SEVENTEENTH ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND,

Being for the Year 1898.

IN THREE PARTS.

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

PART II.—REPORT ON SALMON FISHERIES.

Presented to Parliament by Command of Her Majesty.

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SEVENTEENTH ANNUAL REPORT.

TO THE RIGHT HONOURABLE

LORD BALFOUR of BURLEIGH,

Her Majesty's Secretary for Scotland.

Office of the Fishery Board
for Scotland,
Edinburgh, 15*th April* 1899.

My Lord,

In continuation of our Seventeenth Annual Report, we have the honour to submit—

PART II.—REPORT ON SALMON FISHERIES.

Returns of Scottish Railway and Steamship Companies.

The fishing season of 1898 appears, from all available sources of information, to have been considerably below the average. The returns furnished by the Scottish Railway Companies and Steamship Owners as to the weight of salmon forwarded by them from all parts of the country show a total of 1717 tons 4 cwts., as compared with 2194 tons 5 cwts. in 1897, being a decrease of 477 tons 8 cwts. Particulars for the five last years are shown in the following Table, together with the averages for the five years:—

District.	1894. Weight.				1895. Weight.				1896. Weight.				1897. Weight.				1898. Weight.				Average. Weight.			
	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs.	Tons.	Cwts.	Qrs.	Lbs	Tons.	Cwts.	Qrs.	Lbs.
Berwick to Cairnbulg Point, .	963	8	2	23	1,834	1	3	24	1,583	6	1	26	987	5	1	4	666	8	3	13	1,166	18	1	4½
Cairnbulg Point to Cape Wrath,	729	2	3	7	1,492	12	..	7	987	13	1	8	717	4	..	7	577	16	2	20	900	17	3	8
Cape Wrath to Glasgow, . . .	471	13	3	4	576	7	..	10	414	2	3	5	270	15	..	1	283	18	2	1	403	7	1	20
Glasgow to the Border, . . .	273	6	..	..	326	..	1	17	293	3	..	1	219	8	..	21	189	..	..	20	259	3	2	6
Total, . . .	2,437	11	1	16	4,229	1	2	2	3,278	5	2	12	2,194	12	2	5	1,717	4	..	26	2,730	7	..	10½

In Note V. appended will be found the details of the averages here given. p. 64. The practice of distributing salmon direct from rivers and fishing stations to various markets, rather than as formerly forwarding all fish to London, seems to be on the increase in Scotland, and for this reason we have referred to the returns of the Railway and Steamship Companies as giving a fuller account of the trade in salmon than is now to be obtained from Billingsgate.

Number of Boxes of Salmon sent to Billingsgate.

A comparison of the figures derived from these two sources of information show a marked difference. The number of boxes of salmon sent to Billingsgate in 1898 was 14,174, as compared with 16,284 in 1897, being a decline of 2,110 boxes. But the total delivered at Billingsgate—taking a box as 1 cwt.—represents only 708 tons 14 cwt., so that fully 1,000 tons of salmon seem to have been sent to markets other than Billingsgate.

With reference to the Billingsgate returns themselves, this year's figure is lower than any since 1879. The average for the period of eighteen years since 1879 is 23,161 boxes, compared with which the figure for 1898 shows a decline of 8,987 boxes, but from the information supplied from the Railway and Steamship Companies this decline may be regarded as due in a measure to the practice already referred to of sending salmon direct to other markets.

TABLE showing the Number of Boxes of Scottish Salmon sent to Billingsgate from 1834 to 1898 inclusive :—

Year.	Boxes of Salmon.	Year.	Boxes of Salmon.
1834	30,650	1867	23,006
1835	42,330	1868	28,020
1836	24,570	1869	20,474
1837	32,300	1870	20,648
1838	21,400	1871	23,390
1839	16,340	1872	24,404
1840	15,160	1873	30,181
1841	28,500	1874	32,180
1842	39,417	1875	20,375
1843	30,300	1876	34,655
1844	28,178	1877	28,189
1845	31,062	1878	26,465
1846	25,510	1879	13,929
1847	20,112	1880	17,457
1848	22,525	1881	23,905
1849	23,690	1882	22,968
1850	13,940	1883	35,506
1851	11,593	1884	27,219
1852	13,044	1885	30,362
1853	19,485	1886	23,407
1854	23,194	1887	26,907
1855	18,197	1888	22,857
1856	15,438	1889	21,101
1857	18,654	1890	18,931
1858	21,564	1891	25,889
1859	15,823	1892	21,919
1860	15,870	1893	18,903
1861	12,337	1894	15,489
1862	22,796	1895	25,364
1863	24,297	1896	22,435
1864	22,603	1897	16,284
1865	19,009	1898	14,174
1866	21,725		

Monthly Return of Scottish Salmon sent to Billingsgate.

A monthly return of the number of boxes from all sources received at Billingsgate has been, as hitherto, kindly furnished by the Fishmongers' Company. The column referring to Scotland gives the following totals:—Jan., —; Feb., 525; March, 866; April, 809; May, 1,430; June, 2,668; July, 4,166; August, 3,169; Sept., 487, and 18 frozen; Oct., 20 frozen; Nov., 14 frozen; Dec., 2 frozen; total, 14,174. Prices varied from 2s. 4d. per lb. in April, to 1s. 4d. in July and August, the frozen salmon being from 1s. 9d. to 1s. 11d. per lb.

Table of Boxes of Scottish Salmon sent to Billingsgate in each month.

TABLE showing Number of Boxes of Scottish Salmon delivered at Billingsgate each Month for the Years 1884 to 1898 inclusive:—

Month.	Average of 10 years, 1884-93.	1894.	1895.	1896.	1897.	1898.	Average monthly price per lb. during 1893-96.	Average monthly price per lb. during 1897.	Average Monthly price per lb. during 1898.
							s. d.	s. d.	s. d.
January, .	...	...	...	...	...	...	...	...	2 9
February.	*818*	327	400	822	773	525	1 9½	2 0½	1 10
March, .	*1,071*	692	1,207	1,385	724	866	1 8½	2 5½	2 1
April, .	*1,416*	887	1,160	1,580	1,038	809	1 9½	2 2½	2 4
May, . .	*2,335*	1,745	2,567	2,376	2,311	1,430	1 8	1 6	2 0
June, . .	*3,540*	3,078	4,611	3,595	3,127	2,668	1 4¾	1 4½	1 5
July, . .	*7,949*	4,464	9,066	7,450	5,081	4,166	0 11¼	1 4	1 4
August, .	*6,094*	3,968	5,694	4,477	3,001	3,169	1 1	1 5	1 4
September,	*526*	328	659	750	213	487	1 10	2 0	2 0
Do.,	...	...	...	...	*6	18	...	*1 7	...
October, .	...	...	...	...	*9	*20	...	*1 7	2 11
November,	...	...	...	...	...	*14	...	...	*1 9
December,	...	...	...	...	*1	2	...	...	...
Total, .	*23,749*	15,489	25,364	22,435	16,284	14,174	...	...	...

* Frozen salmon.

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The answers to the queries issued to Clerks of District Fishery Boards show also that, with the exception of the Ness and, in part, the Ythan, the fishing has been below the average. These answers will be found in Note I. appended.

The Spawning Season.

