	H.W.	...	...	5	...	18	0 5 15	52·6 52·4 52·2	11·45 11·35 11·20	7 1 2				
,,	2.43 p.m.	X.	No. 2 Buoy Taymouth, N. 52° E., $\frac{3}{10}$ mile.	Smooth	S.W. by S., 5	B.C.Q.	½ h. eb.	29·65	55·2	...	...	8½	0 2 8	52·3 52·2 52·0	11·30 11·20 11·10	5 7 1				
Sept. 7	9.12 a.m.	XI.	Scurdie Ness Lighthouse, W.S.W., $\frac{4}{10}$ mile.	,,	N. by W., 5–6	B.C.Q.P.	L.W.	30·00	56·5	3	...	6	0 6	52·8 52·7	11·55 11·50	5 1				
,,	10.45 a.m.	XII.	Bervie Bay.	,,	N., 4	B.C.Q.P.	2 h. fl.	30·03	55	2	...	7	0 1 7	52·5 52·5 52·3	11·40 11·40 11·55	2 1 5				
Sept. 11	8.13 a.m.	XIII.	Cromarty Lighthouse, N. 62° W., 1¾ mile.	,,	S.W., 2	O.C.P.	3½ h. eb.	30·11	53·6	3	23	...	0 6 16 22	52·8 52·7 52·2 52·2	11·55 11·50 11·20 11·20	7 5 2 1				
,,	8.40 a.m.	XIV.	Cromarty Lighthouse, N. 76° W., 1¼ miles.	,,	Var., 1	O.C.D.	4 h. eb.	30·12	54·0	...	25	...	0 9 16 24	52·9 52·9 52·6 52·6	11·60 11·60 11·45 11·45	5 7 2 1				

TABLE I.—*continued.*

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.		XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.
Date.	Hour.	Station.	Position.	Sea.	Wind.	Weather.	Tide.	Barometer	Air Temperature.	Transparency of Water.	Depth in Fathoms. T.S.A.	S-L.	Depth of Obser., Fms.	Temp. of Sea, Fah.	Temp. of Sea, Cent.	No. of Ther.	$_4S_T$.	$_4S_{15\cdot56}$	$_{17\cdot5}S_{17\cdot5}$	Salinity.
1888 Sept. 12	5.45 p.m.	XV.	Kirkwall Bay. Crow Ness, N. 31° W. Pier Lighthouse, S. 28° W.	Smooth	W. by N., 3–4	B.C.	3 h. eb.	30·29	56·3	Disc visible at btm.	...	4¾	0	52·8	11·55	1				
													2¾	52·9	11·60	5				
													3¾	52·9	11·60	7				
													4¾	52·4	11·35	2				
													4	52·8	11·55	5				
													4¾	52·8	11·55	7				
													4	52·5	11·40	2				
													4	52·6	11·45	5				
,,	6.15 p.m.	,,	Kirkwall Bay. Crow Ness, N. 31° W. Pier Light, S. 28° W.	,,	W., 4	B.C.	3¼ h. eb.	30·26	57	,,	...	4¾	0	52·8	11·55	1				
													2¾	52·8	11·55	7				
													3¾	52·7	11·50	5				
													4¾	52·7	11·50	2				
Sept. 13	12 15 a.m.	,,	At anchor off Kirkwall.	,,	W. by S., 3–4	B.C.	3 h. fl.	30·30	51·1	...	...	5	0	52·4	11·35	1				
													3	52·3	11·30	2				
													4	52·7	11·50	7				
													4	52·3	11·30					
													5	52·5	11·40	5				
													4	52·3	11·30	1				
													4	52·7	11·50	7				
,,	6.15 a.m.	,,	Kirkwall Harbour, at anchor.	,,	W. by S., 3	B.C.	2¾ h. eb.	30·34	54·6	...	...	5	0	52·3	11·30	5				
													3	52·2	11·20	2				
													4	52·2	11·20	1				
													5	52·4	11·35	7				

TABLE I.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Sea.	VI. Wind.	VII. Weather.	VIII. Tide.	IX. Barometer.	X. Air Temperature.	XI. Transparency of Water.	XII. Depth in Fathoms. T.S.A.	XII. Depth in Fathoms. S–L.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15 \cdot 56}$	XIX. $_{17 \cdot 5}S_{17 \cdot 5}$	XX. Salinity.
1888 Sept. 13	11.25 a.m.	XVI.	Stronsy Firth. Auskerrie Lighthouse, N. 85° E., 2¾ miles.	Smooth	W.S.W., 3	B.C.	2 h. fl.	30·42	55·0	12	23¾	2	0 3 5 9 10 15 20 23½	51·8 51·7 51·6 51·4 51·4 51·3 51·3 51·1	11·00 10·95 10·90 10·75 10·75 10·70 10·70 10·60	1 5 7 2 5 7 1 2				
,,	1.10 p.m.	XVII.	Stronsy Firth. Orkness, N. 62° W., 2¾ miles.	,,	W.S.W., 2	B.O.C.	3¾ h. fl.	30·44	58·0	...	...	18¾	0 3¼ 8¼ 13¼ 18¼	51·9 52·0 51·8 51·8 51·9	11·05 11·10 11·00 11·00 11·05	5 5 7 2 1	1026·83	1025·91	1026·74	3·487
,,	4.3 p.m.	XVIII.	Head of Stronsy Firth. Warness, N. 26° W., ¾ mile.	,,	S.	O.C.	h. eb.	30·40	56·0	9¾	...	15½	0 0 5 10 15	52·0 52·0 51·9 52·0 51·9	11·10 11·10 11·05 11·10 11·05	2 1 2 7 5	1026·94	1026·03	1026·86	3·504
,,	Midnight	XIX.	At anchor in Viera Sound, Orkneys. Manse, N. 36° E. Beinyan, N. 55° W.	,,	Calm, 0	B.C.	3 h. eb.	30·36	51·9	...	...	6½	0 6½	52·1 52·2	11·15 11·20	2 1				

TABLE I.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Sea.	VI. Wind.	VII. Weather.	VIII. Tide.	IX. Barometer.	X. Air Temperture.	XI. Transparency of Water.	XII. Depth in Fathoms. T.S.A.	XII. Depth in Fathoms. S-L.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$	XVIII. $_4S_{15·56}$	XIX. $_{17·5}S_{17·5}$	XX. Salinity.
1888 Sept. 14	6.0 a.m.	XIX.	At anchor in Viera Sound, Orkneys.	Smooth	W. by S., 2	B.C.	3 h. fl.	30·31	51·0	...	...	6½	0 6½	52·2 52·3	11·20 11·30	1 2				
,,	Noon	,,	Manse, N. 36° E. Beinyan, N. 55. W.	,,	E., 2	B.C.	2¾ h. eb.	30·27	57·7	...	...	7	0 7	52·9 52·3	11·60 11·30	1 2				
,,	6.0 p.m.	,,	,,	Surface ruffled	S.S.W., 3-4	B.C.	2¾ h. fl.	30·21	55·7	...	...	7	0 7	52·8 52·8	11·55 11·55	2 1				
Sept. 15	12.5 a.m.	,,	,,	Smooth	S.S.W.,	B.C.	2 h. eb.	30·09	52·0	...	...	6	0 6	52·3 52·3	11·30 11·30	2 1	1026·87	1026·00	1026·83	3·500
,,	6.0 a.m.	,,	,,	,,	S.S.W., 2	B.C.	2 h. fl.	29·99	53·4	...	...	6¾	0 6¾	52·3 52·3	11·30 11·30	2 2				
,,	7.30 a.m.	XX.	Middle of Eda Sound. Spur Ness, S.E., 1¼ mile.	Slight	S.S.W., 4	B.M.	1½ h. eb.	30·00	53·0	...	...	17½	0 10 17	52·1 51·9 51·9	11·15 11·05 11·05	7 5 2	1026·86 1026·83	1025·95 1025·91	1026·73 1026·74	3·493 3·488
,,	6.45 p.m.	XXI.	At anchor off Lerwick.	Smooth	S., 3	O.C.R.Q.	5½ h. fl.	29·95	52·0	...	...	...	8 8	51·2 51·0	10·65 10·55	7 2				
,,	Midnight	,,	,,	,,	Calm, 0	Fog, misty, rain.	5 h. eb.	29·90	53·0	...	...	8	0 7	51·4 51·2	11·35 10·65	2 7				
Sept. 16	6·0 a.m.	,,	,,	,,	N.W., 2	B.C.	4½ h. fl.	30·01	48·5	...	...	10½	0 9½	51·1 50·9	10·60 10·50	7 2				

TABLE I.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Sea.	VI. Wind.	VII. Weather.	VIII. Tide.	IX. Barometer.	X. Air Temperature.	XI. Transparency of Water.	XII. Depth in Fathoms. T.S.A.	XII. Depth in Fathoms. S–L.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. ${}_4S_T$.	XVIII. ${}_4S_{15\cdot56}$	XIX. ${}_{17\cdot5}S_{17\cdot5}$	XX. Salinity.
1888 Sept. 16	2.4 p.m.	XXI.	At anchor off Lerwick.	Smooth	S.W., 3	B.C.	l.-w.	30·12	53·2	...	...	9½	0 9½	51·1 50·5	10·60 10·30	7 2	1027·06 1027·12	1026·07 1026·07	1026·90 1026·90	3·509 3·509
,,	8.22 p.m.	,,	,,	,,	S.W., 4	B.C.	h.-w.	30·11	51·8	...	...	10	0 10	51·0 51·1	10·55 10·60	2 7				
Sept. 17	2.22 a.m.	,,	,,	,,	S. by N., 3	B.C.	l.-w.	30·10	51·0	...	...	8	0 8	51·0 51·0	10·55 10·55	5 1				
,,	8.48 a.m.	,,	,,	,,	S.W., 4–6	B.C.	h.-w.	30·08	55·7	...	...	10½	0 10½	50·9 50·9	10·50 10·50	1 5				
,,	2.48 p.m.	,,	,,	,,	S.W., 3–4	B.C.	l.- w.	30·11	56·4	...	...	8	0 8	51·1 50·9	10·60 10·50	5 1				
,,	9.13 p.m.	,,	,,	,,	W., 3	O.C.	h.-w.	30·14	52·3	...	...	10½	0 10½	51·8 51·0	11·00 10·55	1 5	1026·92 1027·11	1026·00 1026·11	1026·83 1026·94	3·500 3·514
Sept. 18	3.13 a.m.	,,	,,	,,	Calm, 0	B.C.	l.-w	30·19	50·0	...	...	8½	0 8½	50·9 50·9	10·50 10·50	5 1				
,,	8.50 a.m.	XXII.	Noss Head, S. 55° W., 6¼ miles.	,	S.W., 1	B.C.	5½ h. fl.	30·25	53·0	...	60½	61	0 10 20 30 40 50 60	50·6 51·9 50·3 50·1 49·7 49·7 49·0	10·35 11·05 10·15 10·05 9·85 9·85 9·45	2 5 1 7 7 2 5 1	1027·08	1026·04	1026·87	3·505

TABLE I.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Sea.	VI. Wind.	VII. Weather.	VIII. Tide.	IX. Barometer.	X. Air Temperature.	XI. Transparency of Water.	XII. Depth in Fathoms. T.S.A.	XII. Depth in Fathoms. S-L.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$	XIX. $_{17\cdot5}S_{17\cdot5}$	XX. Salinity
1888 Sept. 18	12.25 p.m.	XXIII.	Round Skerry Lighthouse, S. 28° W.	Smooth	S.W. 2,	B.C.	3¼ h. eb.	30·23	53·0	...	60½	60	0	51·0	10·55	2	1027·17	1026·17	1027·00	3·523
													10	51·0	10·55	5				
													20	50·9	10·50	1				
													30	49·8	9·90	1				
													40	49·8	9·90	5				
													50	49·4	9·65	2				
													60	49·5	9·70	7	1027·35	1026·20	1027·03	3·527
,,	4.20 p.m.	XXIV.	At anchor in Balta Sound, Shetland.	,,	W.S.W., 2	B.C.	1 h. fl.	30·27	56·6	...	...	5	0	51·3	10·70	1				
													5	50·9	10·50	5				
,,	9.12 p.m.	,,	,,	,,	W.S.W., 1	O.C.	h.-w.	30·26	51·3	...	...	6	0	51·2	10·65	5				
													6	50·9	10·50	1				
Sept. 19	3.15 a.m.	,,	,,	,,	S.W., 2–3	O.C.	l.-w.	30·26	51·9	...	...	5	0	51·2	10·65	5				
													5	51·0	10·55	1				
,,	9.31 a.m.	,,	,,	,	S.W., 3	O.C.	h.-w.	30·29	54·4	...	...	5½	0	51·1	10·60	1				
													5½	51·0	10·60	5				
,,	11.0 a.m.	,,	,	,,	...	...	...	...	...	...	...	...	0	...	...	...	...	1026·13	1026·96	3·517

TABLE I.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Sea.	VI. Wind.	VII. Weather.	VIII. Tide.	IX. Barometer.	X. Air Temperature.	XI. Transparency of Water.	XII. Depth in Fathoms. T.S.A.	XII. Depth in Fathoms. S-L.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea. Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1888 Sept. 19	2.18 p.m.	XXV.	Lat. 60°·44′ N. Long. 0°·4′ W.	Smooth	W.S.W., 3	O.C.	...	30·33	53	...	49¼	53	0	51·7	10·95	5	1027·10	1026·18	1027·01	3·524
													10	51·5	10·85	7				
													20	50·3	10·15	1				
													22	50·3	10·15	5				
													30	49·4	9·65	2				
													32	49·3	9·90	7				
													42	49·4	9·65	1				
													52	49·0	9·45	2	1027·40	1026·20	1027·03	3·527
,,	6.10 p.m.	XXVI.	Lat. 60°·44′ N. Long. 1°·9′ E.	,	W.S.W., 2	B.C.	...	30·36	54·5	...	78	85	0	52·8	11·55	1	1026·57	1025·74	1026·57	3·466
													10	52·0	11·10	2				
													24	48·6	9·20	7				
													40	47·0	8·35	7				
													54	46·0	7·75	7				
													64	45·0	7·20	2				
													74	43·4	6·35	5				
													84	43·2	6·20	1				
,,	11.25 p.m.	XXVII.	Lat. 60°·44′ N. Long. 2°·37′ E.	,	S.S.E., 1	F.	..	30·39	51·0	...	64	7	0	52·4	11·35	1	1026·47	1025·57	1026·40	3·443
													11	52·1	11·15	5				
													22	49·0	9·45	2				
													32	47·2	8·45	7				
													40	46·5	8·05	1				
													50	46·0	7·75	2				
													60	45·7	7·60	5				
													70	44·9	7·15	7	1027·82	1026·28	1027·11	3·537

TABLE I.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Sea.	VI. Wind.	VII. Weather.	VIII. Tide.	X. Barometer.	X. Air Temperature.	XI. Transparency of Water.	XII. Depth in Fathoms. T.S.A.	XII. Depth in Fathoms. S-L.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1888 Sept. 20	5.5 a.m. to 8.24 a.m.	XXVIII.	Helliso Lighthouse, S. 69° E., 9 miles.	Smooth	S.W., 3	B.C.	...	30·40	55° to 54°·3	...	...	193 w.	0	51·0	10·55	5	1021·64	1020·70	1021·55	2·81
													10	56·0	13·35	2				
													30	54·2	12·35	5				
													50	52·0	11·10	2				
													70	52·3	11·25	7				
													90	52·0	11·10	5				
													110	46·5	8·05	1				
													130	45·8	7·65	1				
													150	44·7	7·05	2				
													170	43·8	6·58	1				
													190	43·0	6·10	2	1027·81	1026·15	1026·98	3·520
,,	11.4 a.m.	XXIX.	Hielte Fiord. Sulanger Lighthouse, S. 34° E., 2¼ miles.	,,	S., 1	O.C.	4¼ h. fl.	30·43	56·0	7½	...	133	0	54·0	12·20	1	1026·10	1025·40	1026·23	3·420
												135 w.	65	44·6	7·00	7				
													105	44·1	6·70	7				
													135	43·0	6·10	2	1027·95	1025·72	1026·55	3·463
,,	1.16 p.m.	XXX.	By Fiord. Beyen Lighthouse, S. ¾° E., 5 miles.	,,	W.S.W., 2	O.C.	h.-w.	30·39	56·0	...	...	157	0	55·2	12·90	1	1012·05	1011·58	1012·48	1·637
													20	51·0	10·53	1				
													30	49·5	9·70	5				
													40	48·9	9·35	5				
													60	45·0	7·20	7				
													80	44·8	6·85	2				
													100	44·5	6·95	1				
													120	44·3	7·10	5				
													140	44·4	6·90	7				
													160	44·0	6·70	2				

TABLE I.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Sea.	VI. Wind.	VII. Weather.	VIII. Tide.	IX. Barometer.	X. Air Temperature.	XI. Transparency of Water.	XII. Depth in Fathoms T.S.A.	XII. Depth in Fathoms S-L.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1888 Sept. 24	1.30 p.m.	XXXI.	...	...	...	...	...	...	...	...	...	$2\frac{1}{2}$	Feet. 0	54·7	12·50	1	1014·23	1013·68	1014·57	1·907
													1	60·0	15·55	2				
													4	69·2	20·65	1				
													7	73·0	22·80	2	1016·15	1017·81	1018·67	2·438
													10	74·0	23·35	2				
													12	72·3	22·40	1				
													15	72·0	22·20	1	1019·54	1021·18	1022·03	2·877
,,	10.0 p.m.	XXXII.	Höre Varde Anchorage.	Ruffled	N., 5–6	B.C.	...	29·95	45·1	...	...	$5\frac{1}{2}$	Fms. 0	53·3	11·85	1				
													5	53·3	11·85	1				
Sept. 25	4.45 a.m.	,,	,,	Smooth	N., 5	B.	...	30·06	44·1	...	...	$6\frac{1}{2}$	0	52·7	11·50	1				
													6	52·8	11·55	1				
,,	10 13 a.m.	XXXIII.	Ekero Lighthouse, S. 59° E., $1\frac{3}{4}$ miles.	,,	S.E., 1	B.	...	30·20	56·2	13	...	33	0	53·6	12·00	7	1025·49	1024·76	1025·59	3·345
													2	53·7	12·05	5				
													7	53·3	11·85	2				
													12	50·9	10·50	2				
													17	48·5	9·15	7				
													22	46·4	8·00	7				
													27	45·9	7·70	5				
													32	43·2	6·20	1				
													32	43·0	6·10	2	1027·48	1025·92	1026·75	3·489

TABLE I.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Sea.	VI. Wind.	VII. Weather.	VIII. Tide.	IX. Barometer.	X. Air Temperature.	XI. Transparency of Water.	XII. Depth in Fathoms. T.S.A.	XII. Depth in Fathoms. S-L.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1888 Sept. 25	3.20 p.m.	XXXIV.	Naze Lighthouse, N. 8° W., 2 miles.	Smooth	W.N.W., 2	B.C.	...	30·20	52·0	...	89	91	0	55·8	13·20	2	1024·78	1024·33	1025·17	3·382
													10	55·9	13·30	1				
													15	55·4	13·00	1				
													20	55·0	12·75	7				
													30	54·5	12·50	7				
													35	53·6	12·00	7				
													40	52·5	11·40	2				
													45	50·2	10·10	1				
													50	46·0	7·75	7				
													60	45·8	7·65	1				
													70	43·5	6·40	2				
													85	43·0	6·10	2				
													90	43·1	6·15	5	1027·72	1026·06	1026·89	3·508
Sept. 26	10 30 a.m.	XXXV.	Anholt Lighthouse, N. 72° W., 8½ miles.	Slight	W.S.W., 4	B.C.	...	30·31	53·0	6	...	21	0	57·0	13·90	1	1024·60	1014·28	1015·17	·9 82
													5	57·0	13·90	2				
													10	56·2	13·45	5				
													15	55·5	13·05	7				
													20	52·2	11·20	7	1024·84	1023·97	1024·81	3·239
Sept. 27	7.40 a.m.	XXXVI.	Trekröner, N. 87° W. Provestan, S. 6° W.	Smooth	W., 2	O.C.	...	30·22	...	...	...	6¾	0	55·8	13·20	2				
													3	57·0	13·90	2				
													6¾	55·6	13·10	2				
Oct. 1	11.0 a.m.	XXXVII.	In Sound Drogden Lightship $\frac{2}{10}$ mile.	Rough	W.N.W., 4–6	B.C.Q.	...	29·20	46·0	...	...	4½	0	54·4	12·45	2				
													4½	54·4	12·45	2	1012·74	1012·19	1013·09	1·719

TABLE I.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Sea.	VI. Wind.	VII. Weather.	VIII. Tide.	IX. Barometer.	X. Air Temperature.	XI. Transparency of Water.	XII. Depth in Fathoms. T.S.A.	XII. Depth in Fathoms. S-L.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1888 Oct. 1	1.30 p.m.	XXXVIII	Baltic. Moen's Light-house, S. 58° W., 15 miles.	Rough	W. by S., 5–7	B.C.Q.	...	29·58 (an)	48·0	...	...	15	0 1 4½ 9½ 14½	55·8 55·9 55·9 55·9 55·9	13·20 13·30 13·30 13·30 13·30	2 5 5 0 0				
Oct. 2	6.9 a m.	XXXIX.	Baltic. Giedser Light-house, S. 71° W., 6¼ miles.	Slight	W.S.W., 5	B.C.	...	29·50	47·5	...	...	7½	0 7	54·1 54·0	12·30 12·20	7 2				
,,	11.15 a.m.	XL.	Femern Belt. Marien Light-house, S. 38° W., 4½ miles.	Smooth	S.W., 4	B.C.	...	29·45	51·0	...	...	15	0 8 10 15 15	54·7 54·0 53·8 50·3 50·3	12·60 12·20 12·10 10·15 10·15	7 2 2 1 7				
Oct. 6	6.0 p.m.	XLI.	Kierteminde Bay.	,,	W.N.W., 5-6	B.C.Q.P.	Current from north. Flood.	29·59	49·1	...	...	5	0 5	52·4 53·7	11·35 12·05	1 1				
Oct. 7	4.45 a.m.	,,	,,	,,	S.W., 2	B.C.	...	29·67	50·6	...	...	5	0 5	51·1 52·3	10·60 11·30	1 1				

TABLE I.—*continued.*

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.		XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.
Date.	Hour.	Station.	Position.	Sea.	Wind.	Weather.	Tide.	Barometer.	Air Temperature.	Transparency of Water.	Depth in Fathoms.		Depth of Obser., Fms.	Temp. of Sea, Fah.	Temp. of Sea, Cent.	No. of Ther.	$_4S_T$.	$_4S_{15\cdot 56}$.	$_{17\cdot 5}S_{17\cdot 5}$.	Salinity.
											T.S.A.	S–L.								
1888 Oct. 8	9.35 a.m.	XLII.	Lat. 57° 13′ 30 N. Long. 5° 21′ 30″ E.	Smooth with swell.	W.N.W., 3	B.C.	...	30·32	48·0	11½	...	29	0	49·0	9·45	1				
													5	49·0	9·45	7				
													10	46·8	8·25	5				
													13	42·0	5·55	7				
													15	41·9	5·50	2				
													18½	41·9	5·50	5				
													22½	42·0	5·55	1				
													28½	41·9	5·50	2				
,,	9.47 p.m. to 11.15 p.m.	XLIII.	Lat. 56° 43′ N. Long. 1° 38′ E.	Smooth, slight swell.	W.S.W.	O.C.	...	30·33	57·0	...	...	47	0	50·9	10·50	2				
													5	50·9	10·50	5				
													10	50·9	10·50	7				
													10	51·0	10·55	7				
													15	50·6	10·35	2				
													20	50·7	10·40	1				
													25	46·0	7·80	7				
													30	43·0	6·10	5				
													32	42·9	6·05	1				
													36	43·0	6·10	7				
													42	43·0	6·10	5				
													46½	42·8	6·00	2				
Oct. 9	1.50 p.m.	XLIV.	May Lighthouse, E., ¾ miles.	Smooth.	N., 1	M.	3 h. fl.	30·10	51·1	3	...	19½	0	50·2	10·10	1	1026·87	1025·77	1026·50	3·469
													0	50·2	10·10	7				
													4	50·2	10·10	5				
													9	50·0	10·00	2				
													14	50·1	10·05	7				
													19	50·0	10·00	1	1026·85	1025·75	1026·58	3·467

Determinations of Specific Gravity.

The specific gravity determinations made during the cruise according to Mr J. Y. Buchanan's method are given in Table I., and those made subsequently in the Chemical Laboratory of the University of Edinburgh in Table IV.

In Table I., Column XVII., gives the densities *in situ;* Column XVIII., the densities at 15°·56 C. (60° F.); Column XIX., the specific gravities at 17°·5 C. (distilled water at 17°·5 C. = 1000), and Column XX., the salinities. These values were calculated from the observed specific gravities by Dittmar's Tables. The values given in Columns XVII. and XVIII. are directly comparable with those published in previous reports by Dr H. R. Mill. Those in Column XIX. are given for comparison with the specific gravities as published by the Kiel Commission.

To those not familiar with Dittmar's Report the symbols heading these columns may require some explanation. S stands for specific gravity of sea water. The index to the left indicates the temperature at which distilled water is taken as the standard, and the index to the right indicates the temperature at which the sea water is supposed to be measured.

Thus ${}_4S_{15\cdot56}$ signifies the weight of a volume of sea water measured at 15°·56 C. divided by the weight of the same volume of distilled water at 4° C., and ${}_{17\cdot5}S_{17\cdot5}$ the weight of a volume of sea water measured at 17°·5 C· divided by the weight of the same volume of distilled water also measured at 17°·5 C. In the first case (${}_4S_{15\cdot56}$), as unit weight (kilogram) of distilled water at 4° C. occupies unit volume (litre), the numbers given under the heading ${}_4S_{15\cdot56}$ are the *densities* of the sea waters at 15°·56°.

The values given in Table I., Columns XVII., XVIII. and XIX., agree fairly well with the corresponding values given in Table IV., Columns XIV., XII., and XIII.—the difference being usually less than 1 in the first place of decimals (water = 1000). As will be explained later on, the values given in Table IV., Column XI., giving the *densities* at 0° C. (${}_4S_0$), have an altogether higher degree of accuracy. They may be taken as correct to within one in the second place of decimals. This, of course, is equally true of the values given in Column VII. under the heading ${}_0S_0$, these being the values arrived at by dividing the actually observed weights of given volumes of sea water measured at 0° C. divided by the actually observed weights of the same volumes of distilled water at 0° C. All these weighings were subjected to a correction for the displaced air, the density of the air at the time of weighing being calculated from readings of the barometer and wet and dry bulb thermometer. In these determinations of specific gravity a modified form of Sprengel's pyknometer was used as described in my former reports. The values given in Table IV., Columns XII., XIII., and XIV., are certainly more accurate than those in Columns XVII., XVIII., and XIX. of Table I., but are necessarily less accurate than those given in Columns VII. and XI. of Table IV. inasmuch as these latter are independent of any assumption as to the exact amount of alteration produced in the volume of the different sea waters by change of temperature.

Throughout the following discussion of the results arrived at, the word *density* when unqualified is to be taken as meaning density at 15°·56 C., the numbers being taken from the columns headed ${}_4S_{15\cdot56}$ and preferably from Table IV. giving the results of the determinations made in the Chemical Laboratory of the University of Edinburgh, these being the more accurate.

The facts ascertained with regard to the density of the sea water in the different parts of the North Sea visited by the 'Jackal' in September and the early part of October 1888 may be summarised briefly as follows :—The densest water met with during the cruise was the bottom water collected at Stations XXV., XXVI., XXVII., and XXVIII., along a line running eastwards from Balta Sound, North Unst, Shetland, to the coast of Norway. At the two central stations the density was slightly higher than that collected at the two outlying stations, being 1026·15 at Station XXVI. and 1026·16 at Station XXVII., as against 1026·09 at Station XXV., nearest the Shetlands, and 1026·14, at Station XXVIII., off the coast of Norway.

At the surface along the same line the density decreased from west to east, that is, as the coast of Norway was approached, falling from 1026·11 at Station XXV. to 1022·54 at Station XXVIII., where the surface current of light warm water due to the outflow from the Baltic was first met with—the most rapid fall (1025·54 to 1022·53) being between Stations XXVII. and XXVIII.

At Station XXI., in Lerwick Bay, the density at the surface was 1026·08 at high water and 1026·04 at low water. This gives an indication of the slight extent to which the density of these waters is influenced by the fresh waters contributed by the Shetlands, the influence of fresh land water being greatest at the surface and at low water. It should be noted that the results obtained by the hydrometer are not sufficiently accurate to show this difference which undoubtedly existed. If the slight difference between the two hydrometer readings (Table I.) were supposed to have any meaning, which it has not, one might be led to suppose that the density of the surface water in Lerwick Bay was greater at low water than at high water. The density of the sea water at Stations XV. to XX., near the Orkney Islands, was remarkably uniform from surface to bottom, and ranged from 1025·89 to 1026·03. It was therefore intermediate between the density at the Shetland stations and that of the water lying off the east coast of Scotland, where the density never reached 1026·00 even at the bottom. The highest densities observed off the coast of Scotland were 1025·74 at the bottom at Station IV., near the Isle of May, 1025·73 at Station VIII., and 1025·73 at Station XII., in Bervie Bay.

Going southwards along the coast of Norway the density varied greatly, being naturally very low at the surface in the fiords—1021·45 at Station XXIX., Hielte Fiord, and 1010·79 at Station XXX., in By Fiord. But at both these stations water was found at the bottom only slightly less dense than that met with out at sea.

As the Baltic was approached, the influence of the fresh water flowing out from it, became more and more marked at the surface, the density falling from 1024·68 at Station XXXIII. to 1023·73 at Station XXXIV., off the Naze, and to 1014·29 at Station XXXV., in the Cattegat. At the bottom on the other hand the influence of the Baltic outflow did not become marked till the shallow water of the Cattegat was reached, the density being 1024·18 at Station XXXV., while at Stations XXXIII. and XXXIV. it was 1025·87.

The lowest densities observed during the whole cruise were at Station XXXVIII., in the Baltic where the density fell to 1005·42 at the surface and 1005·48 at the bottom. At this point, therefore, the sea water finding its way along the bottom into the Baltic, was mixed with about four times its volume of the fresh Baltic water.

On the homeward passage from the Skaw to the Isle of May, water was found at the bottom only very slightly less dense than the bottom water about 200 miles further north, being 1025·97 at Station XLIII. as against 1026·16 at Station XXVII. At the surface, on the other hand, the respective densities found were 1025·62 and 1025·54. This increase of density of the surface water from north to south is evidently due, in part at least, to the upwelling of the bottom water immediately to the north of the Dogger Bank. This upwelling is also clearly indicated by the low temperature of the surface water at Station XLIII.

TEMPERATURE OBSERVATIONS.

Section I. is a graphical illustration of the distribution of temperature along a section of the North Sea from North Unst eastwards to the coast of Norway. On September 19th and 20th, it will be seen that the temperature of the main bulk of the water lying immediately to the east of the Shetland Islands, lay between 47° and 52° F. (8°·3 C. and 11°·1 C.), but as the coast of Norway was approached, the temperature of the upper layer steadily increased, while that of the bottom layer decreased, till at Station XXVIII., off the coast of Norway, the temperature of the water a few fathoms below the surface had risen to 56° F. (13°·3 C.), and the temperature at the bottom had fallen to 43° F. (6°·1 C.). At the same time the depth of the intermediate layer of water having a temperature of between 47° F. (8°·3 C.) and 52° F. (11°·1 C.), diminished from over 50 to less than 20 fathoms, notwithstanding the greatly increased depth from surface to bottom. On the other hand, the warmer upper layer and the colder bottom layer both rapidly increased in thickness, till at Station XXVIII. a layer of water over 90 fathoms deep and having a temperature of from 56° to 52° F. (13°·3 C. to 11°·1 C.), was found overlying a layer of water nearly 90 fathoms deep, the temperature of which was between 47° and 43° F. (8°·3 C. and 6°·1 C.), the intervening layer being less than 20 fathoms deep.

Section II. gives a graphic illustration of the distribution of temperature three weeks later along a section of the North Sea from a point in the Firth of Forth near Kinghorn, passing to the south of the Isle of May and extending 300 miles out to sea towards the Skaw. The first point to be noted with regard to this section is its comparatively slight and uniform depth. Further, as in the section some 200 miles further north, the temperature of the great bulk of water lying to the west, that is, lying off the east coast of Scotland, lay between 47° F. and 50° F. (8°·3 C. and 10° C.). Another point of similarity between the two sections is the gradual thinning from west to east of the layer of water having a temperature between 47° F. and 50° F., accompanied by an increase of thickness of the upper and warmer layer, and also of the lower and colder layer. This similarity, however, only extended to a point about 180 miles distant from the western side of the southern section, for from this point eastwards the thickness of the upper and warmer layer diminished rapidly from west to east, while that of the intermediate layer increased, until at Station XLII. it reached the surface where the temperature of the upper five fathoms was only 49° F. On the other hand it will be noted that the increase of depth of the colder bottom layer from east to west was unbroken, so that at Station XLII. the temperature of the water from the bottom to within 13 fathoms from the surface, was found to be as low as 42° F. (5°·5 C.). At this point, therefore, the warmer layer of water was absent altogether, while a layer of cold water below 43° F. (6°·1 C.) extended from about 10 fathoms below the surface to the bottom.

How far this represents the normal state of affairs it is impossible to say at present, but this upwelling of cold bottom water to the north of the Dogger Bank appears to occur very frequently. It would be interesting to ascertain the exact distribution of temperature along this section after a continued prevalence of southerly winds, on the one hand, and of northerly winds on the other. It appears, to say the least of it, highly probable that, in accordance with Mr John Murray's observations, the vertical distribution of temperature at the two periods would be in marked contrast. The southerly wind, by producing a flow of the surface water from south to north, must tend to increase if it does not originate the inflow of the cold water along the bottom, while northerly winds would probably have an opposite effect.

It is interesting to note that, notwithstanding the comparative shallowness of the water along the southern section, the temperature of the bottom water in the eastern half of this section was distinctly lower than that of the bottom water at any point of the northern section. It was in fact here that the lowest temperatures observed during the whole cruise were met with. It is true that the observations along the southern section were made three weeks later than those along the northern section, but it seems probable that the lower temperature of the bottom water along the southern section is to be accounted for not so much by this fact, but rather by a further advance of the colder water from the north flowing up hill along the bottom of the North Sea.

The observations made off the coast of Scotland were all at points within a few miles from shore and in comparatively shallow water, nowhere exceeding 24 fathoms. Accordingly the range of temperature observed was a very narrow one and lay between 53° F. and 52° F. (11°·7 and 11°·1 C.). A distinct lowering temperature was observed at the stations near the Orkney Islands, but the range was equally narrow, lying between 51° and 52° F. (11°·1 and 10°·5 C.).

A further fall in the temperature of the sea was observed in the Shetlands where the highest temperature observed was 51°·4 F. (10°·8 C.) and the lowest 49°·0 F. (9°·5 C.). This slightly greater range is due in part to the greater depth at some of these stations. From the surface down to 30 fathoms the extreme range was from 51°·4 to 49°·8 F. (10°·8 to 9°·9 C.), and if we except one observation in Lerwick Bay, the range is from 51°·2 to 49°·8 F. (10°·7 C. to 9°·9 C.).

These observations may be summed up as follows :—

East Coast of Scotland.

Mean of 9 observations at the surface, ...	52°·80 F.
„ 4 „ between 8 and 10 fathoms, . .	52°·50 F.

Max., 53°·3 F. at surface, Station VI., near Taymouth.
Min., 52°·0 F. at bottom, Station VIII., off Bell Rock.

Orkney Islands (East Coasts).

Mean of 14 observations at the surface, ...	52°·33 F.
„ 4 „ between 8 and 10 fathoms, . .	51°·65 F.
„ 4 „ „ 15 and 20 „ . .	51°·75 F.

Max., 52°·9 F. at surface in Kirkwall Bay.
Min., 51°·1 F. at bottom, Station XVI., Stronsay Firth (23½ fathoms).

Shetland Islands (East Coasts).

Mean of 15 observations at the surface, ...	51°·11 F.
„ 9 „ between 8 and 10 fathoms, . .	51°·02 F.

Max., 51°·4 F. at surface in Lerwick Bay.
Min., 49°·0 F. at bottom (60 fathoms), Station XXII., off Noss Head.

On the coast of Norway and in the fiords there are several points in striking contrast to the general character of the east coast of Scotland.

Instead of the gradual increase in depth from the coast line outwards characteristic of the east coast of Scotland generally, depths far greater than any off the east coast of Scotland are frequently to be met with close in to land.* Accordingly the range of temperature from surface to bottom was also very considerable and all the greater from the fact of the relatively higher surface temperatures frequently met with. At Station XXIX., in Hielte Fiord, the temperature at the surface was 54°·0 F. (12°·2 C.), and at the bottom, at a depth of 135 fathoms, only 43° F. (6°·1 C.); while in By Fiord the surface temperature was 55°·2 F. (12°·9 C.), and the bottom temperature at a depth of 160 fathoms, 44° F. (6°·7 C.).

Through the courtesy of Mr Buch, Inspector of Fisheries at Bergen, we were able to visit a very remarkable natural pond or small lake in the Island of Tysnös (Station XXXI.). The distribution of temperature in this little patch of water, the depth of which nowhere exceeds 15 feet, is truly phenomenal.

The temperature at the surface on the occasion of our visit was in no way remarkable, being 54°·7 F. (12°·0 C.); but at 1 foot below the surface it rose to 60° F., 4 feet down the temperature was 69°·2, 7 feet down 73°·0 (22°·8 C.), the maximum temperature, 74°·0 F. (23°·35 C.), being reached at 10 feet below the surface.

Further down the temperature fell very distinctly, being only 72° F. at the bottom. Mr Buch informed me that careful search had been made for a hot spring, but that nothing of the kind could be found and that the conclusion come to was that the whole was due to solar radiation. In support of this I may point out that the specific gravity *in situ* of the intermediate and hottest layer lies between that of the surface and bottom layers (see Table I.). This must tend to prevent convection currents and therefore to greatly prolong the cooling of the intermediate layer.

Formerly the only communication with the salt water of the fiord was at high spring tides, but arrangements have been made which permit of the regulation of the inflow of salt water. The salt water admitted intermittently forms the bottom layer, the very thin surface layer is formed by fresh water from a small stream flowing in at the one end of the pond and overflowing at the other into a short watercourse leading to the fiord. It is therefore constantly renewed. The intermediate layer is formed in all probability by very slow mixing of the bottom and surface layers. On June 30, 1888, the maximum temperature was no less than 81°·3 F. (27°·4 C.) at about 7 feet below the surface, but fell to 78°·8 F. (26° C.) by the 21st of July, being then between 9 and 10 feet below the surface. On August 11th the maximum temperature was 73°·9 F. (24·4° C.) at about 11 feet below the surface.

The whole matter is one of very great interest, practical as well as scientific. For some years back this pond has been used as an oyster nursery with great success. Large bundles of twigs or small branches from neighbouring trees are suspended in the warm water by means of stout wire ropes stretching from bank to bank across the pond. To these the spat attaches and favoured by the high temperature develops, so Mr Buch informed me, with remarkable rapidity and with a degree of regularity from year to year which altogether surpasses anything attained hitherto in the fiord waters outside. At a certain stage of growth the young oysters are transferred to beds in the outside waters. Samples of water were collected from the pond at different depths and specimens of the oysters in various stages of growth as found on the occasion of our visit were kindly given by Mr Buch. We also had an opportunity of judging of the quality of the oysters growing in the

* This could not be indicated on the chart (Pl. x.).

pond. After being well cooled by immersion for half an hour in cold water they proved to be excellent.

I hope during the present summer to investigate the subject experimentally and on the completion of my analysis and experiments to communicate the results in a future report. If the source of heat is purely solar, it seems highly probable, that the system will be found capable of wide application.

The temperatures observed in the Cattegat and Sound range from 57–55° F., if one observation be excluded, where the bottom temperature was found to be 52° F. at a depth of 20 fathoms. In the Baltic the temperatures observed were lower, ranging from 54°·7 to 50°·3 F. Time did not permit of any extensive series of observations during this part of the cruise, but this is the less to be regretted as very full data on the subject has been published for years by the Kiel Commission and the Danish Meteorological Institute.

I cannot close this brief account of the more immediate results of the cruise of H.M.S. 'Jackal' without expressing on behalf of those who took part in it our grateful sense of the kindly and hospitable welcome accorded to us on all hands at Bergen, Copenhagen, and Kiel, the three ports at which we made stay. It is not too much to hope that such friendly intercommunication between those working with a common object in view on the different shores of the North Sea may lead to a much more rapid solution of the many interesting problems, practical as well as scientific, connected with this important region.

TABLE II.