If the reports concerning the take of salmon show an unfortunate decline, the reports from the various Fishery District Boards seem to indicate that while the lack of water experienced in almost all our salmon rivers impeded the free entry of fish for most of the season, the full condition of the rivers in the autumn and early winter months enabled large numbers of spawning fish to ascend, and become freely distributed in many of the rivers. Only in a very few districts is the spawning season described as rather under the average. Reports such as "a good average," "fully an average," and "much above average," are more frequent (*vide* Note I. Appendix).

Salmon Disease.

No disease is reported from most of the rivers flowing directly from rocky and mountainous country, as, for instance, the Ness, Lochy, Findhorn, Nairn, Dee (Aberdeenshire), Kennart, Balgay, and Lussa. Lowland rivers which appear to have escaped are the Ayr, Doon, Dee (Solway), Girvan, and Cree. In the rivers of East Sutherlandshire disease has been very slight, but after ceasing in March it reappeared to some extent during July and August. In the Tay, *Saprolegnia* appeared at the end of October, was worst about the end of December, and the Clerks of the District Board report that they are uncertain if it ever quite disappeared during the year. In the Spey it appeared first on 30th October, and was worst in January. 113 fish were removed from the river, of which number 62 were male grilse and 31 were male salmon. In the Forth district the disease did not appear till December. It reached its height in January and disappeared in April. It may be remarked that in most of the rivers where disease appeared the condition of the water level at the time is reported as being low; whereas in some rivers, such as the Aberdeenshire Dee, the Nairn, and the Balgay, where disease occasionally appears, the water ran high during most of the spawning season, and no disease was seen. Unfortunately in the returns dealing with the Lowland rivers which had no disease present last year, no record is given of the height of the water either under the heading of "Disease" or of "Spawning Season."

Inspections during 1898.

In his annual tour of inspection, Mr. Calderwood visited the rivers Tay, Earn, Lyon, Tummel, Ness, Moriston, Beauly, and Conon, with its tributaries of Orrin and Bran. Mr. Calderwood's general report to the Board will be found appended. He also inspected the river Ayr for the purpose of advising with regard to the need for a salmon pass in the dam dyke at Overmills, and also to inquire into the proper carrying out of the requirements of the Salmon Fisheries (Scotland) Act, 1868, with regard to the hecks at Overmills and the Nether or Ayr Mill. He also inspected the lower section of the river Doon. At a later date he visited the Isla and Ericht tributaries of the Tay, the Lochy and Spean, and the Don and Ythan. The pollution of the Don has called for action on the part of riparian proprietors, through the District Fishery Board. Mr. Calderwood, in his report on this river, refers with some detail to improvements necessary to allow salmon to ascend the various artificial obstructions, the greatest of which is the Mugiemoss Dam, and he also states that in order to restore the river to its former condition, and to admit of the proper distribution of spawning fish, it seems necessary that the various large millowners be required to abstract less water from the river than they do at present. In Note III. will be found a report by Mr. Calderwood on the cruives of Scotland. He draws special attention to the position of the cruive at Craigforth, near Stirling. With regard to the river Spey, it has been decided by the First Division of the Court of Session that the pollution caused by the many distilleries which have now been erected in the district may legally be complained against. The particular case which has been the means of establishing the position of riparian proprietors in this matter was that of the Countess-Dowager of Seafield and others *v.* Kemp. The Lord Ordinary (Kyllachy) found that until a period well within the years of prescription the waters of the Ringorm Burn (on which Kemp's Macallan Distillery has long been situated), and also of the river Spey, were substantially unaffected by artificial impurities, and

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Court of Session Case regarding pollution of Spey.

were, under normal conditions, fit for all the primary uses; and that the defender has no right to pollute the waters by discharges of the waste products of the distillery. Consideration of application for interdict against the proved pollution was, however, delayed till the effect of certain remedial works executed by the defender should be tested. The First Division, when this interlocutor was reclaimed against, adhered to the declaratory findings under the two first heads, in so far as these related to the pursuers other than Mrs. Kinloch Grant, Arndilly; and in regard to Mrs. Kinloch Grant, found that the defender had no right or title to discharge into the Ringorm Burn any impure matter prejudicial to the salmon fishings of Mrs. Kinloch Grant. The findings of the Lord President, and of Lord Kinnear on a special point in the case, are fully quoted in Note IV. appended.

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The deplorable state of matters with regard to the salmon fishings of the river Nith, referred to by Mr. Archer in last year's report, seems still to continue. Very little has been done, so far as reports from the district show, to bring the sixteen obstructions, referred to on page 10 of Mr. Archer's report, into harmony with the provisions of Schedule G of the Salmon Fisheries (Scotland) Act, 1868 (31 & 32 Vic. cap. 123).

Annual Close Time. p. 71.

In Note VI. of the Appendices will be found a list of the dates of the commencement and termination of the annual close times for net and for rod fishings in the various salmon rivers in Scotland.

List of Chairmen and Clerks of District Boards. p. 73.

In Note VII. of the Appendices a list is given of the Chairmen and Clerks of the Salmon Fishery District Boards of Scotland. This list contains two additions to the list of 1897, viz., Snizort and Sligachan. These two Skye Boards have arranged to supervise the fresh-water fisheries of the Island by means of a combined force of watchers.

Investigations on the Life History of the Salmon.

The scientific investigations into the Life History of the Salmon reported upon last year have been continued with a view to completion. The results are, however, not yet ready for publication. We again desire to express our thanks to the noblemen and gentlemen who have kindly supplied fish for examination in the Laboratory of the Royal College of Physicians, Edinburgh.

We have the honour to be,

Your Lordship's most obedient servants,

ANGUS SUTHERLAND, *Chairman.*
D. CRAWFORD, *Deputy-Chairman.*
D'ARCY W. THOMPSON.
J. RITCHIE WELCH.
W. R. DUGUID.
ARCHIBALD JAMESON.
L. MILLOY.

WM. C. ROBERTSON, *Secretary.*

SALMON FISHERIES.

APPENDIX.

SEVENTEENTH ANNUAL REPORT TO THE FISHERY BOARD FOR SCOTLAND,

ON THE

SCOTTISH SALMON FISHERIES IN 1898.

BY

W. L. CALDERWOOD, F.R.S.E.,
Inspector of Salmon Fisheries for Scotland.

REPORT.

I HAVE the honour to submit my Report for the year 1898 to the Fishery Board for Scotland.

By direction of the Board, and at the request of the provost, magistrates, and councillors of the town of Ayr, I inspected the dam and hecks at Overmills and the heck at the Nether Mill on 9th September, for the purpose of inquiring into the condition of the structures named, and their effect upon the salmon fisheries of the river. Ayr.

Overmills.—The dam dyke is 490 feet in length, has an average height of about 6 feet, and an average gradient of 1 in 3. There is no fish-pass, and during normal and low conditions of the river, as during my visit, the dam is, in my opinion, a complete obstruction to the ascent of salmon. I was enabled to study the fluctuations of water-flow from readings of water gauges erected at the weir five months before my visit. By these and by enquiries I made as to the water-power necessary to drive the mill in a paying manner, I was satisfied that no loss would accrue to the tenant of the mill, except during extremely low conditions of the river, or when the greater part of the face of the weir was dry, with the crest, in the neighbourhood of the gauges, two inches above the level of the upper pool. I may state, however, that several decisions of the Courts have sufficiently proved that any loss which might occur by the erection of a salmon pass in conformity to the requirements of the Salmon Fisheries (Scotland) Act, 1868, Schedule G, must be regarded as incidental to the requirements of the Act.