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Depth. Fms.	VI. Sea.	VII. Wind.	VIII. Transparency of Water.	IX. Weather.	X. Tide.	XI. Barometer.	XII. Air Temperature. Dry Bulb.	XII. Air Temperature. Wet Bulb.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1889 Jan. 21	8.30 a.m.	I.	Brim's Ness, S. 35° E., ¾ mile.	23½	Moderate	N.W. 4	5	B. C.	3½ h. fl.	30·45	45·0	44·3	0	45·3	7·40	3	1027·0	1025·5	1026·4	3·46
													5	45·2	7·35	1				
													10	45·3	7·40	3				
													15	45·4	7·45	10				
													23	45·3	7·40	10	1027·0	1025·5	1026·4	3·46
,,	9.20 a.m.	II.	Brim's Ness, S. 69° E., 3¾ miles. Sandside Kirk, S. 17 W.	16	Moderate	N.W. 4	5	B. C.	4¼ h. fl.	30·45	45·7	44·5	0	45·5	7·50	3	1027·0	1025·5	1026·4	3·46
													5	44·9	7·15	2				
													10	45·3	7·40	1				
													15	45·6	7·55	10				
													16	45·6	7·55	10	1027·1	1025·6	1026·5	3·47
,,	10.15 a.m.	III.	Sandside Point, S., 37° E., 3 miles. Brims Ness, S. 7° E.	30	Moderate	N.W. 4	5½	B. C.	5 h. fl.	30·47	45·5	44·5	0	45·4	7·45	1	1027·0	1025·5	1026·4	3·46
													5	45·5	7·50	1				
													10	45·3	7·40	2				
													15	45·7	7·60	3				
													20	45·5	7·50	1				
													25	45·8	7·65	3				
													30	45·9	7·70	10	1027·0	1025·5	1026·4	3·46
,,	11.0 a.m.	IV.	Sandside Point, S. 34° E., 4 miles. Skeera Point, S. 48° W.	30	Moderate	N.W. by N. 3–4	5½	B. C.	H.-W.	30·48	46·0	44·8	0	45·8	7·65	1	1027·1	1025·6	1026·5	3·47
													5	45·7	7·60	10				
													10	45·6	7·55	2				
													15	45·8	7·65	1				
													20	46·0	7·75	3				
													25	46·0	7·75	10				
													30	46·2	7·90	10	1027·0	1025·6	1026·5	3·47

TABLE II.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Depth. Fms.	VI. Sea.	VII. Wind.	VIII. Transparency of Water.	IX. Weather.	X. Tide.	XI. Barometer.	XII. Air Temperature. Dry Bulb.	XII. Air Temperature. Wet Bulb.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15}$ 56	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1889 Jan. 21	11.45 a.m.	V.	Strathie Point, N. 76° W., 1½ miles. Skeera Point, S. 7° E.	23	Heavy swell	N.N.W. 3–4	5¼	B. C.	½ h. eb.	30·49	46·0	44·7	0	45·9	7·70	3	1027·0	1025·5	1026·4	3·46
													5	45·3	7·40	2				
													10	45·6	7·55	1				
													15	45·8	7·65	3				
													20	46·0	7·75	10				
													23	46·0	7·75	10	1027·0	1025·5	1026·4	3·46
,,	12.25 p.m.	VI.	Skeera Point, S. 25° E., 1½ miles. Ballygill Head, S. 49 W.	25	Swell	N.N.W. 3–4	4½	B. C.	1¼ h. eb.	30·49	45·9	45·3	0	45·7	7·60	1	1027·1	1025·6	1026·5	3·47
													5	45·5	7·50	2				
													10	45·8	7·55	1				
													15	45·9	7·70	3				
													20	45·8	7·65	1				
													25	46·0	7·75	3	1027·1	1025·6	1026·5	3·47
,,	12.45 p.m.	VII.	Skeera Point, S. 18° W., 1 mile. Ballygill Point, S. 73° W.	25	Swell	N.N.W. 3–4	5	B. C.	1¾ h. eb.	30·51	46·1	45·5	0	46·0	7·75	10	1027·1	1025·6	1026·5	3·47
													5	46·0	7·75	10				
													10	45·9	7·70	1				
													15	46·0	7·75	3				
													20	45·8	7·65	2				
													25	46·0	7·75	3	1027·2	1025·7	1026·6	3·48
,,	1.20 p.m.	VIII.	Skeera Point, S. 71° W., 1½ miles. Sandside Point, S. 48° E.	20	Swell	N.N.W. 3–4	4	B. C.	2¼ h. eb.	30·52	45·2	44·6	0	45·8	7·65	1	1027·1	1025·6	1026·5	3·47
													5	45·7	7·60	2				
													10	45·8	7·65	1				
													15	46·0	7·75	3				
													20	46·0	7·75	3	1027·2	1025·7	1026·6	3·48

TABLE II.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Depth. Fms.	VI. Sea.	VII. Wind.	VIII. Transparency of Water.	IX. Weather.	X. Tide.	XI. Barometer.	XII. Air Temperature. Dry Bulb.	XII. Air Temperature. Wet Bulb.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$	XX. Salinity.
1889 Jan. 21	1.50 p.m.	IX.	Skeera Point, S. 85° W., $2\frac{1}{4}$ miles. Sandside Point, S. 53° W.	22	Swell	N.N.W. 3–4	$4\frac{3}{4}$	B. C.	$2\frac{3}{4}$ h. eb.	30·54	45·5	44·5	0	45·3	7·40	2	1027·1	1025·6	1026·5	3·47
													5	45·5	7·50	1				
													10	45·4	7·45	2				
													15	45·7	7·60	1				
													20	45·8	7·65	3				
													22	45·7	7·60	1	1027·1	1025·6	1026·5	3·47
,,	2.30 p.m.	X.	Sandside Point, S. 19° E., $1\frac{1}{2}$ miles. Brim's Ness, S. 84° E.	24	Swell	N.N.W. 4	5	B. C.	$3\frac{1}{2}$ h. eb.	30·54	46·2	45·0	0	45·7	7·60	3	1027·1	1025·6	1026·5	3·47
													5	45·6	7·55	1				
													10	45·5	7·50	2				
													15	45·8	7·65	1				
													20	46·0	7·75	3				
													24	45·8	7·65	1	1027·1	1025·6	1026·5	3·47
	3 p.m.	XI.	Sandside Kirk, S. 14° W., 2 miles. Brim's Ness, S. 88° E.	22	Swell	N. 3	5	B. C.	4 h. eb.	30·55	44·6	44·4	0	45·4	7·45	2	1026·6	1025·2	1026·1	3·42
													5	45·6	7·55	1				
													10	45·8	7·65	3				
													15	45·6	7·55	2				
													20	45·8	7·65	1				
													22	45·7	7·60	1	1026·8	1025·3	1026·2	3·43
,,	3.30 p.m.	XII.	Brim's Ness, S. 87° E., $2\frac{1}{4}$ miles. Isauld Point, S. 52 W.	20	Slight swell	N. by E. 2	5	B. C.	$4\frac{1}{2}$ h. eb.	30·55	44·8	44·0	0	45·2	7·35	1	1025·7	1025·2	1026·1	3·42
													5	45·5	7·50	3				
													10	45·2	7·35	2				
													15	45·3	7·40	1				
													20	45·3	7·40	2	1026·7	1025·2	1026·1	3·42

TABLE II.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Depth. Fms.	VI. Sea.	VII. Wind.	VIII. Transparency of Water.	IX. Weather.	X. Tide.	XI. Barometer.	XII. Air Temperature. Dry Bulb.	XII. Air Temperature. Wet Bulb.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1889 Jan. 21	4.15 p.m.	XIII.	Sandside Kirk, S. 18° W., 5 miles. Strathie Point, N. 88° W.	40	Swell	N.N.W. 2	$4\frac{3}{4}$	B. C.	$5\frac{1}{4}$ h. eb.	30·56	44·7	43·7	0	45·6	7·55	3	1026·9	1025·4	1026·3	3·45
													5	45·3	7·40	1				
													10	45·3	7·40	2				
													15	45·5	7·50	1				
													20	45·7	7·60	3				
													25	45·7	7·60	3				
													30	45·5	7·50	1				
													35	45·3	7·40	2				
													40	46·1	7·85	1				
													40	46·1	7·85	2	1027·1	1025·7	1026·6	3·48
,,	5.10 p.m.	XIV.	Holburn Head, S. 5° E., $8\frac{1}{2}$ miles. Strathie Point, S. 83° W.	44	Swell	N. W. 2		B. C.	L.-W.	30·67	44·7	43·6	0	45·3	7·40	1	1027·1	1025·6	1026·5	3·47
													5	45·2	7·35	1				
													10	45·1	7·30	2				
													15	45·5	7·50	3				
													20	45·4	7·45	1				
													25	45·3	7·40	2				
													30	45·5	7·50	1				
													35	45·8	7·65	3				
													40	45·9	7·70	2				
													44	46·0	7·75	2	1027·2	1025·7	1026·6	3·48

TABLE II.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Depth. Fms.	VI. Sea.	VII. Wind.	VIII. Transparency of Water.	IX. Weather.	X. Tide.	XI. Barometer.	XII. Air Temperature. Dry Bulb.	XII. Air Temperature. Wet Bulb.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1889 Jan. 22	8.20 a.m.	XV.	Strathie Point, S. 72° W., 5¾ miles. Holburn Head, S. 55° E.	50	Moderate	N.N.W. 4	4	O. C.	2¼ h. fl.	30·49	47·1	47·1	0	46·3	7·95	3	1027·2	1025·8	1026·7	3·50
													5	46·1	7·85	1				
													10	45·8	7·65	2				
													15	46·1	7·85	1				
													20	46·3	7·95	3				
													25	46·4	8·00	10				
													30	46·0	7·75	2				
													35	46·1	7·85	1				
													40	46·4	8·00	3				
													45	46·6	8·10	10				
													50	46·5	8·05	1	1027·3	1025·9	1026·8	3·51
,,	9.20 a.m.	XVI.	Strathie Point, S. 87° W., 5 miles. Sandside Point, S. 8° E.	43	Moderate	W.N.W. 4	4¾	O. C.	3¼ h. fl.	30·49	47·1	47·1	0	45·3	7·40	2	1027·0	1025·5	1026·4	3·46
													5	45·3	7·40	2				
													10	45·3	7·40	1				
													15	45·8	7·65	10				
													20	45·7	7·60	3				
													25	45·9	7·70	3				
													30	46·0	7·75	10				
													35	45·9	7·70	1				
													40	46·3	7·95	2				
													43	46·7	8·15	10	1027·2	1025·8	1026·7	3·50

TABLE II.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Depth. Fms.	VI. Sea.	VII. Wind.	VIII. Transparency of Water.	IX. Weather.	X. Tide.	XI. Barometer.	XII. Air Temperature. Dry Bulb.	XII. Air Temperature. Wet Bulb.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1889 Jan. 22	10.45 a.m.	XVII.	Strathie Point, S. 43° W., 3½ miles. Sandside Point, S. 25° E.	52	Swell	W. by N. 3–4	5	O. C.	4¾ h. fl.	30·47	47·7	47·7	0	45·9	7·70	2	1027·1	1025·7	1026·6	3·48
													5	45·9	7·70	2				
													10	45·9	7·70	2				
													15	46·0	7·75	1				
													20	46·2	7·90	10				
													25	46·2	7·90	3				
													30	46·2	7·90	3				
													35	46·3	7·95	10				
													40	46·3	7·95	1				
													45	46·0	7·75	2				
													52	46·6	8·10	10	1027·1	1025·7	1026·6	3·48
,,	11.30 a.m.	XVIII.	Strathie Point, S. 62° W., 2¼ miles. Sandside Point, S. 24° E.	42	Swell	W. by N. 4–5	5¼	O. C.	5½ h. fl.	30·44	46·8	47·0	0	45·7	7·60	2	1027·0	1025·6	1026·5	3·47
													5	45·8	7·65	3				
													10	45·8	7·65	10				
													15	45·6	7·55	2				
													20	45·8	7·65	1				
													25	46·0	7·75	10				
													30	46·0	7·75	1				
													35	45·9	7·70	2				
													40	46·1	7·85					
													42	46·4	8·00	1	1027·1	1025·7	1026·6	3·48

TABLE II.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Depth. Fms.	VI. Sea.	VII. Wind.	VIII. Transparency of Water.	IX. Weather.	X. Tide.	XI. Barometer.	XII. Air Temperature. Dry Bulb.	Wet Bulb.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1889 Jan. 22	1.15 p.m.	XIX.	Strathie Point, S. 24° E., 10½ miles. Whiten Head, S. 72° W.	50	Moderate	N.W. 6		O. C.	1¼ h. eb.	30·42	46·7	47·5	0	46·3	7·95	1	1027·4	1026·0	1026·9	3·52
													5	46·7	8·15	3				
													10	46·7	8·15	10				
													15	46·6	8·10	2				
													20	47·0	8·35	1				
													25	47·2	8·45	3				
													30	47·3	8·50	3				
													35	47·1	8·40	1				
													40	47·0	8·35	2				
													45	47·2	8·45	10				
													50	47·3	8·50	10	1027·4	1026·1	1027·0	3·54
,,	2.35 p.m.	XX.	Whiten Head, S. 48° W., 15 miles.	55	Moderate Increasing	N.W. 7		O. C.	2½ h. eb.	30·39	46·7	47·5	0	46·8	8·20	3	1027·5	1026·1	1027·0	3·54
													5	46·9	8·30	1				
													10	46·9	8·30	2				
													15	46·9	8·30	1				
													20	47·2	8·45	3				
													25	47·1	8·40	10				
													30	46·9	8·30	2				
													35	46·9	8·30	2				
													40	47·1	8·40	10				
													45	47·1	8·40	3				
													50	47·0	8·35	1				
													55	47·0	8·35	1	1027·5	1026·1	1027·0	3·54

TABLE II.—*continued.*

I. Date.	II. Hour.	III. Station	IV. Position	V. Depth. Fms.	VI. Sea.	VII. Wind.	VIII. Transparency of water.	IX. Weather.	X. Tide.	XI. Barometer.	XII. Air Temperature. Dry Bulb.	XII. Air Temperature. Wet Bulb.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_{4\cdot15}S_{56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1889 Jan. 23	2.45 p.m.	XXI.	Holburn Head, S. 7° W., 13 miles.	40	Rough	W.N.W. 6	4	B.C.P. Q.	$1\frac{3}{4}$ h. eb.	30·34	47·0	46·5	0	46·3	7·95	1	1027·3	1025·9	1026·8	3·51
													5	46·1	7·85	2				
													10	46·4	8·00	10				
													15	46·3	7·95	3				
													20	46·2	7·90	2				
													25	46·3	7·95	1				
													30	46·5	8·05	10				
													35	46·6	8·10	3				
													40	46·6	8·10	3	1027·2	1025·8	1026·7	3·50
Jan. 24	9 a.m.	XXII.	Strathie Point, S. 17° W. $12\frac{1}{2}$ miles.	42	Rough	W. 4–5		O. C. Q.	2 h. fl.	30·27	47·0	47·2	0	46·9	8·30	2	1027·4	1026·0	1026·9	3·52
													5	47·1	8·40	2				
													10	46·9	8·30	1				
													15	47·2	8·45	10				
													20	47·1	8·40	3				
													25	47·0	8·35	1				
													30	47·1	8·40	10				
													35	47·0	8·40	2				
													40	47·2	8·45	3				
													42	47·2	8·45	10	1027·4	1026·1	1027·0	3·54
,,	10.40 a.m.	XXIII.	Strathie Point, S. 1° E., 19 miles.	35	Very rough	W. 7-8		O. C. Q.	$3\frac{1}{2}$ h. fl.	30·26	47·3	47·0	0	47·2	8·45	3	1027·4	1026·1	1027·0	3·54
													5	47·1	8·40	10				
													10	47·0	8·35	1				
													15	47·0	8·35	1				
													20	46·9	8·30	2				
													25	46·9	8·30	2				
													30	46·9	8·30	3				
													35	46·8	8·20	2	1027·5	1026·1	1027·0	3·54

TABLE II.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Depth. Fms.	VI. Sea.	VII. Wind.	VIII. Transparency of Water.	IX. Weather.	X. Tide.	XI. Barometer.	XII. Air Temperature. Dry Bulb.	XII. Air Temperature. Wet Bulb.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15^{\cdot}56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1889 Jan. 24	12.15 p.m.	XXIV.	Stack Skerry, N. 78° W., 8 miles.	30	Very rough	W.N.W. 6		O. C. Q.	5¼ h. fl.	30·24	47·2	46·7	0	46·8	8·20	1	1027·5	1026·1	1027·0	3·54
													5	46·7	8·15	2				
													10	46·7	8·15	3				
													15	46·9	8·30	10				
													20	46·8	8·20	1				
													25	46·8	8·28	2				
													30	47·0	8·35	10	1027·5	1026·1	1027·0	3·54
,,	3 p.m.	XXV.	Farout Head, S. 36° W. 12 miles.	42	Very rough	W.N.W. 7–8		O. C. Q.	2 h. eb.	30·21	47·0	46·5	0	46·8	8·20	1	1027·4	1026·0	1026·9	3·52
													5	46·8	8·20	3				
													10	46·7	8·15	2				
													15	46·8	8·20	1				
													20	46·8	8·20	2				
													25	46·9	8·30	10				
													30	47·0	8·35	3				
													35	46·9	8·30	1				
													40	47·2	8·45	2				
													42	47·3	8·50	3	1027·4	1026·0	1026·9	3·52

TABLE III.

I. Date	II. Hour.	III. Station.	IV. Position.	V. Depth. Fms.	VI. Sea.	VII. Wind.	VIII. Transparency of Water.	IX. Weather.	X. Tide.	XI. Barometer.	XII. Ari Temperature. Dry Bulb.	XII. Ari Temperature. Wet Bulb.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15.56}$.	XIX. $_{17.5}S_{17.5}$.	XX. Salinity.
1889 Feb. 6	2.10 p.m.	I.	Cromarty Lighthouse, N. 73° W., 1¼ miles. West Sutor, S. 25° W.	30	Smooth	E.N.E. 3	5	B. C.	3¼ h. fl.	29·80	41·2	40·8	0	40·4	4·65	2	1026·0	1024·2	1025·1	3·29
													5	40·9	4·95	1				
													10	41·0	5·00	2				
													15	41·1	5·05	10				
													20	41·0	5·00	7				
													25	40·9	4·95	5				
													30	41·3	5·15	10	1026·1	1024·4	1025·3	3·31
Feb. 7	7.45 a.m.	II.	,,	30	Smooth	N. 3–4	1½	B. C.	2½ h. eb.	29·85	33·5	33·8	0	39·7	4·30	2	1026·0	1024·2	1025·1	3·29
													5	39·7	4·30	10				
													10	40·0	4·45	3				
													15	40·8	4·90	2				
													20	41·0	5·00	1				
													25	40·9	4·95	2				
													30	41·3	5·15	3	1026·2	1024·5	1025·4	3·33
,,	10.5 a.m.	III.	Tarbet Ness Lighthouse, W. ¼° N., 8½ miles. Burghead, S. 17° W.	30	Swell	N. by E. 3	4	B. C. P. S.	5 h. eb.	29·88	35·5	35·5	0	42·2	5·65	2	1027·3	1025·6	1026·5	3·47
													5	42·3	5·70	1				
													10	42·6	5·90	3				
													15	42·3	5·70	5				
													20	42·2	5·65	2				
													25	42·7	5·95	10				
													30	42·7	5·95	10	1027·4	1025·7	1026·6	3·48

TABLE III.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Depth. Fms.	VI. Sea.	VII. Wind.	VIII. Transparency of Water.	IX. Weather.	X. Tide.	XI. Barometer.	XII. Air Temperature. Dry Bulb.	XII. Air Temperature. Wet Bulb.	XIII. Depth of Obser., Fms.	XIV. Temp. of Sea, Fah.	XV. Temp. of Sea, Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot56}$.	XIX. $_{17\cdot5}S_{17\cdot5}$.	XX. Salinity.
1889 Feb. 7	12.35 p.m.	IV.	Dunbeath Lighthouse, N. 35° W., 13½ miles.	24	Swell	N. 3–4	5	B. C P. S.	2 h. fl.	29·83	35·3	35·1	0	43·3	6·30	1	1027·2	1025·6	1026·5	3·47
													5	43·5	6·40	10				
													10	43·5	6·40	3				
													15	43·5	6·40	5				
													20	43·5	6·40	1				
													24	43·5	6·40	5	1027·2	1025·6	1026·5	3·47
,,	1.15 p.m.	V.	On Smith Bank. Dunbeath Lighthouse, N. 48° W., 15 miles.	20	Swell	N. 4.	5	B. C. P. S.	2½ h. fl.	29·83	36·2	36	0	43·3	6·30	2	1027·1	1025·5	1026·4	3·46
													5	43·8	6·55	10				
													10	43·8	6·55	5				
													15	43·8	6·55	3				
													20	43·7	6·50	5	1027·2	1025·6	1026·5	3·47
,,	1.50 p.m.	VI.	On Smith Bank. Dunbeath Lighthouse, N. 55° W., 16 miles.	20	Swell	N.N.W. 3–4.	4½	O. C. P. S.	3 h. fl.	29·82	35·5	35·8	0	43·7	6·50	5	1027·3	1025·7	1026·6	3·48
													5	43·8	6·55	10				
													10	43·8	6·55	5				
													15	43·8	6·55	3				
													20	43·8	6·55	3	1027·2	1025·6	1026·5	3·47
,,	2.35 p.m.	VII.	On Smith Bank. Dunbeath Lighthouse, N. 61° W., 17 miles.	2	Swell	N.N.W. 3	4	O. C.	4 h. fl.	29·79	36·2	36·5	0	43·8	6·55	5	1027·3	1025·7	1026·6	3·48
													5	43·8	6·55	3				
													10	43·8	6·55	5				
													15	43·8	6·55	10				
													20	43·9	6·60	10	1027·2	1025·6	1026·5	3·47

TABLE III.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Depth. Fms.	VI. Sea.	VII. Wind.	VIII. Transparency of Water.	IX. Weather.	X. Tide.	XI. Barometer.	XII. Air Temperature. Dry Bulb.	XII. Air Temperature. Wet Bulb.	XIII. Depth of Obser. Fms.	XIV. Temp. of Sea Fah.	XV. Temp. of Sea Cent.	XVI. No. of Ther.	XVII. $_4S_T$.	XVIII. $_4S_{15\cdot 56}$.	XIX. $_{17\cdot 5}S_{17\cdot 5}$.	XX. Salinity.
1889 Feb. 7	3.20 p.m.	VIII.	Dunbeath Lighthouse, N. 71° W., 20¾ miles. Ness Head, N. 13° W.	25	Moderate Choppy	N. W. 4	4½	O. C.	4¾ h. fl.	29·75	36·0	36·3	0	43·8	6·55	5	1027·3	1025·7	1026·6	3·48
													5	43·8	6·55	1				
													10	43·9	6·60	3				
													15	43·9	6·60	5				
													20	44·0	6·65	10				
													25	43·9	6·60	10	1027·4	1025·8	1026·7	3·50
,,	5.15 p.m.	IX.	Halborough Head, N., 3 miles. Clyth Ness, S. 82° W.	40	Choppy	W.N.W. 4–5	5	O. C.	h.-w.	29·69	37·5	37·9	0	43·7	6·50	3	1027·1	1025·5	1026·4	3·46
													5	43·5	6·40	2				
													15	43·8	6·55	7				
													20	44·0	6·65	10				
													25	43·8	6·55	1				
													30	44·0	6·65	3				
													35	44·0	6·65	5				
													40	43·9	6·60	5	1027·4	1025·8	1026·7	3·50

PHYSICAL OBSERVATIONS MADE ON BOARD H.M.S. 'JACKAL' BY MR ANDREW KING, OFF THE NORTHERN COAST OF SCOTLAND, AND IN THE MORAY FIRTH.

These observations were undertaken specially with the view of obtaining data as to the physical conditions at Sandside Bay and Smith Bank, Moray Firth, where flat-fish were at the time congregating in shoals for the purpose of spawning.

The observations made in January in the region immediately to the north of the northern coast of Scotland are detailed in Table II.

The neighbourhood of Sandside Bay was examined with special care, but did not show any very marked peculiarity.

The stations at which observations were taken are shown in the accompanying chart, Plate XI. and Sections 3 and 4 show at once the depth and the vertical distribution of temperature observed at points along two lines, the first running by intention approximately parallel with and at about 15 miles distant from the coast; and the other running north and south at right angles to the first, starting from a central point. It will be seen that the distribution of temperature along the east and west section was very uniform. The maximum temperature observed was 47°·3 F., at the bottom of Station XXV., and the minimum, 46°·1 F. at five fathoms below the surface Station XXI.

For the first 25 miles from west to east the extreme range observed was from 47°·3 to 46°·7 F., and between the surface and a depth of 35 fathoms only from 47°·2 to 46°·8 F.; so that for the great mass of the water the range of temperature was only 0°·4 F. The highest temperature was found furthest west (Station XXV.) Between Station XXII. and Station XXI., lying furthest east, that is nearest the North Sea, a distinct fall in temperature, about 0°·6 F., was observed at all depths between surface and bottom. The warm surface Atlantic water was being blown at the time these observations were taken from west to east towards the colder North Sea.

The distribution of temperature along the north and south section was even more uniform. At Station XIX., the surface temperature was 46°·3 F., but with this exception the temperatures observed never exceeded 47°·3 F., and never fell below 46°·6 F.

This uniformity in temperature was associated with a corresponding uniformity in density.

Along the 35 mile east and west section the density *in situ* varied only between 1027·2 and 1027·5, and along the 35 mile north and south section between 1027·4 and 1027·5. Close in to shore, in Sandside Bay, the influence of the land water was rendered appreciable by a slight lowering of the temperature, accompanied by a similarly slight lowering of the density.

As Dr Mill remarks, the temperature of sea water affected by land water varies during winter directly as the density. In summer the temperature varies inversely as the density. The slightly lower temperature and the slightly lower density of this inshore water were, therefore, due to admixture with land water.

Table III. gives in detail the observations made in the Moray Firth in February 1889. These observations were unfortunately curtailed owing to the very rough weather experienced. The taking of observations along a line running north and south across the Firth had to be abandoned. Section 5 shows the depth and the observed temperatures along a section extending from the mouth of the Cromarty Firth, through the centre of Smith's Bank, to a point about 55 miles out to sea.

The lowest temperatures were observed between the Sutors at the entrance to the Cromarty Firth, Stations I. and II. where they ranged from 39°·7 F. at the surface to 41°·3 at the bottom. At Station III. the temperature was found to be distinctly higher, and ranged from 42°·2 F. at the surface to 42°·7 at the bottom. Further out to sea the temperatures were still higher, and also more uniform from surface to bottom. At Smith Bank the range of temperature from surface to bottom was from 43°·3 to 43°·9 and was slightly higher at Station VIII., a few miles further out to sea. The density *at constant temperature* is lowest between the Sutors 1024·2 to 1024·5 ($_4S_{15·56}$), distinctly higher at Station III. 1025·6 to 1025·7 ($_4S_{15·56}$), equally high and very uniform at Stations IV. to VII. and highest at Station VIII., where the influence of the land water is almost inappreciable.

At Station III. the lowering of the density, owing to admixture with land water, is counterbalanced by the increase of density due to the lower temperature, so that the density *in situ* at this point is if anything slightly greater than at Smith Bank.

On these two occasions a set of hydrometers were used which were obtained from Herr Steger at Kiel in October last. These hydrometers are similar to those used by the Kiel Commission, and, through the kind courtesy of Professor Karsten, were compared directly with their standard set of hydrometers.

A comparison of column XIX. in Table II. with column XIII. in Table V. will show that the results obtained with these hydrometers accord excellently with those obtained by direct weighing. These hydrometers have this great convenience that the readings require only a very simple correction, which can be applied in a few seconds with the help of Professor Karsten's tables, to render them comparable with each other.

On the Chemical Composition of the Waters of the North Sea.

Before the publication of Forchhammer's great work it was commonly supposed that the composition of sea water was subject to very considerable variation dependent upon geographical distribution, that is to say, that the salts dissolved in sea water were either chemically different or that their relative preparations were subject to considerable alterations, so that samples of sea water collected in different localities might reasonably be expected to give very different results on analysis. Forchhammer came to a very different conclusion. He says :

'It is, besides, a result of my analyses of sea water, that the differences 'which occur in water from different parts of the ocean essentially regard 'the proportion between all salts and water, the strength of sea water, or to 'use another expression, its salinity, and not the proportion of the different 'salts *invicem;* in other words, the difference in the proportion between 'chlorine and water may be very variable, but the proportion between 'chlorine and sulphuric acid, or lime, or magnesia will be found almost 'invariable.'

This important generalisation is based upon a great number of analyses of samples of sea water, chiefly surface water brought from widely different parts of the ocean, and subsequent researches have only tended to confirm it. Forchhammer recognised, however, certain exceptions to this general rule, especially in waters obtained in or near the Arctic Regions, the importance and significance of which have been somewhat overlooked, and there has been a tendency to assume that any differences which might exist between different sea waters were so small as to be beyond the reach of analysis. This, if true, would be a very serious if not insurmountable obstacle to the study of oceanic circulation, as the chemical analysis of different samples of sea waters could then afford no clue as to their origin.

Further, if this be true, it follows that the salinity, that is the percentage of total salts in *any* given sample of sea water, may be calculated with perfect accuracy from the simple determination either of its specific gravity or of the percentage of chlorine which it contains, and also, of course, that the percentage of chlorine may be calculated from the specific gravity and *vice versa.* Professor Dittmar in his report on the composition of ocean water expresses this latter assumption by the formula

$$\frac{{}_4S_t - {}_4W}{\chi} = D\,*$$

where : ${}_4S_t$ is the specific gravity of the sea water at temperature t (water at 4° C. = 1000) and ${}_4W_t$ the specific gravity of pure water at $t°$ (water at 4° C. = 1000).

χ = Chlorine in 1000 parts, or more correctly the total halogen (chlorine, bromine, and iodine) calculated as chlorine.

D = Constant.

A simpler expression is—

$$\frac{{}_tS_t - 1000}{\chi} = D \qquad \left(\begin{array}{c}\text{Pure water at } t° \\ = 1000\end{array}\right)$$

Supposing this uniformity of composition to hold in all strictness for true ocean waters, it is obvious that it must be disturbed near the mouths of rivers, which are known to contribute a continual supply of soluble matter composed of salts mixed in proportions altogether different from those in sea water.

In examining the waters of the firths and estuaries along our coast, it appeared to me to be a problem demanding special attention, in view of its possible bearings upon marine biology and questions generally connected with the life history of our food-fishes, to determine the extent to which the relative proportions of the salts in our firths and estuaries differ from that characteristic of the water of the open sea.

At first sight it might appear that the most direct way of arriving at a solution of this problem would have been to make full analyses of large samples of water collected from a few selected localities. To this course, however, there are serious objections. In the first place, from a simple consideration of the labour involved by each such complete analysis, it was certain that a very great expenditure of time and money would necessarily be incurred before anything like a satisfactory knowledge could be gained of the quantitative composition of the saline matter in the waters of any one firth or estuary.

A still greater objection appears when it is remembered that the magnitude of the differences in the quantitative composition of the soluble matter of such waters would be in all probability not unfrequently very small, so that the unavoidable errors attaching to all analytical determinations might, in some cases at least, more than counterbalance them. This would be especially likely to occur in the determinations of the variations in the relative quantities of such constituents as lime, magnesia, carbonic acid, and the dissolved gases, which are precisely those of more immediate importance with respect to marine biology and in which it is difficult to attain to the highest degree of precision. The accuracy of the analytical determinations of the different constituents of the soluble matter in sea water is by no means equally great. Thus the most skilful analyst will not be able to estimate the magnesia present in sea water with a degree of accuracy at all equal to that to which he can attain in the case of the total halogen.

I therefore adopted from the first the method which has been fully de-

* Physics and Chemistry of the Voyage of H.M.S. Challenger, part. i.

tailed and discussed in my previous reports. For the sake of continuity, it may not be out of place to give here a brief account of my plan of work, the more so as a clear understanding of it is necessary for the purposes of the following discussion of the results arrived at up till now. According to the formula given above, viz., $\frac{{}_4S_t - {}_4W_t}{X} = D$, the chlorine, or rather total halogen calculated as chlorine in unit weight of any given sea water, bears a constant relation to the excess of density of the sea water over that of distilled water of the same temperature. Supposing sea water to be diluted with pure water, while the percentage of chlorine would of course be lowered, this relation would remain unchanged, and D would have the same numerical value.

Supposing, however, sea water to be diluted with river water containing a sufficient quantity of saline matter, of different quantitative composition from that of sea water, the relation between total halogen and the excess of density of the water thus diluted over that of pure water at the same temperature would be altered; in other words, D would be represented by a different number. Therefore, in order to determine whether or not a given sample of sea water contains salts, or more generally matter in solution of appreciably different quantitative composition from that to be found in normal sea water, all that is necessary is to determine with a sufficient degree of accuracy the percentage of total halogen, and the specific gravity of the sample in question. It is possible that an alteration in the value of D should be quite appreciable, and yet the alteration in the relative proportion of any one constituent be almost if not quite inappreciable even to the most refined methods of analysis, because the alteration in the value of D is the result of the alteration in the relative proportions of all the constituents of the dissolved matter, and not merely of any one of them. The addition to sea water of any mixture of soluble matter actually derived from the drainage of the land necessarily tends to increase the value for D.

It is evident that if the determination of the value for D is to be of any real value the determination of the specific gravity must be made with a degree of accuracy corresponding to that of the determination of the amount of chlorine, or total halogen calculated as chlorine. This cannot be said, however, of the great majority of the specific gravity determinations of sea water hitherto published. Hydrometers can indeed be made very delicate, but it does not follow that the accuracy of their indications is at all on a par with their delicacy. Another source of uncertainty is that such hydrometer readings only become comparable when corrected to a common temperature, that is to say, when allowance is made for the alteration in the volume of sea water with change of temperature. If sea water behaved in regard to change of temperature in the same manner as pure water this would be no real difficulty, as the coefficient of expansion of pure water has been determined with a more than sufficient degree of precision.

Sea water, as is now well known, does not behave in this respect precisely as pure water, and the determination of the law of its change of volume with change of temperature has been made the subject of investigation by several authorities; but unfortunately the results are not in sufficiently close agreement, nor has it been proved that they are applicable to sea waters affected by admixture with river water.

For the reasons above stated I thought it better to adopt a method not liable to the various sources of error which infect all hydrometer determinations. Without going into any details, for which I must refer to my previous reports, I may state that in every case my specific gravity determinations are based on direct weighings of the weights of the equal volumes of pure water and of the respective samples of sea water measured in a modified form of Sprengel's pyknometer at the temperature of melting ice. Every weighing was subjected to a correction depending upon the density of the air at the time of weighing, so that the observational error of any weighing was certainly less than 0·00005 grammes.

The chlorines, or more strictly the total halogens calculated as chlorine, were all estimated by Dittmar's titrimetric modification of Volhard's volumetric process. This modification is a happy combination of gravimetric and volumetric methods, and gives results not much inferior to the most careful gravimetric determinations.

Dittmar made two determinations of the value for D under the above conditions. The waters he used for this purpose were obtained by mixing several of the 'Challenger' samples of sea water and diluting portions of this mixture down to different specific gravities. In the one instance referred to, he found D = 1·4593, and in the other D = 1·4619.

The mean of these two numbers is 1·4606, which is to all intents and purposes identical with the value which I have throughout assumed as Dittmar's value for D, viz., 1·4600.

The first series of samples I examined were collected during August and September 1883, in the Moray and adjoining Firths. Some of these samples were collected 20 miles out to sea, where the influence of land water would be presumably at a minimum, as compared with the samples collected from the inshore waters, and especially when compared with the samples collected far up in the Inverness Firth near the entrance to the Caledonian Canal, and which had, of course, a very low specific gravity.

The maximum value for D obtained with the sixteen samples examined was 1·4595, and the minimum 1·4429, the difference therefore from the assumed normal value for ocean water being − 0·0171 as a maximum, and − 0·0005 as a minimum. Moreover, thirteen out of the sixteen samples gave values for D falling between the narrow limits of − 1·4595 and − 1·4551. In each of these cases the value for D actually found was *less* than the theoretical value, but the approximation was so very close that my results could not but be regarded as a remarkable confirmation and indeed extension to these Firth waters of Dittmar's proposition. The influence of the river waters in altering the value for D was hardly perceptible.

To take two extreme cases :—

In a surface sample collected 20 miles out to sea, the specific gravity at 0° C. (water at 0° C. = 1000), or as Dittmar expresses it, ${}_0S_0$, was found to be 1028·26, and the chlorine, or rather total halogen calculated as chlorine, 19·363 grammes per kilo.

$$\text{Therefore, } D = \frac{{}_0S_0 - 1000}{\chi}$$

$$= \frac{28{\cdot}26}{19{\cdot}363} = 1{\cdot}4595.$$

In all these calculations χ represents the number of grammes of total halogen calculated as chlorine per kilo of sea water.

In a sample collected at low water near Clachnaharry, at the head of Inverness Firth, ${}_0S_0$ was found to be 1018·56 and the total halogen 12·726.

$$\text{Therefore, } D = \frac{{}_0S_0 - 1000}{\chi}$$

$$= \frac{18{\cdot}56}{12{\cdot}726} = 1{\cdot}4584.$$

Three years later, in August and September, a second batch of samples was collected from the same locality. The results obtained with these samples were altogether unexpected.

This time also, the values found for D were remarkably uniform, but quite different from those found in 1883. In the 45 samples examined, the value for D ranged from 1·4735 as a maximum to 1·4675 as a minimum, the mean value being 1·4710.

In my last Report, sample 26, being a bottom water collected between the Sutors at the entrance to the Cromarty Firth, appears as exhibiting an altogether abnormal value for D, viz., 1·536. This result was seemingly confirmed by the results obtained with two samples collected in May 1888, from or close to the same place. In Table V. of the same Report, the two samples Nos. 46 and 47 show values for D approximating to that attributed to sample 26, viz., 1·5481 and 1·5466 respectively. At the time there appeared no sufficient grounds for rejecting these results, but as the data which appear in the following tables gradually accumulated, my suspicions regarding these results were again aroused. I was thus led to the discovery of errors of calculation affecting these three results. The misplacement of a decimal point at one stage of the calculation of the total halogen of No. 26, and the insertion of the weights of distilled water not corrected to vacuo in the calculation of the specific gravities of samples 46 and 47, led by a curious coincidence to these three altogether incorrect and yet concordant results. The correct values are 1·4725 for sample 26, and 1·4720 and 1·4700 for samples 46 and 47 respectively. These correct results are in perfect agreement with the other 44, so that there is no longer the same reason for considering the water from this particular locality as being altogether different from the mass of the waters in the Moray Firth generally.

Nevertheless, as will be seen later on, this very spot exhibits peculiarities which, if not so altogether abnormal, are still interesting, and looking back I do not regret that my attention was thus specially directed to it.

These apparent local abnormalities being thus cleared away, the general bearing of the results arrived at so far remains to be considered.

The first conclusion to be drawn from the results obtained with these two sets of samples is, that whatever influence the proximity of land may have on the composition of the waters of the Moray and adjoining Firths, it cannot account for the remarkable difference between the composition of these waters at the two periods in which the two sets of samples were collected, viz., August and September 1883 and August 1886. This is evident from the fact that, although the values for D are so very different in the one set of samples as compared with the others, it is nearly constant in each set. Moreover, the samples of low specific gravity collected at points where the influence of rivers is necessarily greatest, show no such differentiation as would in any degree account for the remarkable difference in the composition of the two sets of samples.

The second conclusion to be drawn from these results is, that the sea water present in these Firths at the time of the first expeditions in 1883 was quite distinct from that present at the time of the expedition of 1886, and that this generic difference extended from the sea inwards to the farthest reaches of the inland firths, and from the surface to the bottom, without exception.

The explanation of this remarkable fact may be derived from a consideration of the results obtained during the last year. The data given in Table IV. relating to the samples collected during the cruise of the 'Jackal' in September and October last, show that both kinds of sea water were present in the North Sea at that period, but in different parts of it.

TABLE IV.

I. Station.	II. Date.	III. Hour.	IV. Depth in Fathoms.	V. Depth at which Sample was taken.	VI. State of Tide.	VII. $_0S_0$.	VIII. χ.	IX. D.	X. Difference from Dittmar's Value for D.	XI. $_4S_0$.	XII. $_4S_{15 \cdot 56}$.	XIII. $_{17 \cdot 5}S_{17 \cdot 5}$	XIV. $_4S_T$.	XV. Alkalinity.	XVI. D_A.
I.	1888 Sept. 3	...	21	Bottom.	...	27·946	19·184	1·4567	−0·0033	27·814	25·65	26·48	...	...	...
II.	Sept. 4	2.16 p.m.	15	,,	Ebb.	27·940	19·191	1·4554	−0·0046	27·808	25·65	26·48	26·67	...	...
IV.	Sept. 5	11.55 a.m.	20	,,	4¼ hrs. flood.	28·038	19·055	1·4714	+0·0114	27·906	25·74	26·57	26·84	57·2	0·4902
V.	,,	9.17 p.m.	9½	Surface.	1 hr. flood.	16·314	11·916	1·4572	−0·0028	16·182	14·60	15·49	15·01	34·4	0·4742
VIII.	Sept. 6	1. 4 p.m.	21	Bottom.	5 hrs. flood.	28·028	19·217	1·4585	−0·0015	27·896	25·73	26·56	26·64	51·8	0·5411
XI.	Sept. 7	9.12 a.m.	6	Surface.	L.W.	27·711	19·041	1·4553	−0·0047	27·586	25·43	26·26	26·24	51·4	0·5391
XII.	,,	10.45 a.m.	7	Bottom.	2 hrs. flood.	28·033	19·236	1·4573	−0·0027	27·901	25·73	26·56	26·55	...	...
XIII.	Sept. 11	8.13 a.m.	23	,,	3½ hrs. ebb.	27·713	18·807	1·4735	+0·0135	27·581	25·43	26·26	26·31	51·6	0·5371
XIV.	,,	8.40 a.m.	25	,,	4 hrs. ebb.	27·517	18·712	1·4705	+0·0105	27·385	25·25	26·08	26·08	58·4	0·4712
XVI.	Sept. 13	11.25 a.m.	23¾	Surface.	2 hrs. flood.	28·189	13·364	1·4557	−0·0043	28·057	25·89	26·72	26·81	51·6	0·5463
,,	,,	,,	,,	ottom.	,,	28·193	19·351	1·4569	−0·0031	28·061	25·89	26·72	26·88	58·0	0·4861
XX.	Sept. 15	7.30 a.m.	17½	,,	1½ hrs. ebb.	28·193	19·337	1·4580	−0·0020	28·061	25·89	26·72	26·81	52·2	0·5401

TABLE IV.—*continued.*

I. Station.	II. Date.	III. Hour.	IV. Depth in Fathoms.	V. Depth at which Sample was taken.	VI. State of Tide.	VII. $_0S_0$.	VIII. χ.	IX. D.	X. Difference from Dittmar's Value for D.	XI. $_4S_0$.	XII. $_4S_{15\cdot56}$.	XIII. $_{17\cdot5}S_{17\cdot5}$	XIV. $_4S_T$.	XV. Alkalinity.	XVI. D_A.
XXI.	1888 Sept. 16	2.4 p.m.	9½	Surface.	L.W.	28·349	19·493	1·4543	−0·0057	28·017	26·04	26·87	27·03	...	...
,,	,,	,,	,,	Bottom.	,,	28·422	19·452	1·4611	−0·0011	28·290	26·10	26·93	27·18	52·6	0·5403
,,	Sept. 17	9.13 p.m.	10½	Surface.	H.W.	28·392	19·488	1·4569	−0·0031	28·260	26·08	26·91	27·00	53·0	0·5357
,,	,,	,,	,,	Bottom.	,,	28·367	19·495	1·4551	−0·0049	28·235	26·06	26·89	27·06	53·0	0·5352
XXII.	Sept. 18	8.50 a.m.	60½	Surface.	5½ hrs. flood.	28·384	19·489	1·4564	−0·0036	28·252	26·07	26·90	27·11	...	...
,	,,	,,	,,	Bottom.	,,	28·420	19·523	1·4557	−0·0043	28·288	26·11	26·94	27·30	52·4	·5424
XXIII.	,,	12.25 p.m.	60	Surface.	3¼ hrs. ebb.	28·364	19·487	1·4557	−0·0043	28·232	26·05	26·88	27·05	52·0	0·5455
,,	,,	,,	,,	Bottom.	,,	28·397	19·503	1·4560	−0·0040	28·265	26·09	26·92	27·44	55·6	0·5107
XXV.	Sept. 19	2.18 p.m.	53	Surface.	...	28·427	19·268	1·4753	+0·0153	28·295	26·11	26·94	27·42	...	...
,,	,,	,,	,,	,,	...	28·436	19·267	1·4759	+0·0159	28·304	26·12	26·95	27·05	52·4	0·5427
,,	,,	,,	,,	Bottom.	...	28·397	19·262	1·4742	+0·0142	28·265	26·09	26·92	27·28	51·2	0·5546
,,	,,	,,	,,	,,	...	28·406	19·262	1·4746	+0·0146	28·274	26·09	26·92	27·28	...	...
XXVI.	,,	6.10 p.m.	85	Surface.	...	27·917	18·928	1·4743	+0·0143	27·785	25·63	26·46	26·45	52·8	0·5287
,,	,,	,,	,,	,,	...	27·914	18·928	1·4742	+0·0142	27·782	25·62	26·45	26·44	...	...