I made a careful examination of the whole of the weir, and of the bed of the river below the weir, and I indicated to the surveyor of the burgh of Ayr, whose duty it will be to carry out the erection of the fish-pass, as also to the chairman and clerk of the District Fishery Board, the exact position where, in my opinion, the pass should be erected. At the same time I explained to the surveyor the requirements of Schedule G, and indicated what seemed to me the most advantageous method of adaptation in the Overmills Dam.

The upper heck of the mill conformed to the regulations, but the lower heck was so arranged as to be readily converted into a salmon trap. This, I indicated, should be modified in accordance with the bye-law.

Nether Mill or Ayr Mill.—I found the heck on the upper lade much damaged, but constructed on a satisfactory principle. There was no lower heck. The representatives of the burgh—eight of whom were present, and by whom the mills are leased—raised the objection that no tail-lade existed, and that, therefore, they could not be compelled to put up a heck, or to construct a tail-lade for the purpose of erecting a heck. The clerk of the District Fishery Board having indicated that his Board did not intend to ask the Town Council to build a tail lade, I took the opportunity of indicating how a heck might be conveniently erected without the construction of a tail lade.

At a subsequent date I attended a meeting of the committee of the Town Council and representatives of the District Fishery Board, for the final adjustment of difficulties which had arisen in connection with the proposed alteration of the dam dyke at Overmills. The Town Council being embarrassed, however, by the attitude of the lessee of the mill, the matter was carried before the Sheriff. The following extract from a letter of the clerk of the District Board of Ayr shows clearly the result, and may be instructive to those who may be similarly situated in the future. Mr. Macrorie writes to me under date of 23rd March 1899 as follows:—"The Sheriff intimates to the Town Clerk that, after considering all the authorities, he was clearly of opinion that the town was bound to form the salmon ladder and put on proper hecks. In consequence of that expression of opinion the town have now lodged a minute consenting to an order being pronounced ordaining them forthwith to form a salmon ladder and to put on hecks, the work to be done at your sight and to your satisfaction, and the Sheriff has to-day granted the order in terms of the minute. I have written the Town Clerk to send you on at once a plan and specification of the proposed ladder for your consideration. . . ."

Doon. On visiting the river Doon on the occasion of my inspection in the Ayr river, I was able to instance a heck, built at the mouth of a culvert at the Dutch Mills, above the old Brig o' Doon, as constructed on a plan suited to the culvert of the Nether or Ayr Mill, concerning which difficulty had been raised.

Forth. I visited the cruive dyke at Craigforth in the neighbourhood of Stirling, for the purpose of examining that structure. Special reference to it will be found at the end of Note III. appended (p. 56).

Earn. A scheme for the improvement of the salmon fisheries of the river Earn is at present under the consideration of the Tay District Fishery Board. A memorandum, prepared by Sir Robert Moncreiffe, the chairman, was first addressed to the various proprietors interested in November 1897. A report on an inspection of the river Earn by my predecessor, Mr. Archer, will be found in Note II. (p. 49.) In general terms the proposals are to lease for a period of years the net fishings and cruive fishings of the river, and to erect suitable salmon passes in such weirs as at present form obstructions to the passage of fish. There are in all six weirs on the river Earn.

In accordance with a decision of the Fishery Board for Scotland, by which, as part of the annual tour of inspection, the obstructions referred to should be examined, I visited the district during the second week of October.

The cruive dyke at Dupplin is, without doubt, the most serious obstacle in the river. It is the first obstruction encountered by ascending fish, and, except during floods, is a complete barrier. One cruive-box exists, and all the water of the river during low levels is compelled to find its way through the box. At the time of my visit salmon and sea-trout had accumulated in great numbers below the cruive, the latter being so closely packed in the shallow water at the margins of the main current that they could be easily lifted out. The rush of water through the cruive box was too great for any fish to penetrate. A second cruive-dyke exists at Strathallan, a very steep if comparatively low weir about eight miles up the river. In this case also one cruive-box causes a very great rush of water. In the Eighth Annual Report, Part II., Appendix, p. 57, the measurements of the weirs and the cruive-boxes are given by Mr. Young. Further reference to cruives will be found in Note III., p. 51. A short distance up stream another obstruction is formed by Millearn Weir. The mill is now only used for threshing purposes, previously it was a meal mill. The dyke is low, and although it has no salmon pass, it does not seem to offer any very serious barrier to the ascent of fish when the river is in a condition for salmon running. Next in the ascent of the river comes Colquhalzie dyke, also a low dyke, though rather more difficult of ascent than Millearn. No pass exists. About a mile below Crieff is Dornoch dyke, an obstruction of considerable magnitude. Two meal mills are worked by the water obtained by means of this weir, one on each side of the river. Mr. Young (*loc. cit.*) states that a right of cruive-fishing was originally held here by Lord Willoughby, but that, in order to benefit the fishings, the cruive was removed and a fish-pass substituted. Since the date of this sportsmanlike action another structure has been added to the dam, ostensibly for the purpose of assisting salmon to ascend. A breach has, however, recently occurred in the dyke which happily is to be permitted to remain (Note I., Appendix, p. 16). A short distance above Crieff bridge is the last weir on the river, excepting a couple of insignificant dams for working small saw-mills. Cook's mill dyke, which supplies water to what is termed the Bridge End Meal Mill—the name of Cook seems associated only with the dyke—is again not very serious as an obstacle to the ascent of fish, although it certainly should be provided with a salmon pass. None of the mill lades on the Earn are provided with hecks, and the case of the Bridge End Mill is certainly the most serious. The upper lade is about 500 yards long, and is provided with strong sluices. Two wheels exist in the mill, and the tail-lade is continued into the river in such a way that it forms a ready opening for the entrance of fish. It is overhung with bushes, and has a stony natural bed. It should not be allowed to continue without a heck. A bye-wash also exists which, when the mill is not working, throws a torrent of water at right angles to the natural flow of the river. So far back as 1882 the Tay District Fishery Board issued circulars explaining the requirements of the Salmon Fisheries (Scotland) Act, 1868, with regard to hecks, and calling upon every mill-owner in the Tay District to comply with the regulations. The requirements of the Act with regard to hecks are as follows (Schedule G):—

"3. At the intake of every lade there shall be placed and constantly kept a heck or grating for each opening, or one embracing the whole openings, the bars to be not more than three inches apart, if horizontal, and not more than two inches if vertical.

4. A similar heck or grating shall be placed and constantly kept across the lade or troughs immediately above the entrance to each mill-wheel.

5. A similar heck or grating shall be placed and constantly kept across the lower end of each tail-lade at its entrance into the main river." (Then follows a note containing a recommendation as to the construction of lades, so as to compensate for the space occupied by the bars of the hecks).