TABLE IV.—*continued.*

I. Station.	II. Date.	III. Hour.	IV. Depth in Fathoms.	V. Depth at which Sample was taken.	VI. State of Tide.	VII. $_0S_0$.	VIII. χ.	IX. D.	X. Difference from Dittmar's Value for D.	XI. $_4S_0$.	XII. $_4S_{15 \cdot 56}$.	XIII. $_{17 \cdot 5}S_{17 \cdot 5}$	XIV. $_4S_T$.	XV. Alkalinity.	XVI. D_A.
XXVI.	1888 Sept. 19	6.10 p.m.	85	Bottom.	...	28·476	19·363	1·4710	+0·0110	28·344	26·15	26·98	27·80	...	...
XXVII.	„	11.25 p.m.	72	Surface.	...	27·828	18·864	1·4752	+0·0152	27·696	25·54	26·37	26·40	52·4	0·5434
„	„	„	„	„	...	27·830	18·864	1·4753	+0·0153	27·698	25·54	26·37	26·40	...	...
„	„	„	„	Bottom.	...	28·483	19·299	1·4759	+0·0159	28·348	26·16	26·99	27·69	53·6	0·5314
„	„	„	„	„	...	28·483	19·299	1·4759	+0·0159	28·351	26·16	26·99	27·69	...	...
XXVIII.	„	5.0 a.m. to 8.24 a.m.	193	Surface.	...	24·669	16·939	1·4563	−0·0037	24·537	22·54	23·39	23·50	52·2	0·4726
„	„	„	„	„	...	24·654	16·932	1·4560	−0·0040	24·522	22·52	23·37	23·48	...	...
„	„	„	„	Bottom.	...	28·463	19·536	1·4569	−0·0031	28·331	26·14	26·97	27·80	55·6	0·5120
XXIX.	Sept. 20	11.4 a.m.	133	Surface.	4¼ hrs. flood.	23·522	16·157	1·4559	−0·0041	23·390	21·45	22·30	22·11	46·8	0·5026
„	„	„	„	Bottom.	„	28·170	19·341	1·4565	−0·0035	28·038	25·87	26·70	27·53	54·0	0·5217
XXX.	„	1.16 p.m.	157	Surface.	H.W.	12·300	8·419	1·4611	+0·0011	12·268	10·79	11·70	11·26	24·4	0·5041
„	„	„	„	Bottom.	„	28·143	19·334	1·4556	−0·0044	28·011	25·84	26·67	27·43	51·6	0·5454
XXXI.	Sept. 24	1.30 p.m.	15 Feet.	Surface.	...	14·577	9·910	1·4710	+0·0110	14·445	12·95	13·84	13·50	25·2	0·5784

TABLE IV.—*continued.*

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.
Station.	Date.	Hour.	Depth in Fathoms.	Depth at which Sample was taken.	State of Tide.	${}_0S_0$.	χ.	D.	Difference from Dittmar's Value for D.	${}_4S_0$.	${}_4S_{15\cdot56}$.	${}_{17\cdot5}S_{17\cdot5}$	${}_4S_T$.	Alkalinity.	D_A.
XXXI.	1888 Sept. 24	1.30 p.m.	15 Feet.	Intermediate.	...	20·858	14·166	1·4724	+0·0124	20·726	18·92	19·79	17·16	...	...
,,	„	,,	„	Bottom.	...	23·427	15·940	1·4697	+0·0097	23·295	21·36	22·21	19·72	44·8	0·5229
XXXIII.	Sept. 25	10.30 a.m.	33	Surface.	...	26·953	18·482	1·4584	−0·0016	26·821	24·68	25·52	25·41	51·2	0·52643
,,	„	,,	„	Bottom.	...	28·171	19·318	1·4583	−0·0017	28·039	25·87	26·70	27·53	...	...
,,	„	,	,	,,	..	28·182	19·343	1·4570	−0·0030	28·050	25·88	26·71	27·54	52·4	0·5378
XXXIV.	„	3.30 p.m.	91	Surface.	...	25·925	17·812	1·4555	−0·0045	25·793	23·73	24·58	24·21	50·8	0·5103
,,	„	,,	„	Bottom.	...	28·170	19·338	1·4567	−0·0033	28·038	25·87	26·70	27·53	53·6	·5256
XXXV.	Sept. 26	10.30 a.m.	21	Surface.	...	15·986	10·931	1·4625	+0·0025	15·854	14·29	15·18	14·60	38·8	0·4120
,,	„	,,	„	Bottom.	...	26·395	18·119	1·4567	−0·0033	26·263	24·18	25·02	25·05	49·4	0·5343
XXXVI.	Sept. 27	8.0 a.m.	6¾	Surface.	...	10·472	7·155	1·4635	+0·0035	10·340	9·05	9·97	9·46	...	...
XXXVII.	Oct. 1	11.0 a.m.	4½	Bottom.	...	13·732	9·376	1·4647	+0·0047	13·600	12·15	13·05	12·70	39·8	0·3450
XXXVIII.	„	1.30 p.m.	15	Surface.	...	6·706	4·551	1·4735	+0·0135	6·574	5·42	6·35	5·87	33·6	0·1996
,,	„	,,	„	Bottom.	...	6·711	4·564	1·4703	+0·0103	6·579	5·48	6·41	5·86	32·4	0·2071
XXXIX.	Oct. 2	6.9 a.m.	7½	Surface.	...	11·016	7·530	1·4629	+0·0029	10·884	9·56	10·47	10·12	34·8	0·3165

TABLE IV.—*continued.*

I. Station.	II. Date.	III. Hour.	IV. Depth in Fathoms.	V. Depth at which Sample was taken.	VI. State of Tide.	VII. $_0S_0$.	VIII. χ.	IX. D.	X. Difference from Dittmar's Value for D.	XI. $_4S_0$.	XII. $_4S_{15 \cdot 56}$.	XIII. $_{17 \cdot 5}S_{17 \cdot 5}$	XIV. $_4S_T$.	XV. Alkalinity.	XVI. D_A.
XXXIX.	1888 Oct. 26	6.9 a.m.	7½	Bottom.	...	15·325	10·496	1·4601	+0·0001	15·193	13·66	14·55	14·26	41·6	0·3684
XL.	„	11.15 a.m.	15	„	...	21·489	14·605	1·4712	+0·0112	21·357	19·52	20·38	20·51	...	...
XLIII.	Oct. 8	10.30 p.m.	47	Surface.	...	27·912	18·906	1·4764	+0·0164	27·780	25·62	26·45	26·63	...	...
„	„	„	„	„	...	27·915	18·906	1·4766	+0·0166	27·783	25·62	26·45	26·63	...	...
„	„	„	„	Bottom.	...	28·277	19·214	1·4717	+0·0117	28·145	25·97	26·80	27·65	...	...
XLIV.	Oct. 9	1.50 p.m.	19½	Surface.	3 hrs. flood.	28·013	19·043	1·4710	+0·0110	27·881	25·72	26·55	26·80	52·2	0·5366
„	„	„	„	Bottom.	„	28·000	19·032	1·4712	+0·0112	27·868	25·71	26·54	26·81	52·6	0·5323

A reference to the values for D given in Table IV. column IX. will show that almost all the samples collected at Stations I. to XXIV. in the early part of the cruise along the east coast of Scotland, and off the Orkney and Shetland Islands, had practically the same composition as the waters found in the Moray Firth in the summer of 1883. The values for D ranging between 1·4611 and 1·4543 in seventeen out of the twenty bottom and surface samples. The three exceptions are the bottom water near the Isle of May at the mouth of the Firth of Forth (Station IV.), and the bottom waters from between the Sutors at the entrance of the Cromarty Firth (Stations XIII. and XIV.)—the values for D in these samples being 1·4714, 1·4735, and 1·4705 respectively. But on crossing over from Shetland to Norway, the 'Jackal' passed through a great tract of water the composition of which both at surface and bottom was the same as that found in the Moray Firth in the summer of 1886. The value for D belonging to the six samples collected at Stations XXV., XXVI., and XXVII. range from 1·4759 to 1·4710.

On nearing the coast of Norway, the composition of the sea water reverted to that found generally off the Scottish coast, but as the Baltic was approached the character of the water again changed. In the Sound, Stations XXXVI. and XXXVII., and in the Baltic, Stations XXXVIII., XXXIX., and XL., the values for D again approximate to 1·4710. The samples collected during the homeward passage at Stations XLIII. and XLIV., which are situated in the southern part of the northern area of the North Sea, that is, to the north of the Dogger Bank, all correspond in composition to those found at Stations XXV., XXVI., and XXVII., more than 200 miles further north.

The water corresponding to that found in the Moray Firth in the summer of 1886, if we look away for the moment from the samples collected in or near the Baltic, is seen to have occupied, broadly speaking, a central position, while the waters corresponding to that found in the Moray Firth in the summer of 1883 were apparently confined to a comparatively narrow strip along the coast.

It must not, however, be supposed that this is due to any influence of land or of rivers draining the land. The result obtained with the Moray Firth samples collected in 1883 and 1886 are proof to the contrary. Further, as already stated, the influence of the land waters would necessarily tend to raise the value for D, and not to lower it. Any addition to sea water of salts containing a less proportion of chlorine, or what is much the same thing, a less proportion of common salt, must necessarily raise the value for D. Now the salts derived from the drainage of the land uniformly contain a much smaller proportion of common salt than that found in sea water. Moreover the effect of such admixture of sea water with land water is really very small. I have come to the conclusion that the presence of land water in sea water may be better traced, apart from the lowering of the specific gravity produced thereby, by the determination of the alkalinity of the sea water, that is to say, by the determination of the amount of bases present in combination with carbonic acid.

TABLE V.

I. Date.	II. Hour.	III. Station.	IV. Depth in Fathoms.	V. Depth at which Sample was taken.	VI. State of Tide.	VII. ${}_0S_0$.	VIII. χ.	IX. D.	X. Difference from Dittmar's Value for D.	XI. ${}_4S_0$.	XII. ${}_4S_{15\cdot56}$.	XIII. ${}_{17\cdot5}S_{17\cdot5}$	XIV. ${}_4S_T$.
1889. Jan. 21	9.20 a.m.	II.	16	Surface.	$4\frac{1}{4}$ hours flood.	27·861	19·136	1·4559	−0·0041	27·73	25·57	26·40	27·04
,,	,,	,,	,,	Bottom.	,,	27·872	19·146	1·4557	−0·0043	27·74	25·58	26·41	27·04
,,	11.45 a.m.	V.	23	Surface.	$\frac{1}{2}$ hour ebb.	27·924	19·181	1·4558	−0·0042	27·79	25·63	26·46	27·07
,,	,,	,,	,,	Bottom.	,,	27·970	19·206	1·4563	−0·0037	27·84	25·68	26·51	27·12
Jan. 22	8.20 a.m.	XV.	50	Surface.	$2\frac{1}{4}$ hours flood.	28·085	19·294	1·4556	−0·0044	27·95	25·78	26·61	27·20
,,	,,	,,	,,	Bottom.	,,	28·249	19·400	1·4561	−0·0039	28·12	25·94	26·77	27·34
,,	1.15 p.m.	XIX.	,,	Surface.	$1\frac{1}{4}$ hours ebb.	28·317	19·428	1·4576	−0·0024	28·19	26·01	26·84	27·43
,,	,,	,,	,,	Bottom.	,,	28·442	19·527	1·4565	−0·0035	28·31	26·12	26·95	27·46
Jan. 24	12.15 p.m.	XXIV.	30	Surface.	$5\frac{1}{4}$ hours flood.	28·346	19·472	1·4558	−0·0042	28·22	26·04	26·87	27·42
,,	,,	,,	,,	Bottom.	,,	28·338	19·460	1·4562	−0·0038	28·21	26·03	26·86	27·39
,,	3.0 p.m.	XXV.	42	Surface.	2 hours ebb.	28·340	19·471	1·4555	−0·0045	28·21	26·03	26·86	27·41
,,	,,	,,	,,	Bottom.	,,	28·388	19·479	1·4574	−0·0026	28·26	26·08	26·91	27·42

TABLE VI.

I. Date.	II. Number.	III. Latitude.	IV. Longitude.	V. $_0S_0$	VI. χ	VII. D	VIII. Difference from Dittmar's value for D.	IX. $_4S_0$	X. $_4S_{15\cdot56}$	XI. $_{17\cdot5}S_{17\cdot5}$	XII. Remarks.
1888. May 11	1	77° 38′ N.	3° 14′ E.	27·743	18·840	1·4726	+0·0126	27·61	25·46	26·29	Amongst drift ice. Water dark green. Birds very numerous.
June 1	2	78° 47′ N.	3° 6′ E.	27·517	18·687	1·4726	+0·0126	27·39	25·25	26·08	Amongst drift ice. Water dark green. Birds numerous.
,, 3	3	79° 10′ N.	0° 25′ W.	27·865	18·947	1·4707	+0·0107	27·73	25·57	26·40	Fields of ice numerous. Water blue and clear and destitute of life.
,, 21	4	74° 27′ N.	13° 57′ W.	27·419	18·624	1·4722	+0·0122	27·29	25·15	25·98	Amongst floes. Water blue and clear. No life.
July 31	5	75° 15′ N.	10° 30′ W.	25·573	17·374	1·4719	+0·0119	25·44	23·40	24·25	Near the ice. Water dark green. Much life apparent.
Aug. 19	6	72° 2′ N.	13° 2′ W.	25·417	17·286	1·4704	+0·0104	25·29	23·25	24·09	Near the ice. Blue water. Not much life.
,, 30	7	62° 44′ N.	0° 30′ W.	28·065	19·071	1·4716	+0·0116	27·93	25·76	26·59	Open sea. Water dark green.

Turning now to Table V., which gives the results obtained with 12 samples collected by Mr King in January 1889 off the northern coast of Scotland, the values for D will be seen to range within the narrow limits of 1·4576 and 1·4555, and on the other hand a reference to Table VI. will show that the seven samples of surface water collected in the summer of 1888 in high northern latitudes, and kindly entrusted to me for analysis by Mr Robert W. Grey, have values for D ranging between the similarly narrow limits of 1·4726 and 1·4704. I am much indebted to Mr Grey for these samples. The light thrown by their composition on the matter in hand is very great. I am now of opinion that the waters in the North Sea which show a value for D approximating to 1·471 come from very high latitudes, if not from the Arctic Ocean, and that those which show a value for D approximating to 1·455 come in the first instance from the surface of the North Atlantic Ocean, and are moreover in all probability of southern origin.

These conclusions appear to me to be in accordance with the observations made during the 'Pommerania' Expedition as well as with those made during the recent cruise of the 'Jackal.' From the brief sketch which I have endeavoured to give of Dr Meyer's Report, it will be readily understood, for instance, why in the passage across from the Shetland Islands to Norway, after passing over a great tract of water giving values for D approximately to 1·4710, water should be met with close to the Norwegian coast at Station XXVIII. giving low values for D corresponding to the water met with off the Orkney and Shetland Islands, and generally along the Scottish coast. While in the Shetland Islands, we were still on the borders of the surface Atlantic waters of southern origin; on crossing over, we traversed a great mass of water of northern or Arctic origin, and finally again met with water showing a low value for D close to the coast of Norway just where it ought to have been found according to Dr Meyer's view, by which surface Atlantic water finds its way through the English Channel into the southern area of the North Sea, passes out from this southern area as a current hugging the coasts of Schleswig-Holstein and Jutland, enters the Skagerack, is there deflected northwards along the Norwegian coast, where we found it.

The samples of the bottom water at Stations XXVIII. and XXIX. did not give such high values for D as might have been expected, supposing there to be an under-current of water of northern or Arctic origin flowing southwards along the Norwegian coast. I do not think, however, that it would be safe to draw any conclusions from these isolated results. It is a matter for further investigation.

The influence which the rivers draining the north of Europe have in altering the composition of the sea water entering the Baltic is shown in a striking manner by the results obtained with the samples collected in the Cattegat, in the Sound, and in the Baltic.

At Station XXXIV., off the Naze, the value for D was 1·4555 for the surface water and 1·4567 for the bottom water, the depth being 91 fathoms. The water at this point, therefore, showed at surface and bottom the composition which I take to be characteristic of the surface Atlantic water which flows into the North Sea. The surface water was evidently affected by the outflow from the Baltic, as its density at 0° C. (${}_4S_0$) was only 1025·793, the density of the bottom being 1028·038. At Station XXXV. in the Cattegat, the density fell to 1015·854 at the surface and 1026·263 at the bottom. The effect of the fresh water salts in altering the relation between chlorine and density is still not perceptible in the denser bottom water, the value for D found for this water being only 1·4567; but in the case of the surface water it begins to make itself felt, the value for D having risen to 1·4625. After this the value for D steadily rises as the Baltic is approached, being 1·4635 and 1·4647 at Stations XXXVI. and XXXVII. in the Sound to the south of Copenhagen, and 1·4735 in the surface water and 1·4703 in the bottom water at Station XXXVIII. in the Baltic.

The density ($_4S_0$), as will be noticed, falls as the value for D increases. At Station XXXVIII. it fell to 1006·574 at the surface and 1006·579 at the bottom. At Station XXXIX. the density increased to 10·884 at the surface and 1015·193 at the bottom, the values for D falling to 1·4629 and 1·4601 respectively.

The determinations of alkalinity made during the cruise threw a great deal of light upon the question of the influence of fresh water in raising the value for D. I intend to determine the alkalinity of a number of the samples in my possession, and to communicate the results of my investigation on this subject at a later date.

The merit of attracting attention to the fact of the alkalinity of sea water belongs to Tornoë, the author of the Report on the Chemistry of the Norwegian North Atlantic Expedition. During the cruise I determined the alkalinity of a number of samples by boiling 250 cc. of the sea water with excess of a carefully standardised solution of hydrochloric acid and titrating back with lime water. Aurine was used as an indicator; the end point being of course determined repeatedly. This is practically Tornoë's method. The use of lime water was suggested by Dittmar. As Dittmar points out, such determinations are liable to error if the boiling with excess of acid is done in glass vessels, owing to the action of the solution on glass. He accordingly used porcelain basins. In order to make quite sure of the absence of any such error I used large platinum basins. In Column XV., Table IV. the results which I obtained are given calculated to miligrams of carbonic acid per litre. Under the heading Da, Column XVI. Table IV., the numbers obtained by dividing those in Column VII. by those in Column. XV. will be found.

They express the relation between alkalinity and the excess of density of the sea water over that of pure water under the same conditions, and are in this respect analogous to those given under the heading D in Column IX. When, therefore, the alkalinity increases relatively to the density, the value Da decreases just as the value for D decreases when the chlorine increases relatively to the density.

The samples collected in or near the Baltic show remarkably low values for Da, and moreover the value for Da decreases in those samples when the value for D increases. Take the extreme case of the surface sample collected at Station XXXVIII. in the Baltic. This water we may suppose to have resulted from the mixing of water of high specific gravity, such as the bottom water off the Naze, Station XXXIV., with the fresh water flowing into the Baltic from the land.

Now, if we compare the density ($_4S_0$) of the bottom water at Station XXXIV. with that of the surface water at Station XXXVIII., it will be seen to have fallen from 1028·038 to 1006·574, but the alkalinity has only fallen from 53·6 to 33·6. Had this bottom water from Station XXXIV. been mixed with pure water until its density had fallen to that of the surface water at Station XXXVIII., then the alkalinity would have fallen from 53·6 to about 12·6. Subtracting 12·6 from 33·6, the alkalinity due to the fresh water is 21 mg. Thus about two-thirds of the total alkalinity, or to put it in another way, two-thirds of the total bases present as carbonate in this brackish water, were originally contained in the fresh water, and only about one-third in the sea water. To put the matter in another light, let the 21 mg. of carbonic acid per litre contributed by the fresh water be supposed to be due to the presence of carbonate of lime, then there would be approximately 47·5 mg. per litre of carbonate of lime mixed with the salts contributed by the sea water.

Now, besides carbonates there are present in river water other salts, notably sulphates, which all tend to alter the relation between chlorine and density in the same direction, that is, to increase the value for D. If for the purpose of illustration the amount of these other salts be assumed to be equal in amount to the carbonates as measured by the alkalinity, 95 mg. per litre would be the amount of salts contributed by the fresh water. If also for the purpose of illustration merely, the excess of density ($_0S_0$) of this brackish water over that of distilled water under the same conditions, namely 6·706, be taken as representing the number of grammes of total salts present in it per litre a rough approximation to the quantity of sea salts proper present in one litre of this brackish water will be obtained by subtracting the 95 mg., from 6·706, and if the remainder, namely 6·611 grammes, be divided by the number of grammes of chlorine actually found in this water, namely 4·55 the value for D corresponding to the sea water as it was before dilution with fresh water of the Baltic becomes 1·4529, while the observed value for D corresponding to the water found at the botton off the Naze was 1·4567.

Considering the very rough and ready method which I have adopted for the purpose of illustration, this is a very close approximation, and goes far to prove that the sea water entering the Baltic at the time was surface Atlantic water similar to that actually found off the Naze.

Were this brackish water from the Baltic concentrated by evaporation until it had a density equal to the cold water flowing into the North Sea from the north, the mere determination of the density and the chlorine might not be sufficient to detect any difference between the two, as the value for D would be very much the same in both cases. But the determination of the alkalinity would at once show the difference, for the water obtained by concentrating the brackish water of the Baltic would have an alkalinity about three times greater than that of the North Sea water.