This need for hecks in the Tay district is also seen in the neighbourhood of Blairgowrie, in the river Ericht, a tributary of the river Isla. I visited this locality at a subsequent date, and saw, in the lade of the Muckle Mill, a pair of small salmon, and several pairs of sea-trout preparing to spawn. It may be argued that the Ericht is now a quite unimportant salmon river, and that migratory salmonidæ do not reach Blairgowrie till the close season; but so far as my observation goes, the pollution referred to in Mr. Young's first report, page 13, does not now exist, and such fish as enter the river are only stopped by the high impassable weirs where the Tay District Board have already experimented unsuccessfully with the Macdonald Fish Pass. Mr. Ericht.

Young (*loc. cit.*), referring to a book by William Gloag, Deputy Collector of Cess, says that it is there stated that the fishings at the Keith—which is situated between the present mills of Ashbank and Westfield—were worth £164 16s. annually, at so recent a date as 1835, and, he adds, no doubt with truth, that no one would now give £1 a year for them. The mills were all working at the time of my visit, yet the water ran clear, and I understand that it is never polluted by the flax mills. The river seems well suited to salmon, and I have no doubt they would enter it in numbers and ascend to the impassable weirs above Blairgowrie, if the river Isla formed a greater attraction to the salmon and sea-trout of the main river Tay.

Isla. It seems certain that in former times salmon entered the Isla earlier in the season, and were numerous in the river. Where the more rapidly flowing Ericht joins the Isla several fine streams give life to the latter river; and in the neighbourhood of Meigle other streams exist; but for twelve or thirteen miles upwards from the junction of Isla with Tay, at Meiklour, the Isla is a sluggish canal-like river, except for the localities mentioned. It does not appear that when the fishings were more prosperous the chief features of the river were different, and on this account I was anxious to inspect carefully the junction of Isla and Tay at Meiklour. On 3rd November 1891, a committee of the District Fishery Board reported to the Board at Perth that the rumour of the existence of a gravel bank at the mouth of the Isla was without foundation, that no gravel bank had accumulated at the mouth of the river, and that there was sufficient water for fish to enter the tributary at all times and seasons. The report of the committee contains no suggestion as to the cause of the decline in the fishings in Isla.

The Tay, at Meiklour, sweeps round in a bow-shaped course, the greatest force of the current being towards the east or Isla side. The current impinges with some force above the mouth of the Isla, and the fact that the point between the two rivers, as well as the bank for some distance up the Tay, is strengthened by solid masonry, inclines one to suppose that the encroachment of the water on the lands of Meiklour had become marked, and that building was resorted to in order to prevent a further denudation of the point which separates the two rivers. If this supposition is correct, we have only to restore, in imagination, the point and the left bank of the Tay above the point, to see that the "lead" into the Isla has been rendered much less direct by the process of denudation than it formerly was. It may not be possible at this date to restore the banks so as to give a greater chance for ascending fish to enter Isla, but the other alternative remains of attempting to increase the sluggish flow of Isla at the point, by concentrating the water, by means of a croy or imperfect dam, so as to increase the current. Such an attempt has recently been made at the mouth of the Teviot by means of a barrier or imperfect dam. At present the current of the Tay may be said to be quite unaffected by the entrance of the Isla water. I would venture to suggest, however, that the projection of the point of land is likely to produce the best results for the Isla. At present the fishings of this river have sunk to so low an ebb, during the best of the season, that no attempt is made to maintain them, nor is any assessment levied upon the proprietors. Pike have become too numerous, and attempts which have been made to net them out have not resulted in much success. The characteristics of the Isla seem to be favourable to grayling fishing, yet graylings are not taken in numbers. This fish seems to me to deserve more attention than is commonly given to it. The introduction of grayling into the Clyde at Abington, in 1855-56, formed the first attempt to acclimatise the species, and the experiment has been most successful. Although the sporting qualities of this fish are not equal to those of trout, the grayling is adapted for the rather more sluggish water which is to be found in some of our rivers, and which is of inferior value for trouting; and the fish is in best condition during the winter months, when trout are out of condition if not out of season.

Banks of gravel, such as were supposed to exist at the mouth of the Isla, are more likely to arise at the confluence of rather rapid streams, as at the points where the Lyon or the Tummel joins the Tay. The Gallan Falls, above Meggernie, on the Lyon, were visited on the last day of the rod-fishing season, but, owing to the low condition of the river, the few salmon which were seen attempting the lower cascades were unable to ascend. The Falls of Tummel, the weir at Dalcroy, and the falls at Dunalister were the obstructions visited during the inspection of the latter river. Lyon. Tummel.

Several parts of the Spey District were also visited. The important case of the Countess Dowager of Seafield and others against Roderick Kemp, of Macallan Distillery, with reference to the pollution of the Ringorm Burn and River Spey, has significance not only for all other distillers who pollute the Spey, but for the manner in which river pollution in general may be opposed by riparian proprietors. Several good salmon streams in Scotland have been entirely closed to migratory fish through being regarded as convenient effluents for the poisonous bye-products of manufactories. In the case of the Spey, time has been granted by the Court, in order that another method of disposing of the deleterious matter may be devised The decision of the First Division of the Court of Session will be found in Note IV. Spey. p. 58.

A river which may be described as hanging in the balance between extreme pollution and a return to its former condition of a salmon river of the first class, is the Don. To render this river satisfactory to both upper and lower proprietors three lines of improvement seem to be necessary:—(*a*) To stop pollution by arranging that deleterious matter be disposed of through other channels. (*b*) To regulate the amount of water which it may be permissible for any mill or factory to abstract. (*c*) To afford salmon greater facilities for ascending the artificial obstructions of the river. Don.

In my inspection I ascended the river from the Bridge of Don. I shall mention the matters which more especially engaged my attention in the order in which they occur from the mouth upwards. At *Kettoch Mill*, on the left bank—a barley and meal mill which appears to cause little or no pollution—a heck exists at the foot of the tail race, but it is of an unsatisfactory type. The bars are thin and irregular, and even at normal flow of the river do not reach as high as the surface of the water. Ascending salmon could easily swim over the upper surface of the heck, and I was informed by the local inspector that they do so in considerable numbers, and that the lade between the mill and the heck is hunted by poachers on all possible opportunities. A more suitable heck should be provided. The dam-dyke offers little or no obstruction to ascending fish. It is built at a bend of the river, and has a V-shaped angle pointing up stream. The apex of the V forms a good pass for salmon, the dyke being comparatively low.

Gordon's Mills and *Don Mills*, on the right bank—carding and spinning mill, and paper mill respectively. The dyke which enables water to be drawn to those mills is not only a dam-dyke, but is also a cruive-dyke or fishing weir. At normal conditions of flow the whole of the water in the river passes through the four cruive boxes (*vide* Note III.). Immediately below the cruives, Plate I., the fishing pool known as the Lebby Pot occurs. This pool, which has been netted for a great p. 54.

number of years, is maintained by a check-dyke, a structure which, unless explained in some very special way, seems to me to be illegal, and concerning which I have entered into communication with the Don District Fishery Board.