This would seem to show that the high value for D characterising the cold North Sea water cannot be solely due to the influence of land water. The only other cause which I can suggest as possibly sufficient to produce such a water from water having the composition of the surface Atlantic water as it flows into the North Sea is the formation and subsequent melting of sea water ice. According to Petterson's observations, the water obtained by melting sea water ice from the Arctic regions and also from the Baltic contains a much higher proportion of sulphates to chlorides than that characterising the sea water from which the ice was produced. That is to say, that the value of D would be greater in the water obtained by melting the sea water ice than in the original sea water.

On the other hand, the action of the various forms of life, vegetable and animal, existing in such enormous profusion in the warmer waters of the south must tend to lower the value for D, inasmuch as they abstract substances other than common salt and thus tend to increase the chlorine relatively to density.

The whole subject is one of great difficulty and complexity, and I offer these suggestions as to the origin of these two different waters and as to the causes which may have brought about their difference in chemical composition, not because I attach much importance to them in the present state of our knowledge, but simply as a basis for discussion. The problem cannot be satisfactorily solved until a clearer insight has been attained into the distribution of such differences in the chemical composition of ocean waters. What I do consider important is the fact of the difference in the chemical composition of these waters and the application of the method I have adopted for the recognition of such differences.

To return to the Moray Firth, a further confirmation of the view that the waters which filled it in August and September 1883 really came from the surface of the Atlantic is to be found in the relatively high temperatures observed by me on that occasion along the bottom as well as at the surface. The lowest bottom temperatures which I met with were 51°·8 and 51°·9 F. respectively, while the mean bottom temperature calculated from the observations made in the Moray Firth at depths not less than 8 fathoms and excluding those observed in the shallow waters of the Cromarty and Inverness Firths, and those near the mouth of Spey, was 52°·5. Now Dr Mill in August 1886 found that in the Moray Firth the great mass of the water, all that lying below a depth of 6 fathoms off the Caithness coast and 12 off the Morayshire coast, was at a temperature between 52° and 50°·5; on one occasion he found the temperature near the bottom at a depth of 33 fathoms as low as 49°·5—the mean of 10 bottom temperatures in the Moray Firth being only 51·0.

The question now arises as to how the interchange of waters in the Moray Firth comes about. Dr John Murray's extremely suggestive observations with regard to the action of wind on the surface of the water in the Scottish lochs appear to give the clue. Suppose at a time when the Moray Firth is filled as it was in August 1883 with warm surface Atlantic water, that the wind should commence blowing steadily from the south-west. The surface water in the wedge-shaped estuary would then be blown out to sea, while the wind acting on the entire surface of the water in the estuary would prevent more or less completely the setting in of any surface return current. It follows that the surface water blown out to sea must be replaced by water flowing in along the bottom. An undercurrent would set in therefore flowing from out to sea, towards the head of the Firth, that is, in an opposite direction to that of the wind.

Now in the northern area of the North Sea there is a lower layer of water markedly colder than the water which flows in from the Atlantic round the North of Scotland and through the English Channel, and further the analytical results ~~detailed above~~ clearly show that these waters differ not merely in temperature but in chemical composition. If then the wind continued blowing steadily for a sufficient time in the same direction, the result would be that the layer of water which at the commencement was at the surface in the Moray Firth would all be blown out to sea, and that the water which was originally at the bottom of the Firth would come to the surface, and its place be taken in turn by the colder water from the North Sea. We should thus expect to find at this stage the surface water in the Moray Firth different in chemical composition from that at the bottom. If, however, the wind continued blowing in the same direction for a sufficiently long period, the whole of the water originally present in the Firth would be blown out to sea and replaced by water flowing in along the bottom, and thus the action of the wind would result in an entire and complete replacement of the warm Atlantic water originally filling the Moray Firth by bottom water from the North Sea.

This process may no doubt be followed to a certain extent by means of the thermometer and hydrometer without the help of any chemical analysis, but the indications thus arrived at are at once less easily interpreted and more uncertain than those given by the method described above. Moreover, the use of purely physical means could not lead to the recognition of the very important distinction between the two sets of waters, that, namely, of chemical composition.

This superiority is very clearly shown by a comparison of the information given as to the state of matters near Smith Bank in the Moray Firth in February last, by the two methods respectively. What is the conclusion to be drawn from the observations of temperature and specific gravity ~~detailed in Table III~~. Surely that of almost perfect uniformity. These purely physical observations give no clear indication of the advance of the water along the bottom from the North Sea into the Moray Firth, which was undoubtedly taking place at the time. The temperature and the specific gravity of the surface, intermediate, and bottom layers are almost identical. And yet at the time these observations were made, the process of replacement of the one kind of water by the other was actually in progress. Shortly before the 'Jackal' went to the Moray Firth a series of westerly and north-westerly gales passed over the North of Scotland. The observations in the Pentland Firth towards the end of January were impeded by the strong north-westerly winds prevailing, and very unfortunately the weather in the Moray Firth was such as to make it impossible to complete the whole of the observations as originally planned. The results given in Table VII. are however quite sufficient to exemplify the intermediate stage in the replacement in the Moray Firth of the surface Atlantic water by the bottom water of the North Sea. Without exception the samples of water collected from the *bottom* give values for D higher than 1·4700, and with one significant exception the *surface* waters give on the other hand values for D lower than 1·4600, that is to say, the water found at the bottom of Moray Firth corresponded in chemical composition to the samples collected during the cruise of the 'Jackal' from the central portion of the North Sea and also to the samples collected by Mr Grey in northern latitudes, and on the other hand the chemical composition of the surface samples was practically identical with the water found some twelve days previously filling the whole area immediately to the north of Scotland. The one exception is the surface water at Station I., but so far from being in contradiction with the view above stated, it may be said to prove the rule. When these results were first tabulated this apparent discrepancy at once caught my attention.

The fact that this sample was collected in the narrow channel between the Sutors, taken in conjunction with the fact that the other surface sample collected at the same spot gave a value for D in accordance with all the other surface samples, led me to express the following opinion:—If the view be correct that a value for D higher than 1·4700 is characteristic of the North Sea water flowing in along the bottom, then this particular sample must have been collected during flood tide when the strong inflow through the narrow channel might easily bring the water from lower layers to the surface, and further, the sample from the same spot, which gave a value for D corresponding with all the other surface samples, must have been collected at ebb tide.

At the time I had nothing but a table giving the analytical results and the number of the stations at which the different samples were collected. When I looked up the observation books I found that the first sample had been collected at $3\frac{1}{2}$ hours' flood and the second at $2\frac{1}{2}$ hours' ebb.

The uniformity in the temperature from surface to bottom observed on this occasion as occurring generally in the Moray Firth, may, I think, be easily explained when it is remembered that the weather previous to the commencement of the gales which brought about this interchange of waters had been very cold, and that the layer of Atlantic water still found at the surface when the samples were collected was so thin as to permit the lower

TABLE VII.

I. Date.	II. Hour.	III. Station.	IV. Depth in Fathoms.	V. Depth at which Sample was taken.	VI. State of Tide.	VII. ${}_0S_0$.	VIII. χ.	IX. D.	X. Difference from Dittmar's Value for D.	XI. ${}_4S_0$.	XII. ${}_4S_{15\cdot56}$.	XIII. ${}_{17\cdot5}S_{17\cdot5}$.	XIV. ${}_4S_T$.
1889 Feb. 6	2.10 p.m.	I.	30	Surface.	$3\frac{1}{4}$ hours flood.	26·468	18·010	1·4696	+0·0096	26·34	24·25	25·09	26·20
,,	,,	,,	,,	15 fathoms.	,,	26·874	18·237	1·4735	+0·0135	26·74	24·63	25·47	26·38
,,	,,	,,	,,	Bottom.	,,	26·869	18·229	1·4741	+0·0141	26·74	24·63	25·47	26·37
Feb. 7	7.45 a.m.	,,	,,	Surface.	$2\frac{1}{2}$ hours ebb.	26·188	17·968	1·4575	−0·0025	26·06	23·98	24·82	25·78
,,	,,	,,	,,	15 fathoms.	,,	26·894	18·467	1·4563	−0·0037	26·76	24·65	25·49	26·41
,,	,,	,,	,,	Bottom.	,,	26·972	18·301	1·4738	+0·0038	26·84	24·73	25·56	26·47
Feb. 6	2.50 p.m.	II.	20	Surface.	$3\frac{3}{4}$ hours flood.	26·215	18·075	1·4503	−0·0097	26·08	24·00	24·84	...
,,	,,	,,	,,	10 fathoms.	,,	26·879	18·438	1·4578	−0·0022	26·75	24·64	25·48	...
,,	,,	,,	,,	Bottom.	,,	27·094	18·380	1·4741	+0·0141	26·96	24·84	25·67	...
Feb. 7	1.50 p.m.	VI.	,,	Surface.	3 hours flood.	28·058	19·265	1·4564	−0·0036	27·93	25·76	26·59	27·37
,,	,,	,,	,,	Bottom.	,,	28·054	19·004	1·4762	+0·0162	27·92	25·75	26·58	27·36
Feb. 7	5.15 p.m.	IX.	40	Surface.	h-w.	28·000	19·209	1·4576	−0·0024	27·87	25·70	26·53	27·30
,,	,,	,,	,,	Bottom.	,,	28·013	19·025	1·4725	+0·0125	27·88	25·71	26·54	27·30

layer to appear at the surface of the water between the Sutors when flowing with the flood tide into the Cromarty Firth.

The fact that the sample collected during ebb tide at 15 fathoms from the surface at the same spot shows so low a value for D seems to make it probable that inside the Cromarty Firth the interchange of water had not been so complete as outside. This interchange must indeed be considerably retarded by the narrowness of the entrance to the Cromarty Firth, so that a certain amount of temporary differentiation between the water in the Cromarty Firth and that outside must frequently occur.

This appears to have been the case in 1883 when, as pointed out in my first report, the samples collected in or near the mouth of the Cromarty Firth gave the lowest value for D.

A purely local peculiarity already referred to remains to be noticed. The depth of water in the channel between the Sutors is much greater than that outside or inside of the Sutors. At one spot it even reaches over 30 fathoms, while the depth outside and inside is only about 6 or 7 fathoms. Now, if once the cold heavy water from the North Sea gets into this deep hole, it may lie there for a long time before it mixes with the waters flowing to and fro over it. The waters in this hole may thus have a composition corresponding to that to be found at the bottom of the northern area of the North Sea, while the mass of the water in the Cromarty Firth has the composition of surface Atlantic water mixed of course with fresh water. This appears to have been the state of matters when the 'Garland' visited the Cromarty Firth in May 1888. All the samples collected by Mr F. M. Gibson in the Cromarty Firth on this occasion and subsequently examined, gave values for D (Table VIII.) corresponding with what I assume to be surface Atlantic water, except the two bottom samples from between the Sutors at Stations IV. and VI., the one being collected at low water and the other at about 2 hours flood.

From the data given in Table VIII. it seems almost certain that at this time the mass of the water in the Moray Firth, or at least near the head of the Moray Firth, was surface Atlantic water. Excluding the two samples above mentioned, the value for D varies within the narrow limits of 1·4578 and 1·4541 in the other thirteen samples collected at different localities at varying states of the tide, and having densities (${}_4S_0$) ranging from 1018·51 to 1027·52. Nothing could more clearly show how very small is the difference in the chemical composition of sea water produced by admixture with even a large proportion of ordinary river water. It cannot indeed be otherwise, for the total salts in river water are measured in miligrams per litre, while normal sea water contains over 30 grams per litre. The dilution therefore of sea water with its own volume of river water means only the addition of say one or two centigrams of river salts to 30 grams of sea salts.

Summary and Conclusions.

Water in which the total halogen calculated as chlorine bears a practically constant ratio to the excess of the density of the water over that of pure water of equal temperature was during last summer found over a great area reaching from 79° north latitude down to the North Sea in 56° north latitude. Under the conditions in which I worked, the number (D) expressing this ratio may be taken as slightly over 1·4710.

On the other, hand water which, to judge from the comparatively high temperature which it still retains on reaching our shores, must have come from southern latitudes flows into the North Sea from the surface of the Atlantic round the north of Scotland, and also through the English Channel. This water gives evidence of an equally constant, though

TABLE VIII.

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Depth.	VI. Wind.	VII. Tide.	VIII. Air Temp.	IX. Depth of Obs.	X. Temp. of water. Fah.	XI. Temp. of water. Cent.	XII. No. of Ther.	XIII. $_0S_0$	XIV. χ	XV. D.	XVI. Difference from Dittmar's value for 2.	XVII. $_4S_0$	XVIII. $_4S_{15\cdot56}$	XIX. $_{17\cdot5}S_{17\cdot5}$	XX. $_4S_T$.
1888 May 30	p.m. 12.55	I.	Cromarty Anchorage. Hugh Miller's Mon. S.E. by S. ¼ S. Ferry Hotel, E. by N.	5	W.	...	54·0	Surface.	49·9	9·95	5	...	...	...	...	...	...	...	...
„	„	„	„ „	„	„	...	„	Bottom.	49·1	9·50	7	26·876	18·450	1·4567	−0·0033	26·75	24·64	25·48	25·80
„	4.0	II.	Mid Channel. E. Nigg Sands Buoy, N. E. Sutor, E. by S. ¼ S.	14⅓	W.	...	55·6	Surface.	49·5	9·70	5	27·187	18·663	1·4568	−0·0032	27·06	24·94	25·78	26·07
„	„	„	„ „	„	„	H.W.	„	7⅙ faths.	49·0	9·45	7	27·430	18·826	1·4570	−0·0030	27·30	25·16	25·99	26·34
„	„	„	„ „	„	„	„	„	Bottom.	49·0	9·45	7	...	...	...	...	...	...	...	...
„	4.40	III.	E. Nigg Sands Buoy (close to).	11	W.	...	57·0	Surface.	49·8	9·90	5	27·204	18·668	1·4573	−0·0027	27·07	24·95	25·79	26·05
„	„	„	„ „	„	„	...	„	Bottom.	49·0	9·45	7	...	...	...	...	...	...	...	...
June 2	12.10	IV.	W. Sutor, W. by S. Ferry Inn, N. W. by N.	24	E.S.E.	L.W.	45·8	Surface.	48·1	8·95	5	26·742	18·358	1·4566	−0·0034	26·61	24·51	25·35	25·75
„	„	„	„ „	„	„	„	„	12 faths.	47·3	8·50	7	27·543	18·917	1·4560	−0·0040	27·41	25·27	26·10	26·60
„	12.25	„	„ „	„	„	„	„	Bottom.	47·0	8·35	7	27·590	18·745	1·4719	+0·0119	27·46	25·32	26·15	...
„	1.5	V.	Ferry, N. W. by W. Fort-George, S. W. ¼ W.	6	„	First of flood.	45·1	Surface.	48·1	8·95	5	26·949	18·510	1·4559	−0·0041	26·82	24·70	25·54	25·95

TABLE VIII.—*continued.*

I. Date.	II. Hour.	III. Station.	IV. Position.	V. Depth.	VI. Wind.	VII. Tide.	VIII. Tide.	IX. Depth of Obs.	X. Temp. of water. Fah.	XI. Temp. of water. Cent.	XII. No. of Ther.	XIII. $_0S_0$	XIV. χ	XV. D.	XVI. Difference from Dittmar's value for 1 D.	XVII. $_4S_0$	XVIII. $_4S_{15\cdot56}$	XIX. $_{17\cdot5}S_{17\cdot5}$	XX. $_4S_T$.
1888 June 2	p.m. 1.5	V.	Ferry, N. W. by W. Fort-George, S. W. ¼ S.	6	E.S.E.	First of flood.	45·1	Bottom.	47·5	8·60	7	...	...	...	...	...	...	...	...
„	1.25	VI.	Mid Channel. Cromarty Light, W. by N. West Suter, S.	28	„	...	44·8	Surface.	48·5	9·15	5	26·798	18·414	1·4553	−0·0047	26·67	24·57	25·41	25·79
„	1.35	„	„ „	„	„	...	„	14 faths.	47·0	8·35	7	27·654	18·970	1·4578	−0·0022	27·52	25·37	26·20	26·72
„	1.40	„	„ „	„	„	2 hrs. flood.	„	Bottom.	47·0	8·35	7	27·640	18·801	1·4701	+0·0101	27·51	25·36	26·19	...
June 4	3.0	VII.	Store House, N. Balconie Point, W. ¼ S.	4	E.	First of flood.	47·2	Surface.	46·9	8·30	5	18·641	12·795	1·4569	−0·0031	18·51	16·81	17·69	17·99
„	„	„	„ ,	„	„	„	„	Bottom.	47·0	8·35	7	...	...	...	...	...	...	...	...
„	8.15	VIII.	Alness Store, W. by N. ¾ N. Invergordon Free Church, N. by E.	11½	Calm.	H.W.	46·1	Surface.	48·0	8·90	7	25·164	17·275	1·4567	−0·0033	25·03	23·00	23·84	24·23
„	„	„	„ „	„	„	„	„	Bottom.	47·0	8·35	5	26·960	18·508	1·4567	−0·0033	26·83	24·72	25·56	26·06
June 5	8.45	IX.	Quarry Black Isle, S. by E. Noven House, Alness, W. by N. ¾ N.	7½	Calm.	nearly H.W.	54·7	Surface.	47·3	8·50	5	...	...	...	...	...	...	...	...
„	„	„	„ „	„	„	„	„	Bottom.	46·9	8·30	7	27·351	18·810	1·4541	−0·0059	27·22	25·09	25·92	26·43

different chemical composition to that of the water coming from the north, and is characterised according to my determinations by a value for D about 1·4556. It was found during the cruise of the 'Jackal' lying off the East Coast of Scotland, and stretching northward as far as Balta Sound in North Unst, the farthest point to the north visited by the 'Jackal' during the cruise. It was also traced as a narrow band lying immediately off the coast of Norway. The water forming this band may be assumed to have entered the North Sea by the English Channel, with a degree of probability approaching to certainty. The observations made during the 'Pommerania' Expedition as to the direction of the currents, the temperature, and the specific gravity of the different waters in the North Sea, confirmed by the observations of a similar character made during the short cruise of the 'Jackal' and taken along with the apparently identical composition of this water with that flowing in from the Atlantic round the North of Scotland, appear to me to lead to this and no other conclusion.

A third though less important contribution to the waters of the North Sea is the outflow from the Baltic, which also flows northward along the Norwegian coast. It is characterised by its low specific gravity, its high temperature in summer, and its high alkalinity.

The cold dense water coming from the north occupies in general a somewhat central position in the North Sea. The explanation of its having been found at the surface, and not under a superficial layer of surface Atlantic water, may be in a great measure ascribed to the action of the wind. The North Sea, with the exception of the comparatively narrow outlets into the English Channel and into the Baltic, is bounded on three sides by land, and is open to the north. When the wind therefore blows over the surface of the North Sea, from any point of the compass with a touch of south in it, it will tend to blow out the surface Atlantic water and bring in the cold water from the north along the bottom. The advance southwards of this cold water, as is well known, is arrested by the Dogger Bank, to the north of which therefore it will probably be frequently found at or near the surface, as was the case during the recent cruise of the 'Jackal.'

The conclusions thus briefly summarised have an important bearing on the problems connected with oceanic circulation, and oceanography generally. I have been led by them to examine the data regarding the relation between chlorine and density in sea water, published in the reports of previous scientific expeditions. In a preliminary note recently read before the Royal Society of Edinburgh, I have endeavoured, I believe with some success, to trace similar relationships and differences between the great number of samples collected during the 'Challenger' Expedition, the densities of which were determined by Mr. J. Y. Buchanan, and the chlorines by Prof. Dittmar. In this connection I would like to record my sense of indebtedness to Prof. Dittmar's great work on the Composition of Ocean Water constituting Part I. of the volume on the Chemistry and Physics of the 'Challenger' Expedition. Whatever the value of my results may be, they are in a very great measure due to the fact that I have been able to follow up, as it were, the lines of research therein laid down.

It would go beyond the scope of this report to discuss any of the interesting questions connected with oceanic circulation, which appear to me to be materially affected by the conclusions which I have been able to draw. I may however point out that, unless I am altogether mistaken, it will be possible to trace some at least of the great ocean currents. If in future expeditions a number of small samples of sea water be collected from various positions and depths, and carefully preserved in glass bottles of good quality, the mere determination of their chlorines and densities will almost certainly lead to results of the highest value.

Of course the determinations must be made with a degree of accuracy corresponding to the very slight differences to be detected. I do not therefore think that it would be advisable to attempt these determinations on board ship.

The question may be asked—What bearing have these researches on the important problems, practical and scientific, connected with our fisheries? It is beyond my province to approach this subject either from a biological or statistical point of view, but there are certain deductions which I may be permitted to make, especially as they point towards certain lines along which these researches should be prosecuted in the future if they are to lead to the important practical results which I believe there is good ground for expecting from them. It has been often pointed out that the temperature of the sea waters along our coasts is intimately connected with meteorological conditions. The observations of Mr Dickson clearly show that upwelling of cold water from the bottom does take place along our coasts, and that this is due in part at least to the action of the wind blowing off shore is rendered almost certain by his observations, especially when considered in the light of the observations of Dr John Murray and the earlier observations of Mr J. Y. Buchanan.

The discovery, however interesting and important, of differences in chemical composition between the waters which come and go along our coasts, does not at first sight seem to tend in any way to simplify the task of following their movements and of endeavouring to find out the causes which bring them about. But when it is remembered that these chemical differences not merely make it possible to detect the coming and going of these different waters with a degree of certainty and exactness quite unattainable hitherto, but also to draw conclusions which have at least a very high degree of probability attaching to them as to the origin of these waters both in an immediate and in a remoter sense of the word, it appears to me that the systematic application of the method which I have described, although it will involve a very great deal of laborious analytical work, is none the less certain to lead more rapidly to conclusions of practical value than the purely physical means usually employed hitherto. If, for example, systematic observations be made as to the times and seasons at which the water from the bottom of the North Sea on the one hand and the surface Atlantic water on the other, enter and leave the Moray Firth, and if these observations are considered along with the prevailing meteorological conditions which proceed or accompany these movements and with the statistics of the relative takes of herring compared with that of large haddock and other bottom feeding fish generally, I am confident that results of real practical value will be attained before very long.