Immediately below the cruives the tail lade of the *Grandholm Mills*—a cloth manufactory—on the left bank, enters and swells the water of the Lebby Pot. This lade is about a mile in length, and contains a large amount of water. In this mile the fourth mill occurs—Messrs. Pirie's rag mills—but the water for this mill is led off on the right bank by a long lade starting from a dyke about 200 yards above that which gives water to the Grandholm Mills, so that the cruive and dam-dyke at Gordon's Mill is deprived of water by the very long lade of the Grandholm Mills alone. Some advantage is gained by the length of the lade to the last-mentioned mills—a substantial structure cut through rock for a great part of its course—in that the dam-dyke at the upper sluices is low, and offers no great obstacle to the ascent of salmon. The same may be said of the dyke supplying *Woodside* rag mills, although, unlike the Grandholm Mills, these are close to the river. It is built, like the dam at the Kettoch Mill, with an up-stream angle, and in addition, a broad race passes off close to the left bank and enters about a hundred yards lower down without any obstruction, so that by this race salmon could pass up stream without ascending the dam. An example of the effect of a too short lade is seen at the next or *Mugiemoss* Mill—Messrs. Davidson's paper mill. The dyke here has become notorious as an obstruction to the ascent of salmon, and during last close season the fish had to be netted out of the pool below, and conveyed (in the water-carts of Aberdeen) to the river some distance above. This Mugiemoss Dam is referred to by Mr. Young in his 1st, 8th, and 9th Reports, and more briefly by Mr. Archer in the 11th Report. Several modifications have from time to time been made on this dyke in order to facilitate the ascent of salmon, but the obstruction is still most formidable. In my opinion no slight modification will here be of much avail, and unless a radical remodelling is undertaken, any improvements in other parts of the river will suffer if (and the ample supply of pure water must be considered of paramount importance) the increased distribution of migratory fish so much needed for the improvement of the general fisheries of the river be not facilitated at Mugiemoss.

At the time of my inspection, owing to a sudden reduction in the water-flow, due presumably to the opening of mill sluices further up, Mugiemoss dyke was deprived of much water (the state of the river had been previously estimated as six inches above normal). By wading, I was therefore enabled to make a thorough examination of the whole structure.

The down-stream face of the dyke is roughly elliptical in contour, a straight salmon pass exists down the centre of the dyke, and at the foot of this pass, between the side arms of the dyke, a long flat apron extends. The outline of the apron is necessarily also elliptical; it is rendered perfectly smooth by cement, and is the most singular feature of the obstruction. The height of the dyke from the flat surface of the apron is about 8½ feet, and the length of the down-stream face, as measured down the side of the pass, is 45 feet. This measurement also represents the length of the pass, the breadth of which I found to be 5 feet, the depth about 3½ feet, the floor being roughly rounded throughout; and the depth at the sill 18 inches. No breaks or stops exist, and therefore, although measuring from the sill to foot of pass, the gradient is one in five—the minimum recognised by Schedule G of the Salmon Fisheries (Scotland) Act, 1868—the length of the pass is such that the descending water attains very great momentum. Except in low conditions of water, it would be impossible for salmon to swim through the foaming race in the pass, and during these conditions the water covering the flat surface of the apron is not more than ankle deep, thus entirely depriving fish of a "take-off." On the left side of the dyke a slight angle in the masonry and upper sill exists, and I am informed by the keeper, who has for a number of years carried on the net fishing in the neighbourhood, that when the river rises, and fish begin to run, the ascent is made at this slight angle. The length of the apron from the foot of the pass I found to be 124 feet. Immediately beyond the apron, which ends quite abruptly, the water is very deep. Fish attempting to ascend the Mugiemoss dyke have therefore to come to the surface at the lower end of the apron, to traverse the shallow water on top of the apron, and then from this almost impossible position to attempt the very difficult ascent of the weir.

In order to give facilities for fish to ascend, it is necessary, in my opinion, to give them deep water on the surface of the present apron. Three subsidiary dykes of 3 feet, 4 feet, and 5 feet height, built transversely across the line of water flow, parallel to each other, would accomplish this end, and would also flood the present pass sufficiently to afford salmon an easy entrance to the upper river. It is necessary that the lowest subsidiary dyke be placed at the extreme end of the apron, so as to allow fish the benefit of the deep pool in jumping the dyke. A depression in the centre of this dyke 6 in. deep by 5 feet broad might be allowed. I would suggest that from this point the other two dykes should be erected 30 feet up stream and 60 feet up stream. A pool-pass of this kind takes advantage of all the water of the river, and fish are enabled to ascend in the main channel without great effort.

About half a mile above Mugiemoss, Messrs. Pirie's *Waterton works and Stoneywood works*—paper mills—occur. The works are in the same enclosure and are of great extent, having been recently much enlarged; but two separate dykes and lades exist. The Stoneywood lade, an immense and substantial structure, is conducted in an aqueduct above the other. The two lades unite before the contained water is returned to the river, and the breadth of the united tail-lade is apparently as great as the breadth of the channel of the Don. This matter is referred to by Mr. Young in page 22 of the First Annual Report. No change for the better seems to have transpired since his report in 1882.

The Waterton dyke is comparatively low and a gap exists in the centre of it. Owing to the rough nature of the river bed immediately below, the position of the pass does not seem to be well selected. Perhaps the simplest plan here would be to insert a "diagonal" pass on the face of the dyke from the extreme left, where some rocks project. The "diagonal" to project downwards and outwards for a distance of about 10 feet, so that the foot of it rests upon the lower margin of the dyke. Such a "diagonal" is most readily formed of 3-inch wood against iron uprights driven into the face of the dyke. The chief trouble in this locality, however, seems to be the abstraction of water, which during the summer months, and when the water is low, renders the main channel below the dam so dry that fish have not sufficient water in which to ascend.

Stoneywood dyke, the seventh artificial obstruction, has a long easy gradient and is not high. The river bed immediately below is broad and shallow, however, the latter by reason of the amount of water abstracted by the great lade supplied by the dyke, and I am readily led to suppose that during low levels of the river fish cannot reach the dyke. A fish-pass exists which is, in my opinion, suitable for the purpose intended

A slight deepening of the channel below the fish-pass might result in great advantage in this case; but if the salmon fishings of the Don are to be preserved it seems to me essential that the mill-owners be required to use less water.

Ness. I have also visited the district of the river Ness. My attention was here called to the Dochgarroch weir, which maintains the level of the Caledonian Canal at the north end of Loch Ness, and forms the source of the river Ness. The weir stretches a distance of about 700 feet across the head of the river; the down-stream face measures 20 feet, and the height of the weir is 5 feet. A broad gap or pass occurs at a very suitable point for the ascent of fish, but, owing to the large, abruptly-projecting stones forming the apron immediately below the pass, the descending water breaks most roughly, and is scattered in foam in such a way as to seriously impede the ascent of salmon. A water gauge exists at the Dochgarroch Lock on the Canal, the daily readings of which, covering a great number of years, were kindly sent to me by the Engineer and Superintendent of the Canal. Finding the weir an obstruction to the ascent of fish, except during flooded conditions of the river, I made a special report on the subject, suggesting that in order to obviate the unfortunate condition a barrier parallel to the weir should be erected opposite the mouth of the pass, to check the force of water, and that as far as possible the projecting points of rock should be pinched off. This report was approved by the Fishery Board on 27th January of this year, and, at the request of the Ness District Board, was subsequently forwarded to them.

In the Ness district I also visited Invermoriston. The celebrated salmon pass at the Invermoriston Fall has undergone some modification since it was visited by Mr. Archer in 1892. It now consists of nine steps and a run at the top, but the second and third step, counting from below, need not now be taken by fish owing to a run of water which has broken round them. The high floods to which the river is subject have also moved a rock of several tons weight into the centre of the pass, but this does not in any way injure the chance of fish ascending; while a two-doored sluice, which has been erected at the upper end, now enables the flow of water in the pass to be regulated. A short distance below the Fall the river becomes sluggish, and at its entrance to Loch Ness the current is unfortunately slight. A partial barrier or large croy might here be of advantage, as suggested with reference to the river Isla, p. 6, *ante*. Above the Fall the river is very rapid, and but few pools or resting-places for fish seem to exist. The erection of one or two croys at judiciously selected points might greatly improve the fishing. Four miles up stream another serious natural obstruction occurs. Just above a rocky islet the course of the river is narrowed in a rocky gorge. The fall is not of great height, but owing to the concentration of the water the current is excessively strong; in addition to which, just at the point where the plunge is made, the water splits upon a large rock. Above this point the river for a few miles assumes a sluggish character, as in the river Lyon, but at Torgyle, to which point I drove with Mr. Ewen Grant, a pleasant series of streams again occurs. The Superintendent of the Ness district informed me later that a large number of salmon had penetrated to the upper reaches of the Moriston, and had there spawned and been killed by local people.

On a subsequent occasion also I inspected the tidal mouth of the river Ness in connection with certain dredging and building works proposed by the Inverness Harbour Trustees.

Beauly. In the Beauly district, all the fishing rights of which are held by Lord Lovat, I first visited the cruives, a description of which will be found in Note III., p. 53. I afterwards inspected the Kilmorack Falls. At the lower Fall no pass exists, and at the upper Fall a slight pass at the extreme right is alone present.

Conon.

A description of the Conon cruives will also be found in the note above referred to. The part of the water in this district, which is described as the river Conon, is only about 14 miles in length, being that which connects Loch Luichart with the sea at Conon Bridge, yet the drainage area served by the upper waters of Bran and Fannick or Grudie, and by the lower tributaries of Blackwater, Meig, and Orrin, is upwards of 400 square miles in extent. Considering the great extent of most beautiful water which exists in the district, the mileage to which salmon have access is very small. I made a careful inspection of the large Falls at the source of the Conon proper, and also of the Falls on the Bran above Loch Luichart. In my opinion a wider distribution of spawning salmon throughout the district would materially develop the great potentiality of the fishings which appears to exist. Reference to the proposed opening up of the district will be found in the Report of the Commission on Crown Rights in Scottish Salmon Fisheries, p. 13.

Establishment of District Boards in Isle of Skye.

On 9th February 1898 a District Fishery Board was duly constituted by the Sheriff of Inverness, Elgin, and Nairn for the district of the river Snizort, being the western district of the Isle of Skye.

Also on 4th May 1898 a District Fishery Board was constituted by the same Sheriff for the district of Sligachan, Broadford, and Portree, being the eastern district of the Isle of Skye.

I am further able to state that at a meeting of the said Boards, held on 22nd June, the two Boards agreed to combine in maintaining a common staff of officers for the better protection and regulation of their fisheries, in terms of sec. 22 of the Salmon Fisheries (Scotland) Act, 1862 (25 & 26 Vict. cap. 97).

Salmon Fishery Investigation.

The scientific investigations instituted by my predecessor, Mr. Archer, in 1894, have, as far as possible, been continued. The extremely valuable results which have been obtained were summarised in the last Annual Report (p. 13). During the past year Dr. Noel Paton and his colleagues have obtained fish, principally from the Spey and Dee, but also to some extent from the upper waters of the Tay, for the purpose of extending the investigations which formed the subject of the Special Report on the Life History of the Salmon which was presented to both Houses of Parliament on 8th March 1898. This additional work is not yet sufficiently advanced to admit of publication, but from a memorandum furnished me by Dr. Noel Paton, I am able to indicate the following as the points principally studied :—

(1) The conditions governing the migration from sea to river. By Dr. Noel Paton and Dr. J. C. Dunlop.
(2) The source of the colouring matter of the flesh and ovaries. By Miss Newbigin.
(3) The growth of the "hook" on the lower jaw of the male fish as the spawning season is approached. By Dr. Crawford.

For the purposes of (1), His Grace the Duke of Richmond and Gordon, and the Fishery Board for the District of the River Dee (Aberdeenshire), have kindly supplied 32 fish during the months of February, March, April, May, June, July, and December of 1898, and in January of 1899. The purpose has been to fill up the slight hiatus which existed in the published report. In connection with the inquiry mentioned as (2), Sir John Murray has kindly forwarded a supply of crustacea from Loch Fyne, and it is hoped that material for purposes of comparison may shortly be obtained from Ireland. The statement in Dr. Noel Paton's published report which seems to have attracted the greatest amount of public notice, is that which refers to the habit which the salmon has of ceasing to feed when in fresh water. A certain degree of misconception seems to have arisen on this point, in two ways. Some who have discussed the matter have not understood that the salmon referred to are those which have reached the adult stage, or have at least returned from the sea after feeding heavily there. By others, what may be termed the mere impulse to feed, or to seize objects somewhat similar to natural food, has been confused with the habit of taking nourishment, a habit which amongst salmon in fresh water is, in our country, practised only by parr and smolts, and perhaps by not a few kelts, for we still need much information about kelts, especially mended kelts. If the impulse to seize objects, which by experience are known to be attractive to salmon under certain conditions, were not present, we should have no salmon angling. Many observers have remarked that amongst salmon taken in fresh water none are to be found with food in their stomachs. In 1872, for instance, Professor S. F. Baird, of the U.S. Fish Commission, inserted a note in his report as follows (p. 371):—"According to Dr. A. C. Hamlin, the examination of many hundred salmon in the Bangor (Maine?) market revealed no kind of food, excepting in a single instance where two small fishes were discovered." The statement, however is very general, inasmuch as we are not told where the salmon were caught, or whether the two small fishes were of marine or fluviatile species. The thoroughly scientific discussion of the question, both from the physiological and chemical aspects, and the proof that the salmon, when seeking the fresh water with tissues charged with fat, ceases to take nourishment, and speedily undergoes a change in its digestive tract which renders it incapable of absorbing nourishment, places the whole question on a different level. In all probability the migratory salmonidæ of the American Continent have the same peculiarity; indeed, the fruitlessness of angling for salmon in some rivers of the Pacific Coast would seem to show that even the impulse to seize food is deficient, but in this connection it is necessary to except the land-locked salmon. This salmon, found also in some Scandinavian inland waters, migrates only from rivers to great lakes, and does so even when the passage to the sea is open to it. The eggs of *S. salar*, which the late Sir James Maitland hatched and reared at Howietoun in 1880-1884 (*vide* Day's British and Irish Salmonidæ, p. 102), and which successfully spawned in December of the latter year, and the offspring of which hatched out in February and March of 1885, form examples of artificially fed and land-locked salmon. Yet just as Loch Leven and common trout transported to New Zealand assume a migratory habit, so it would appear that our present migratory species may under certain conditions continue to exist exclusively in fresh water, and to feed there.

Marking of Salmon.