I am not sure that the observations already made do not even now point to a connection between the presence of Atlantic water in the Moray Firth as a condition of successful inshore herring fishing. In the summer of 1883 when surface Atlantic water filled the Moray Firth, the inshore herring fishings in this firth are reported to have been unusually productive; while on the other hand, in the summer of 1886, when water from the bottom of the North Sea filled the firth during the month of August at any rate, it is reported that more than one half of the entire season's catch in the inshore waters was made during one single week, and that all the rest of the season these inshore waters were comparatively unproductive.

It appears to me not improbable that the plaice which were found spawning at Smith Bank very shortly before Mr King's observations were made had been brought to Smith's Bank by the inflow along the bottom of water from further out to sea. Further observation will show whether this surmise is correct or not. In the meantime it is sufficient to insist on the importance of a careful investigation of the coming and going of the chemically distinct waters present in the North Sea in relation to the migration of our food-fishes.

The present is, however, not the time to discuss these questions with any degree of fulness. This can indeed only be satisfactorily done by a combination of workers, biological and statistical, as well as physical and chemical.

My endeavour has been to prove that the chemistry as well as the physics of sea water must be allowed an important and direct influence in the conduct of the scientific inquiries connected with the fisheries, and thus to justify the granting of those facilities for research, for which I have to thank the Fishery Board for Scotland.

In conclusion I have much pleasure in gratefully acknowledging my great indebtedness to Mr J. F. Barbour, Mr J. S. Ford, B.Sc.; Mr Andrew King, Mr W. C. Mackenzie, B.Sc.; and Mr T. Murray, for the valuable assistance which they have given me throughout the progress of the mass of analytical work embodied in this report.

NOTE ON THE CARBONIC ACID AND MICRO-ORGANISMS IN THE AIR AT VARIOUS STATIONS DURING THE CRUISE OF H.M.S. 'JACKAL.' By Charles Hunter Stewart, M.B., B.Sc.

Though not immediately connected with the special work for which the cruise of H.M.S. 'Jackal' was arranged, it was thought that advantage should be taken as far as possible of the opportunity of determining the condition of the air as regards carbonic acid and micro-organisms. Time did not permit for making such arrangements in the 'Jackal' previous to her sailing as would have made an investigation of this kind easy, yet with a little pains this difficulty was overcome, and the number of observations, though few in number, were made with as much care as though there had been a laboratory for the purpose.

Carbonic Acid in the Air.

A bottle of nearly 10 litres capacity was used, and instead of bellows, advantage was taken of the action of the wind for the purpose of taking the sample. Two holes were bored in the cork of the bottle, through one of which passed a funnel with its stem reaching to the bottom, and through the other a glass tube cut level with the cork inside, and bent at nearly right angles outside. This apparatus having been carefully cleaned and dried inside, was fastened on the forecastle, facing the direction of the wind, and left there for one hour. Though the weather was sometimes stormy during an experiment, the funnel effectually prevented any spray from passing into the bottle.

In each sample of air at least two determinations of the amount of carbonic acid were made. The absorbing solution used was a 1 per cent. baryta water made with pure barium hydrate. The acid used for titration was a solution of oxalic acid, such that each 4 cc. were equivalent to 1 cc. carbonic acid of 0° C. and 760 mm. pressure. The oxalic acid, twice recrystallised and air-dried, corresponded to the formula $C_2H_2O_4 2H_2O$, and


SHETLAND ISLANDS
ORKNEY ISLANDS
SCOTLAND
Moray Firth
Peterhead
ABERDEEN
DUNDEE
EDINBURGH
NEWCASTLE
HULL
Humber R.
Cromer
Yarmouth
Lowestoft
LONDON
Thames R.
Strait of Dover
Calais
FRANCE
Ostend
BELGIUM
ANTWERP
ROTTERDAM
Maas R.
AMSTERDAM
ZUIDER ZEE
HOLLAND
Texel
Vlieland
Ter Schelling
Emden
OLDENBURG
BREMEN
Wilhelmshaven
HAMBURG
Heligoland
Kiel
Schleswig
SCHLESWIG HOLSTEIN
JÜTLAND
FÜNEN
ZEALAND
LALAND
CATTEGAT
Frederikshaven
Læsö
SKAGER RACK
CHRISTIANSAND
Mandal
Arendal
CHRISTIANIA
NORWAY
Bergen
Dogger Bank
Outer Wells Bank
Wells Bank
Depth of Sea indicated thus
0 to 20 Fathoms
20 . 30
30 . 50
50 . 100
over 100


STORMY BANK
NUN BANK
WHITEN HEAD BANK
PENTLAND FRITH
SCAPA FLOW
HOY
SOUTH RONALDSHA
THURSO BAY
THURSO
SINCLAIR BAY
WICK
SMITH BANK
DORNOCH FRITH
CROMARTY FRITH
INVERNESS
DINGWALL
CROMARTY
NAIRN
FORRES
ELGIN
BANFF
ULLAPOOL
Loch Broom
Little Loch Broom
Annat B.
Baden Bay
Horse Sound
Enard Bay
Loch Roe
Loch Inver
Eddrachilles Bay
Handa St.
Laxford Loch
Loch Inchard
L. Glen Dhu
L. Glen Coul
LOCH CAIRN BAHN
KYLE OF DURNESS
LOCH ERIBOLL
KYLE OF TONGUE
Whiten Head
Farout Head
Strathy Bay
Melvich
Armadale
Holburn Hd.
Dunnet Head
Brough Bay
Stroma
Duncansby Hd.
Freswick B.
Noss Head
Wick Bay
Pulteney
Warrows Hills
Lybster
Clyth Ness
Forse Pt.
Ord of Caithness
Helmsdale
Loch Fleet
Dornoch
Tarbet Ness
Tain
Invergordon
Nigg Bay
Burgh Head
Burghead Bay
Findhorn
Lossiemouth
Garmouth
Fochabers
Port Gordon
Buckie
Cullen
Portsoy
Macduff
Troup Head
Aberdour
Fraserburgh
Beauly
Fortrose
Ft. George
Kirkwall
Irland Bay
Brak Ness
Roray Head
Turn Ness
Cantick Hd.
Swona
Flota
Burra
Holm Sound
Water Sound
Brough Ness
Pentland Skerries
Copinsha
Mull Head
Sandwick
Deer Ness
Rose Ness
Scrabster
Loch Shin
L. Naver
R. Naver
Strathie R.
Halladale Wr.
Thurso R.
Wick Wr.
Berriedale Wr.
Helmsdale Wr.
Brora Wr.
R. Oykell
Shin R.
R. Conan
Meig W.
Orrin W.
Beauly R.
R. Nairn
Findhorn R.
Lossie R.
R. Spey
Deveron R.
Magnetic
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
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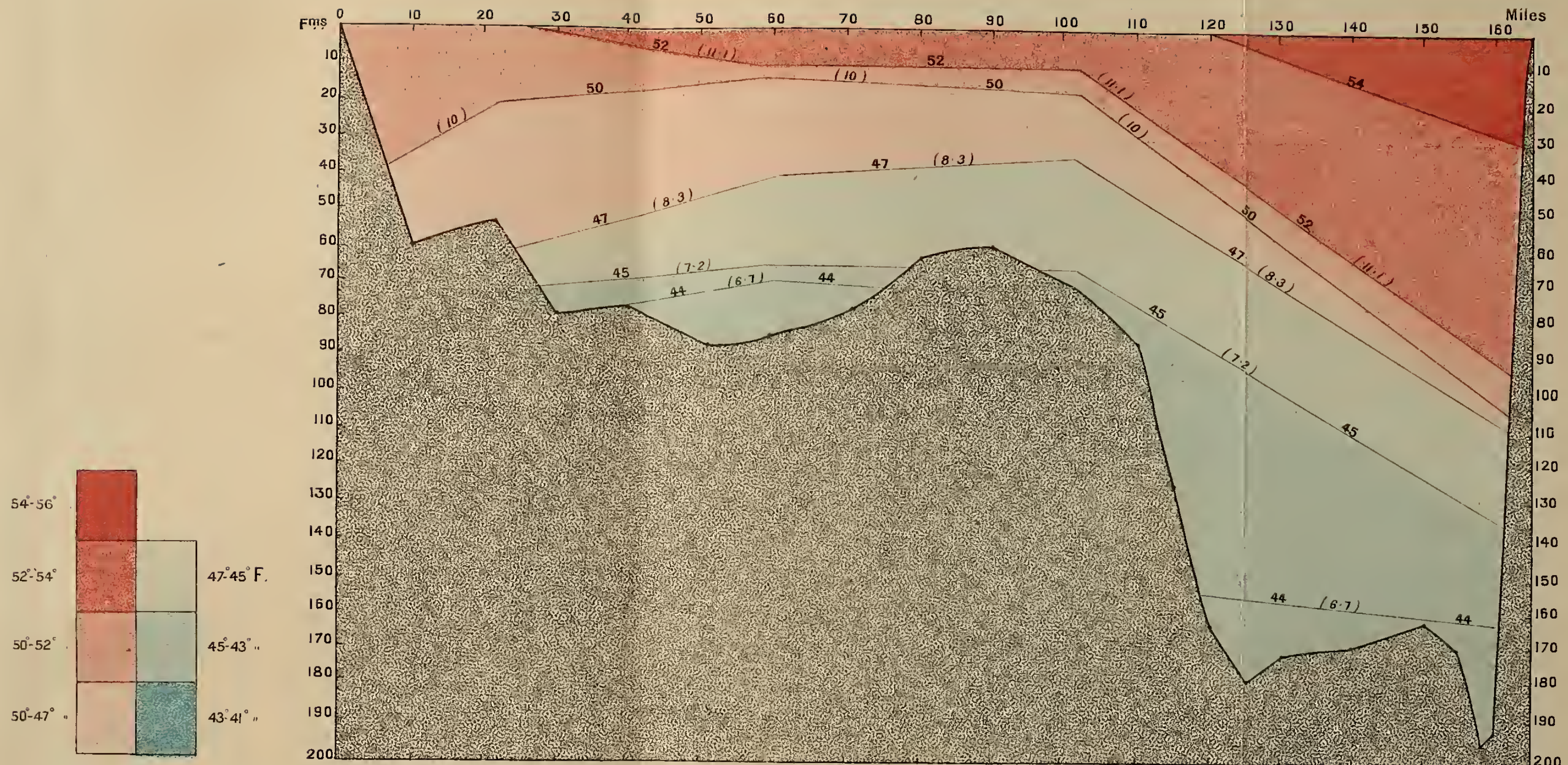
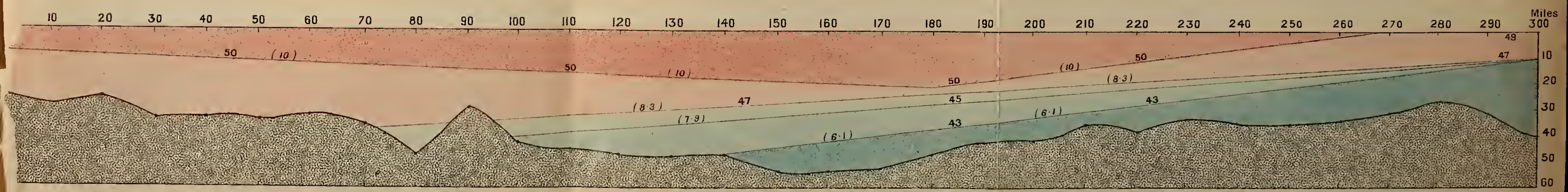
XX
XXI
XXII
XXIII
XXIV
XXV

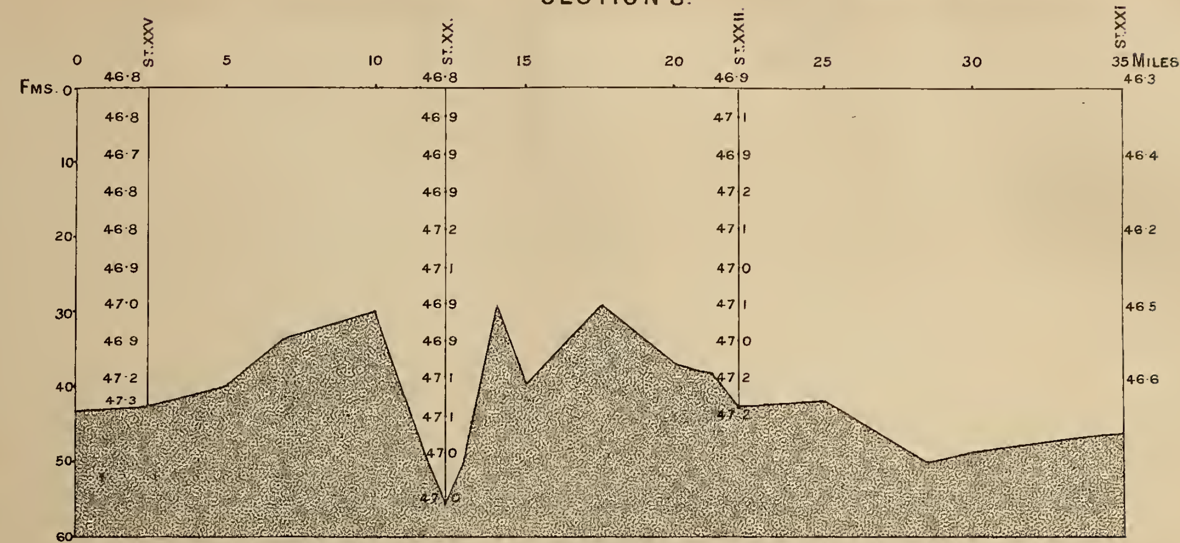
SECTION 1.



SECTION 2.



SECTION 3.



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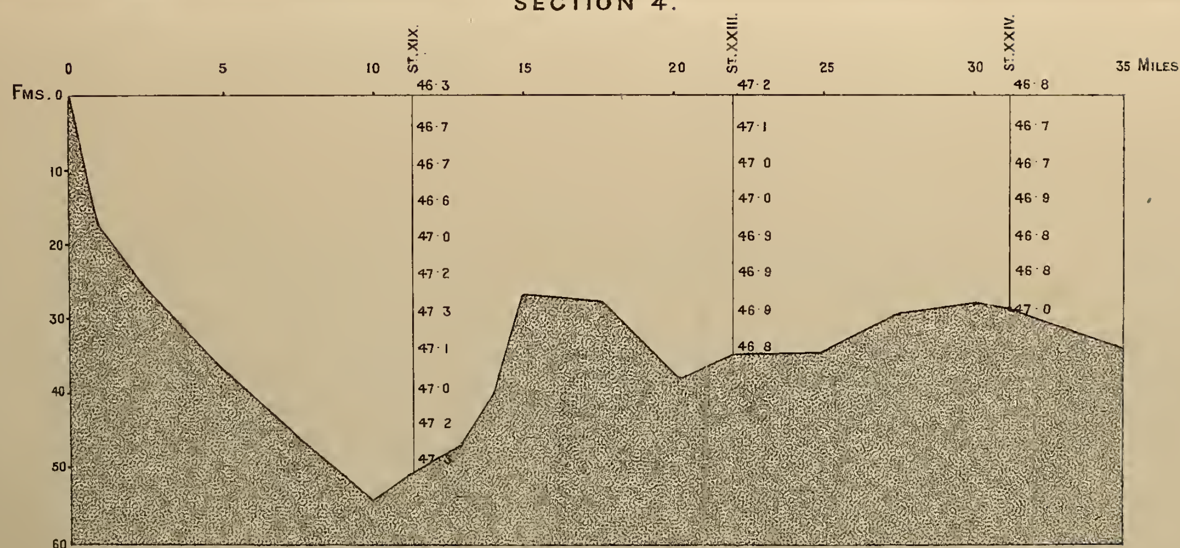

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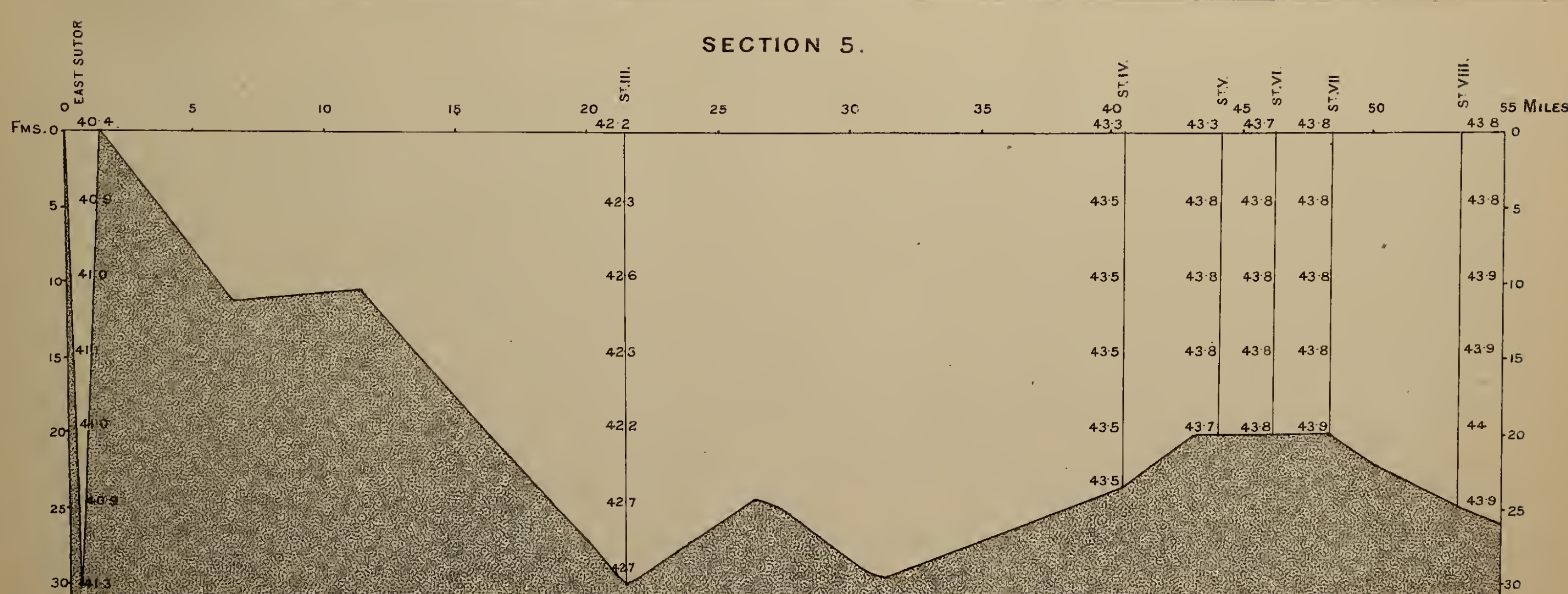


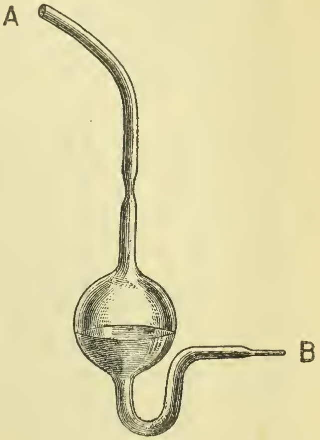
was also titrated against a carefully prepared standard hydrochloric acid solution.

Micro-Organisms in the Air.

The method followed was that of slowly aspirating a small volume of air through a liquid nutritive medium, which was subsequently solidified and incubated at a temperature between 15° and 16° C.

The nutritive solution was Koch's peptonised broth sterilised under pressure at 120° C., and rendered alkaline both to litmus and yellow turmeric paper, because of the *amphoterie* or double reaction of animal fluids. The bulb tubes (see figure), contrived by Miguel of Paris, and used by him at the Montsouris Observatory for bacteriological examination of air, were used.

These were prepared as follows:—Rinsed with strong sulphuric acid and washed first with distilled water till washings were neutral, and then with alcohol; a plug of sterilised cotton wool in the end A and a cap of the same put over the pointed end B, and lastly, kept for an hour in the hot chamber at 150° C. One dozen such tubes were each charged with 10 cc. of the broth on 4th Sept., sterilised at 100° C., and fastened in the laboratory in such a way as to prevent the rolling of the ship affecting the level of the fluid in them. On the 19th Sept. all the tubes were sterile but one, which showed turbidity during the first week. One dozen sterilised test tubes were each charged with 10 cc. of a sterilised 15 per cent. solution of gelatine, and finally kept for half an hour at 100° C. for two successive days.



The experiments were made on the forecastle deck, when the ship was in motion, and facing the direction of the wind. The tube was fixed to a support on the deck, the plug at A removed, and the aspirator connected. The cap at B was now removed, this end of the tube heated by the flame of a spirit-lamp, and allowed to cool, and then the amount of air slowly sucked through. This done, the end at B was again heated, and the cap replaced, as was also the plug at A. The contents of the tube were, with the usual precautions, transferred to one of the tubes of gelatine (previously liquefied), thoroughly mixed, plugged, and capped, and allowed to solidify, and incubated for 4 weeks.