The marking of salmon by means of a small silver label attached to the dorsal fin has been continued. Labels have been sent or delivered personally to the Spey (George Muirhead, Esq., factor to His Grace the Duke of Richmond and Gordon, Fochabers), the Dee (Clerks to District Board, Aberdeen), the Tay, upper and lower waters (H. W. Johnston, Esq., Dunros, and Mr. Lumsden, Superintendent of District, Perth), the Brora (Mr. T. Trussler, Brora, through D. M'Lean, Esq., factor to His Grace the Duke of Sutherland). In addition to this, 2000 labels have been sent to E. W. L. Holt, Esq., who, in the interests of the Royal Dublin Society, is working at the migrations of the salmon in Ireland, and who has kindly offered to mark fish and transmit to me the results which he obtains. The extension of the system of marking secured by this arrangement will, it is hoped, benefit the salmon fisheries of both Ireland and Scotland. Since the commencement of the marking operations, 6000 labels have been distributed.

NOTE I.

THE FOLLOWING QUERIES HAVE BEEN SENT TO CLERKS OF DISTRICT BOARDS, AND OTHERS:—

Take of Fish—

1. Has the take of fish in your district in 1898 been above, about, or below the average—
   (*a*) In tidal waters?
   (*b*) In fresh waters?
   (*c*) By fixed engines?
   (*d*) Generally throughout the district?

2. Can you give the number of fish caught in your district, exactly or approximately—
   (*a*) By net and coble?
   (*b*) By fixed engines?
   (*c*) By rods?

3. At what period of the year in your district during 1898—
   (*a*) Were the first clean fish taken?
   (*b*) When was the main take of salmon?
   (*c*) When did the grilse and sea-trout run?

4. In order that accurate records be kept as to whether the run of salmon in your district is becoming earlier or later, it is desirable that you should, if possible, obtain and furnish me with statistics of the percentage of fish taken in each month—
   (*a*) By net and coble?
   (*b*) By fixed engines?

5. What was the weight of the heaviest salmon or trout caught in your district in 1898—
   (*a*) By net and coble?
   (*b*) By fixed engines?
   (*c*) By rods?

Protection—

1. Please state the amount of the assessable rental of your district in 1898?
2. What was the assessment levied thereon during this year?
3. State the number of water bailiffs employed in your district in 1898?
4. Were any prosecutions instituted under the Salmon Fishery Acts in 1898? If so, for what offences were they instituted, and what was the result?

Obstructions to the Passage of Fish—

1. Give full particulars of any dams destroyed or disused in your district in 1898; or any new dams built or old dams altered?
2. Are the dams and cruives (if any) in your district worked in accordance with the provisions of the bye-laws (Schedules F and G) regulating the same?
3. Have any fish-passes been built or altered in 1898?
4. Do the existing fish-passes afford at all, or any, or at what times a free passage to salmon wishing to ascend?

5. Have any natural obstructions been opened up during 1898?
6. Generally, have any acts been done, either by new fisheries being started, old fisheries not being used, or in any other way, whereby the ascent of fish has been influenced? If so, state fully what changes have taken place.

Pollutions—
1. Were any fresh causes of river-pollution introduced in your district in 1898?
2. Were any steps taken in 1898 to remove causes of pollution; and if so, were they attended with success?

The Salmon Disease—
1. Has the salmon disease shown itself in your district this year? If so, when did it first make its appearance? When was it at its height? When did it disappear?
2. What was the level of the river during the prevalence of the salmon disease?
3. Can you state the number of diseased salmon taken from the river in each month, specifying the proportion of male and female, of kelts and of clean fish?
4. Generally, have you any remarks or suggestions to make with regard to the salmon disease?

The Spawning Season—
1. What was the earliest date, during the season of 1897-98, on which salmon were noticed spawning?
2. Between what dates did the greatest number spawn?
3. When did the spawning season finish?
4. What was the level of the river during the spawning season?
5. Were the numbers of spawning fish more or less than usual?
6. Which were the principal spawning streams in your district?

Kelts—
1. On what date, during last season, were kelts first noted migrating seawards?
2. When did the chief migration take place?
3. When was the river free from kelts?
4. What was the level of the river during the period kelts were migrating?

Smolts—
1. On which dates, during the year, were smolts noticed migrating?
2. Was it a good smolt year?

Artificial Propagation of Salmon—

Is there any hatchery in your district for the artificial propagation of salmon and trout, either belonging to the District Board or supported by private enterprise? If so, describe its situation, and state how many ova have been secured during the past season.

Proportion of Male to Female Salmon—

Can you state the proportion of the male to the female salmon in your district or river, specifying whether your return, so far as it goes, is based upon an estimate or on actual enumeration?

General Question—

Are there any other points relating to the salmon fisheries in your district to which you would wish to direct the attention of the Board, in addition to those suggested by the preceding queries?

ANSWERS TO THE FOREGOING QUESTIONS.

THE DISTRICT OF THE RIVER FORTH.

Take of Fish—

1. (*a*), (*b*), (*c*), and (*d*) Below the average throughout the district.
2. (*a*), (*b*), and (*c*) No. The tacksmen refuse to give any information.
3. (*a*) 11th February; (*b*) June, July, and August; (*c*) grilse in June, July, and August, and sea-trout all the fishing season.
4. (*a*) and (*b*) See answer to No. 2. The percentage cannot be given, but there is no doubt a great many more fish are taken by fixed engines than by net and coble.
5. (*a*) 48 lbs.; (*b*) 56 lbs.; (*c*) 32 lbs.

Protection—

1. £3,791 14s. 4d.
2. 2s. 6d. per £.
3. One superintendent and eleven bailiffs.
4. Yes. Taking fish by small mesh nets, gaffing, jiggering, fishing with salmon and other roe and contravening bye-law (Schedule F). Convictions obtained in every case but one.

Obstructions to the Passage of Fish—

1. Nothing done.
2. Yes. An offender was prosecuted for contravening bye-law (Schedule F) at Craigforth Cruive in the River Forth. He was convicted.
3. No.
4. At the outlet works from Loch Venacher into the Teith, constructed by the Glasgow Corporation under the Waterworks Act of 1855, the Corporation are bound to construct the outlet thereby directed to be made so that salmon may at all times, or during such periods as water shall be discharged, freely pass into or from the loch. The works, in the opinion of the salmon fishery proprietors, are not constructed in terms of this obligation, which applies also to Loch Katrine outlet under the same Act.
5. No.
6. No.

Pollutions—

1. No.
2. No.

The Salmon Disease—

1. Yes. 1st December, 1897. End of January. April, 1898.
2. Very high.
3. No.
4. No.

The Spawning Season—

1. 16th November, 1897.
2. In December, 1897.
3. About 15th January, 1898.
4. Very high.
5. About the same.
6. Teith, Allan, and Forth.

Kelts—

1. 10th December, 1897.
2. February and March, 1898.
3. End of April, 1898.
4. Very high.

Smolts—
1. March and April, 1898.
2. Yes.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
No.

General Question—
The fishings are very injuriously affected by hang or drift net fishing in the River Forth from Alloa Bridge to Culross.

THE DISTRICT OF THE RIVER TAY.

Take of Fish—
1. (*a*), (*b*), (*c*), and (*d*) Below average.
2. No. There will be a better opportunity of getting the numbers now that the net fishing is practically in the hands of one company. (*c*) No.
3. (*a*) Clean salmon are in Tay at all seasons of the year. (*b*) During July and August. (*c*) First Grilse, 15th May ; sea-trout, I don't know.
4. (*a*) and (*b*) Impossible under present arrangements.
5. (*a*) 54 lbs.; (*b*) 44 lbs.; (*c*) 56½ lbs.