TABLE *showing Amount of Carbonic Acid and Micro-Organisms in the Air at Various Stations.*

Place.	Date.	Hour.	Temp.	Pressure.	Direction of Wind.	Weather.	Carbonic Acid per 10,000 vols. at 0° C. and 760 mms.	Micro-Organisms.	Amount of Air Aspirated.
Moray Firth,	11th Sept.	9.40 A.M.	53°·5 F.	30·15 in.	Variable.	Rain and fog.	5·5		
Pentland Firth,	11th ,,	4 P.M.	59° F.	30·25 ,,	E. (3)	Fine	5·1		
Viera Sound, Orkney,	...	5 P.M.	58° F.	30·4 ,,	S. (1)	Fine	3·8		
Bressay Sound, Shetland,	15th ,,	5 P.M.	53° F.	29·93 ,,	S.S.W. (4)	Rain	3·6		
Balta Sound, at anchor,	18th ,,	5 P.M.	56° F.	30·25 ,,	W.S.W. (4)	Fine	4·6		
North Sea, 60° 44′ N. lat., 0° 40′ E. long.,	19th ,,	5.30 P.M.	54° F.	30·30 ,,	W.S.W. (2)	Fine	3·75	2 *colonies.* Mould.	2 litres
Off coast of Norway, near Hillisoe,	20th ,,	11 A.M.	56° F.	30·42 ,,	S.W. (2)	Fine	3·7		
Off coast of Norway, west of Naze,	25th ,,	2.30 P.M.	54° F.	30·33 ,,	W.N.W. (3)	Cloudy	3·98	2 *colonies* 1 mould 1 bacteria	1 ,,
Cattegat, 56° 52′ N. lat., 11° 45′ E. long.,	26th ,,	10 A.M.	53° F.	30·28 ,,	W.S.W. (4)	...	3·97		
Cattegat, near entrance to Sound,	26th ,,	2 P.M.	53° F.	30·28 ,,	W.S.W. (4)	...	3·65		
Mouth of Baltic,	1st Oct.	2 P.M.	46° F.	29·33 ,,	W.S. (5–7)	...	4·1	None	1 ,,
Kiel Bay,	2nd ,,	3.30 P.M.	47° F.	29·5 ,,	...	Cloudy	5·1		
North entrance to Great Belt,	7th ,,	4 P.M.	57° F.	...	...	...	4·4		
North Sea, 57° N. lat., 3° E. long.,	8th ,,	4 P.M.	51° F.	...	...	...	4·3	None	2 ,,
North Sea, 56° 13′ N. lat., 1° 40′ W. long.,	9th ,,	12 A.M.	51° F.	30·1 ,,	...	Fog	4·6		

INDEX.

Actinia, 347.
Alcyonium palmatum, 347.
Amphioxus lanceolatus, 385.
Amphipoda of the Forth, 319.
Anceidæ of the Forth, *Anceus maxillaris*, 321.
Angler (*Lophius piscatorius*)—
Food of, 231, 236, 237, 240, 252.
Spawning of, 197.
Animal colouring matters, 386.
Anomia ephippium, 347.
Argina pescata, 341.
Arenicola piscatorium, as bait, 352, 356.
Armed Bull-head (*Agonus*) post-larval forms, 308.
Artificial baits, 352.
Artotrogidæ of the Forth, *Cymbasoma rigidum*, 316.
Asteroidea of the Forth, 316.
Austria as a market for Scottish-cured herrings.
Bait—
Experiments, 12.
Inquiries into the supplies of, 11.
Balanoglossus, Tornaria, 387.
Bateson, Mr W., 385.
Beam trawling, 2.
Beam trawl nets, new inventions, 29.
Belgium as a market for Scottish-cured herrings, 165.
Bib (*Gadus luscus*)—
Caught by bait, 356.
Food of, 240.
Biological investigations, 182.
Bouchôts, 331, 334.
Bourne, Mr Gilbert C., 384, 387.
Brand, complaints regarding trustworthiness of, 170.
Brassie (*Gadus luscus*)—
Caught by bait, 356.
Spawning of, 197.
Brill (*Rhombus lævis*)—
Food of, 240.
Post-larval forms of, 307.
Spawning of, 192.
Buccinum undatum—
As bait, 347, 352, 356.
Egg cases of, 337.
Buckhaven haddock and cod line fishery, 9.
Calderwood, Mr W. L., 183.
Callionymus lyra, caught by bait, 356.
Callista gigantea, 341.
Cardium edule, as bait, 328, 352, 356.
Cat-fish (*Anarrhichas lupus*)—
Food of, 448.
Spawning of, 197.
Chemical compositions of waters of the North Sea, 448.
Cladocopa of the Forth, *Polycope compressa*, 318.
Clam, the various names for, 341.
Clam beds of the Firth of Forth, 11.
Cobbler. *See* Father-lasher.
Cod (*Gadus morrhua*)—
Food of, 227, 234, 235, 237, 239, 240, 247, 257.
Ova, 305.
Post-larval forms, 307.
Rearing of, 404.
Spawning of, 195.
Species of, 404.
Committee of Advice and Reference, 1.
Contemporary Fishery work, 13, 384.
Denmark, 405.
Oyster fishery, 406.
Trawling, 406.
France, 389.
Arcachon, Marine Station, 392.
Boulogne-sur-Mer, 390.
Concarneau, 389.
Investigations by Prince of Monaco, 395.
Marseilles, Marine Station, 392.
Mussels in France, 392.
Shrimp fisheries, 394.
Holland, 399.
Italy, 401.
Norway, 402.
Artificial fertilisation of ova, 403.
Hatching of flat-fish, 405.
Hatching of lobsters, 405.
Rearing of cod, 404.
Spain, 396.
Bait, 398.
Congers, 398.
Crustaceans, 399.
Firearms in pursuit of dolphins, 398.
Oyster culture, 397.
Sardines, 399.
Sub-marine light, 399.
Sweden, 405.
United States, 388.
Co-operation in mussel growing, 340.
Copepoda of the Forth, 316.

Copepoda of the English Channel, 335.
Cribella, 347.
Cruise of the 'Jackal,' 412.
Physical observations, 447.
Specific gravity observations, 429.
Temperature observations, 431.
Crustacea of the Forth, 316.
Crustacea of the Forth, Corrigenda to Report of 1888, 326.
Cumaceæ of the Forth, 322.
Cunningham, Mr J. T., 385, 386.
Cyprina islandica, 341.
Cytheridæ of the Forth—
Bythocythere constricta, 318.
Cythere cuneiformis, 317.
,, *navicula*, 317.
,, *pellucida*, 317.
,, *?semipunctata*, 317.
Cytheridea punctillata, 317.
Cytheropteron angulatum, 318.
,, *depressum*, 318.
Cytherura producta, 318.
,, *similis*, 318.
Loxoconcha impressa, 317.
Pontocypris mytiloides, 316.
Xestoleberis aurantia, 318.
Dab, common (*Pleuronectes limanda*)—
Caught by bait, 356.
Food of, 225, 232, 235, 236, 237, 238, 239, 243, 253, 257.
Ova of, 304.
Post-larval forms, 307.
Spawning of, 189.
Dab, long rough (*Hippoglossoides limandoides*)—
Food of, 225, 232, 236, 237, 239, 244, 254.
Spawning of, 172, 191.
Daniell, Dr A., 178.
Dannevig, Captain, 384, 402.
Day, Dr, 388.
Decapod Crustacea of Plymouth, 385.
Decapoda-macrura of the Forth, 324.
Denmark as a market for Scottish-cured herrings, 166.
Diastylidæ of the Forth *Eudorella truncatula*, 322.
Dinophilus metameroides, 385.
Dragonet (*Callionymus lyra*)—
Post-larval forms of, 309.
Spawning of, 197.
Drechsel, Lieutenant, 384.
Earthworm (*lumbricus terrestris*) as bait, 356.
Echinodermata of the Forth, 316.
Echinus sphœra, 347.
Edington, Dr A., 12, 368.
Eggs of fish—
Artificial hatching of, 403.
Distinguishing various species of, 401.
Floating, 171.
Influence of salinity on, 403.
Electric light in tow-netting, 387.
Ensatella americana, 341.
Ewart, Professor J. C., 9, 182, 384.
Father-lasher (*Cottus scorpius*)—
Post-larval forms of, 309.
Spawning of, 197.
Firth of Forth, additions to the fauna of the, 10.
Flounder (*Pleuronectes flesus*)—
Fishing, Solway, 175.
Food of, 226, 234, 240.
Ova of, 304.
Spawning of, 190.
Fluke, Sail (*Arnaglossus megastoma*), spawning of, 192.
Food of fishes, 9.
Food of marine food-fishes, 182.
Foraminifera of the Forth, 311.
Foreign countries, demand for Scottish fish in, 8.
Form C., copy of, 184.
Form F., copy of, 185.
France as a market for Scottish-cured herrings, 164.
Fullarton, Mr J. H., 11, 175, 341, 352, 384.
Fulton, Dr T. Wemyss, 8, 9, 158, 171, 182, 222, 352, 384, 387.
Gadus æglefinus, caught by bait, 356.
,, *luscus*, caught by bait, 356.
,, *merlangus*, caught by bait, 356.
,, *morrhua*, caught by bait, 356.
,, *virens*, caught by bait, 356.
Gammaridæ of the Forth, 319.
Amathilla sabini, 321.
Anonyx longipes, 320.
Atylus vedlomensis, 321.
Callisoma crenata, 319.
Gammarus edwardsii, 321.
Lafystius sturionis, 320.
Metopa alderi, 319.
Phoxus holbölli, 320.
Pontocrates norvegicus, 320.
Stenothoe marina, 319.
'Garland,' 2, 3, 171, 183.
The work of—
Firth of Forth, 17.
St Andrews Bay, 18.
Other East Coast Districts, 18.
Gasteropoda of the Forth, 324.
Limapontia nigra, 324.
Stilifer turtoni, 324.
Germany as a market for Scottish-cured herrings, 167.
Gibson, Dr J., 409.
Globigerinidæ of the Forth—
Bolivina dilatata, 315.
Orbulina universa, 315.
Polystomella crispa, 315.
Virgulina schreibersiana, 315.
Glycimeris generosa, 341.
Goby, post-larval forms, 309.
Greece as a market for Scottish-cured herrings, 163.
Green cod, post-larval forms, 307.
Gurnard, common (*Trigla gurnardus*)—
Caught by bait, 356.
Food of, 227, 233, 237, 238, 240, 246, 255.
Ova of, 305.
Spawning of, 196.
Gunnel, post-larval forms, 309.
Haddock (*Gadus æglefinus*)—
Food of, 229, 233, 236, 237, 238, 239, 248, 255, 258.
Ova of, 306.
Spawning of, 193.
Halibut (*Hippoglossus vulgaris*) spawning of, 192.

Hake (*Merluccius vulgaris*)—
Food of, 240.
Spawning of, 195.
Helix nemoralis and *H. aspersa* as bait, 356.
Herdman, Professor, 384.
Herring (*Clupea harengus*) as bait, 352, 356.
Hoek, D. P. P. C., 384.
Hybrids—
Between *Clupea* or *Alosa* and *Roccus lineatus*, 382.
Between *Trigla gurnardus* and *Gadus merlangus*, 382.
Between *Pleuronectes microcephalus* and *Rhombus maximus*, 382.
Hydrobia ulvæ, 328.
Inshore waters, spawning of fish in, 183.
Invertebrata of the Forth, 311.
Investigations carried on during 1888, 2.
Immature fish, capture and destruction of, 5.
Inquiries into the food, maturity, and habits of the food-fishes, 8.
Intercrossing in the genus *Salmo*, 12.
Isopoda of the Forth, 321.
Italy as a market for Scottish-cured herrings, 163.
'Jackal,' cruise of, in the North Sea, 1888, 412.
Jamieson, Mr Peter, 183, 188.
Johnston, Mr James, 183.
Læmargus—
Cranial nerves of, 384.
Skull of, 385.
Lagenidæ of the Forth—
Ammodiscus incertus, 314.
Cristellaria crepidula, 314.
,, *rotulata*, 314.
Lagena hexagona, 314.
Nodosaria pyrula, 314.
Polymorphina gibba, 315.
,, *oblonga*, 315.
Vaginulina linearis, 314.
Lamellibranchiata of the Forth, *Lepton nitidum*, 324.
Large and small fish, distribution of, 171.
Larval forms of food-fishes, 301.
Lemon Sole (*Pleuronectes microcephalus*)—
Caught by bait, 356.
Food of, 224, 234, 238, 239, 242.
Spawning of, 188.
Ling (*Molva vulgaris*)—
Caught by bait, 356.
Spawning of, 195.
Littorina litorea, 328, 337.
Lituolidæ of the Forth, *Haplophragmium pseudo-spirale*, 313.
Lobster fry, 403.
Loligo vulgaris as bait, 352, 356.
Lump-sucker (*Cyclopterus lumpus*)—
Ova of, 306.
Spawning of, 197.
Lumbricus terrestris as bait, 356.
Lythe (*Gadus pollachius*)—
Food of, 240.
Spawning of, 194.
Mackay, Captain, 188.
Maitland, Sir James R. G., 12.
Marion, Professor, 384, 392.
Marine Biological Laboratory, Plymouth, 385.
Marine food-fishes—food, spawning, and habits of, 182.
Marking fish by labels, 406.
M'Intosh, Professor, W. C., 10, 259, 387.
MacMunn, Dr. C. A., 386.
Merry-sole. *See* Sail-fluke.
Miliolidæ of the Forth—
Biloculina depressa, 312.
,, *elongata*, 312.
,, *ringens*, 312.
Cornuspira foliacea, 311.
Miliolina agglutinans, 313.
,, *bicornis*, 313.
,, *ferussacii*, 313.
,, *oblonga*, 312.
,, *secans*, 312.
,, *trigonula*, 312.
Mill, Dr H. R., 409.
Mollusca of the Forth, 324.
Molva vulgaris, caught by bait, 356.
Monaco, His Highness Prince Albert, 384.
Monk. *See* Angler.
Montagu's sucker, post-larval forms, 309.
Montenegro as a market for Scottish-cured herrings, 163.
Müller's top-knot, ova of, 304.
Mussel farming at Montrose, 11, 327.
Method of cultivation, 320.
Description of the Mussel-Beds, 331.
Ferryden and Usan Society's Beds, 331.
Big Bank, 332.
Ferryden Shore of River, 332.
Guano Bank, 333.
Inch Burn Bed, 332.
Inshore Bank, 333.
Middle Bank, 333.
Rossie Island, 332.
Salthouse Bank, 333.
The Scalp, 331.
Messrs Johnston & Sons' Beds, 333.
Basin Bank, 335.
Binny Bank, 333.
Briggs of Binny, 333.
Broad Water Bank, 334.
East Steinschell Bank, 334.
Gaswork Burn Bank, 335.
Miller's Bank, 334.
Scaud Man's Head Banks, 334.
Sticks Burn Bank, 334.
Tayock Bank, 335.
West Steinschell Bank, 334.
Common Bed, 335.
East Tayock Bank, 335.
Fauna of the Beds—
Broad Water Bank—
Foraminifera, 336.
Ostracoda, 336.
Salthouse Bank—
Copepoda, 337.
Foraminifera, 326.
Ostracoda, 337.
Ferryden and Usan Fishermen's Mussel Society.
Mussels, poisoning by, 393.
Mya arenaria, 341.

Mysidæ of the Forth—
Erythrops goesii, 322.
Heteromysis formosa, 323.
Leptomysis gracilis, 323.
Mysidopsis didelphys, 322.
Siriella armata, 323.
Mytilus edulis, 328, 387, 356, 349.
Mytilus modiolus, 347, 352, 356.
Names of fishes, common and scientific, 36.
Nephrops norvegicus as bait, 356.
Netherlands as a market for Scottish-cured herrings, 165.
Norway and Sweden as a market for Scottish-cured herrings, 166.
North Sea, Physics and Chemistry of, 13.
'Ocean River,' 172.
Offshore waters, spawning of fish in, 183.
Ostracoda of the Forth, 316.
Oyster fishery in Denmark, 406.
Pachydesma crassatelloides, 341.
Palæmonidæ of the Forth, *Hippolyte gaimardii*, 324.
Palinurus vulgaris, 385.
Patella vulgata as bait, 352, 356.
Pecten, habits of, 11.
Pecten opercularis as bait, 352, 356.
Pelagic fauna of St Andrews Bay, 10, 259.
Pelagic ova of food-fishes, 301.
Petersen, Dr, 384.
Physical observations, 13, 409.
Pisces of the Forth—
Arnoglossus megastoma, 325.
Lumpenus lampetriformis, 326.
Phycis blennoides, 326.
Trachinus draco, 326.
Plaice (*Pleuronectes platessa*)—
Caught by bait, 356.
Food of, 223, 231, 236, 237, 238, 239, 241, 252.
Ova of, 303.
Spawning of, 171, 187.
Pleuronectes microcephalus. *See* Lemon Sole.
Pleuronectes limanda. *See* Dab, common.
Pleuronectes platessa. *See* Plaice.
Pleuronectids, post-larval forms, 306.
Pogge (*Agonus cataphractus*), spawning of, 197.
Polynoe, 347.
Post-larval forms of food-fishes, 306.
Pouchet, Professor, 384, 389.
Pteropoda of the Forth—
Clione borealis, 325.
Spiralis retroversus, 325.
Puffin Island Biological Station, 387.
Purpura lapillus, 337.
Raia batis, cranial nerves of, 384.
Relative quantities of fish taken by line and beam trawl, 20.
Reports, distribution and exchange of, 14.
Ripe fish, 171, 185.
Rockling—
Ova of, 306.
Post-larval forms, 308.
Roumania as a market for Scottish-cured herrings, 164.
Russia as a market for Scottish-cured herrings, 167.
Saithe (*Gadus virens*), spawning of, 195.
Sand-eel, post-larval forms, 309.
Sand fluke, food of, 237, 240.
Saprolegnia of salmon disease and allied forms, 12, 368.
Sauvage, Dr, 384, 390.
Schizopoda of the Forth, 322.
Schizothærus nuttalli, 341.
Scott, Mr Thomas, 11, 171, 183, 222, 311, 382.
Scrobicularia piperata, 328.
Semele decisa, 341.
Sepia officinalis as bait, 352.
Servia as a market for Scottish-cured herrings, 163.
Shrimp fishing, Solway, 175.
Shrimp trawl net, 16, 29.
Skate, food of, 231, 234, 236, 237, 239, 251.
Smith, Mr Anderson W., 384, 385, 392.
Smith, Mr Ramsay, W. 9, 222.
Solaster papposus, 347.
Sole, ova, 304.
,, spawning of, 190.
,, black, food of, 236.
,, little (*Solea lutea*), spawning of, 191.
,, witch, food of, 226, 238, 239, 246.
,, spawning of, 385.
Solen siliqua, as bait, 352.
Solway shrimp and flounder fishing, 175.
'Southesk,' 3, 183.
Spain and Portugal as markets for Scottish-cured herrings, 163.
Spawning grounds of plaice and other food-fishes, 4.
Spawning of marine food-fishes, 171, 182.
Special statistics of fishing boats, 27.
Special statistics of fish caught by line fishermen and beam trawlers, 19.
Spisula solidissima, 341.
Sprat, ova, 305.
Statistics, Fishery, 6.
,, ,, Report on, 178.
Stewart, Dr C. Hunter, 412, 472.
Switzerland as a market for Scottish-cured herrings, 166.
Table A. Showing summary of fish taken by the 'Garland' on the East Coast in 1888, 30.
——B. Analysis of the 'Garland's' statistics relating to the relative abundance of fish, 34.
——C. Record of observations made on board the 'Garland' on the East Coast, 37.
——D. Anstruther district, Buckhaven haddock and cod line fishing 1887–88, 103.
——E. Showing fish landed by net and line boats, and by steam beam trawl boats, 104.
——F. Showing the monthly 'takes' of line and net boats from inshore grounds in the Leith, Anstruther, Montrose, Stonehaven, and Aberdeen Districts, 118.

Table G. Showing the monthly 'takes' of cod, haddock and whiting by forty-one East Coast fishing boats in 1888, 155.
—— H. Showing the monthly amounts of round and flat-fish landed by line fishermen and beam trawlers on the East Coast of Scotland during 1888, 157.
—— showing the annual catch and value of Scottish herrings, from 1882 to 1888, with the amounts cured, branded, and exported, 159.
—— showing the number of barrels of cured herrings imported into Stettin from various countries during 1882–88, 161.
—— showing the spawning of fishes, 198.
—— showing the food of fishes, 241.
—— showing the number and kind of fish caught by various kinds of bait, 353.
—— showing the percentage of fish caught by the various baits, 354.
—— showing the results of the bait experiments carried on, on board the 'Garland' 1888–89, 356.
—— Amount of carbonic acid and micro-organisms in the air, 474.
Teleostean fishes, sense organs of, 385, 386.
Tellina balthica, 328.
Trawling, comparison of adjacent closed and unclosed areas, 22.
Trigla gurnardus. *See* Gurnard.
Turbot (*Rhombus maximus*)—
Food of, 234, 240.
Ova of, 304.
Post-larval forms, 307.
Spawning of, 192.
Turkey as a market for Scottish-cured herrings, 164.
Turritella, 347.
Tusk (*Brosmius brosme*), spawning of, 196.
United States as a market for Scottish-cured herrings, 169.
Uraster rubens, 347.
Vertebrata of the Forth, 325.
Wattel, M. Raveret, 384.
Webster, Mr H. A., 384.
Weever, greater (*Trachinus draco*), spawning of, 197.
West Coast, fishing ground on, 5.
West of Scotland, vertebrate fauna of, 385.
Whale, notes on, 365.
White, Dr P., 385.
Whiting (*Gadus merlangus*)—
Food of, 230, 234, 236, 237, 238, 240, 250, 256, 258.
Ova of, 306.
Post-larval forms, 308.
Spawning of, 194.
Witch sole (*Pleuronectes cynoglossa*), spawning of, 190.

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