Protection—
1. Rental, £21,047 18s. 2d.
2. Assessment, £1,473 7s. 1d, being at the rate of 7 per cent.
3. Twenty during close season.
4. Generally for taking salmon either illegally or in close time ; chiefly convicted when detected. Number of cases tried, 24 ; involving 44 persons, of whom 39 convicted ; complaints against 2 withdrawn, and 3 not proven.

Obstructions to the Passage of Fish—
1. Dornoch Dam on the Earn having been damaged by floods, arrangements have been made for the breach remaining open so as to allow a passage for fish.
2. No ; but the Board has recently issued a peremptory circular on the subject with good results.
3, 4, and 5. A committee of proprietors on the Earn are negotiating with the view of removing obstructions and improving the fishings generally.
6. Notice may here be taken of the formation of a syndicate which has rented most of the commercial fishings with a view to their more economical working. This will probably involve the less frequent fishing of some stations.

Pollutions—
1. Nothing, except the growth of the population and industries, chiefly bleaching and dye works.
2. No.

The Salmon Disease—
1. Yes ; first observed towards end of October ; at its height about end of December. I am not quite sure if it ever altogether disappeared.
2. Usual winter conditions.
3. No ; they are nearly level as to sex. About a score of clean salmon were found dead ; but they are mostly foul fish.
4. I would just remark that a wet season is no cure for disease, and a dry season does not seem to make it any worse.

The Spawning Season—
1. 3rd November, but they must have been spawning earlier, as one kelt was landed by rod in October.
2. 15th November and 15th December.

3. About 10th January.
4. About usual winter level.
5. Less.
6. Tay, Earn, Ruchill, Isla, Tummel, Garry, and Lyon.

Kelts—
1. Middle of December.
2. April.
3. June.
4. Usual spring conditions.

Smolts—
1. April and May.
2. Very good.

Artificial Propagation of Salmon—
The salmon hatchery at Dupplin on Earn belonging to District Board; about 400,000. The hatching capacity is 570,000, but we did not get it filled.

Proportion of Male to Female Salmon—
I would say there are more females than males, but I have never counted.

General Question—
The question of the legality of "toot and haul" nets has been before the Court of Session. Both the Lord Ordinary and the First Division have decided against these nets. The legality of "hang" nets has also again been raised, but both the Lord Ordinary and the First Division have felt themselves bound to follow previous decisions holding these nets to be legal, although their Lordships have carefully guarded themselves against desiring to add weight to these decided cases as to the soundness of which doubts have been expressed. It is probable that both cases will be carried to the House of Lords.

THE DISTRICT OF THE RIVER SOUTH ESK.

The answers were unfortunately too late for publication when received.

THE DISTRICT OF THE RIVER NORTH ESK.

No answers have been received.

THE DISTRICT OF THE RIVER BERVIE.

No answers have been received.

THE DISTRICT OF THE RIVER DEE (ABERDEEN).

Take of Fish—
1. Below the average in each of these four cases.
2. No.
3. (*a*) 11th February; (*b*) February was the best month of the season, the grilse fishing poor; (*c*) grilse began to run, 15th April—sea-trout, 11th February.
4. No information got on these points.
5. (*a*) 32 lbs.; (*b*) 46 lbs.; (*c*) 37 lbs.

Protection—
1. £17,423 8s. 6d.
2. Six per cent. on above assessable rental.
3. Twenty-one.
4. Fourteen prosecutions, implicating 22 individuals. For having unseasonable salmon and poaching implements in their possession. One case not proven, another settled out of court, others fined from 7s. 6d. to £5. Twelve of the 14 cases went to prison. Terms of imprisonment from 7 days to a month.

Obstructions to the Passage of Fish—
1. No dams.
2. No cruives.
3. No.
4. Does not apply to Dee District.
5. No.
6. No changes.

Pollutions—
1 and 2. No changes in this department since last year, but arrangements are in progress between the Town Council and District Board whereby the sewage that had obtained fall into the lower Dee is to be carried to the sea at the Bay of Nigg.

The Salmon Disease—
1, 2, 3, and 4. No diseased fish seen in 1898.

The Spawning Season—
1. 15th October.
2. Upper river between middle of October and middle of November. Lower river between end of November and end of January.
3. Practically at the end of January.
4. Largely flooded during whole spring time.
5. Upper waters more than usual; lower water less.
6. Upper river and tributaries in upper district.

Kelts—
1. End of January.
2. From 1st April to middle of May.
3. Never quite free, but most free in July.
4. Low.

Smolts—
1. Early in April.
2. Yes.

Artificial Propagation of Salmon—
Board has constructed and maintains a hatchery at Drum, about 11 miles up the river. 1,000,000 ova put into the hatching boxes in 1898, 97 per cent. of which were successfully hatched and put into the river.

Proportion of Male to Female Salmon—
No information on this point.

General Question—
No.

THE DISTRICT OF THE RIVER DON.

Take of Fish—
1. Below the average in each of these four cases.
2. No.
3. (*a*) 11th February; (*b*) in month of July; (*c*) grilse middle of May; sea-trout 11th February.

4. No information of a reliable kind on these points.
5. (*a*) 38 lbs.; (*b*) 43 lbs.; (*c*) 26 lbs.

Protection—

1. £3,429 18s. 11d.
2. 23 per cent. on above assessable rental.
3. Sixteen bailiffs, besides inspector.
4. Ten different prosecutions, implicating 20 individuals, 15 of whom convicted, and 5 not proven. Having poaching implements or foul fish in their possession. Fines from £2 to £5, with option of imprisonment for 7 to 30 days. The fines paid in one case; others went to prison.

Obstructions to the Passage of Fish—

1. No dams destroyed or given up, nor have any new dams been built or old dams altered.
2. The cruives are worked in accordance with the bye-laws.
3. None.
4. Fish can always ascend when river is high; but at Mugiemoss and Waterton Mill Dykes, ascent at lcw water is impossible.
5. None.
6. None.

Pollutions—

1. No fresh causes of pollution, but existing sources are yearly increasing.
2. One source of pollution from the Great North Railway's creosote works at Dyce put a stop to in 1898. The Town Council and the District Committee of the County Council were called upon as sanitary authorities to put a stop to the pollution finding its way into the river from sources within their respective areas, and no result having followed, the matter was reported to the Secretary for Scotland, by whom representations on the subject have been made to both these bodies. It is believed that there are now fair prospects of a comprehensive scheme being entered into by the Town Council, the District Committee, and the mill owners for dealing with the entire pollution at present being discharged into the river.

The Salmon Disease—

1. Only to a limited extent. First appearance on 15th October, and worst about end of January.
2. 10 to 12 inches above ordinary level.
3. One male and one female fish, 15th October. Two male and two female 2nd November, and 8 male and 11 female fish in December. About one half of these kelts. No clean fish showing signs of disease.
4. The comparative absence of disease is believed to be due to the fact that river was high during the greater part of the winter.

The Spawning Season—

1. 5th November.
2. Between 15th and 31st December.
3. About 31st January.
4. 10 to 12 inches above normal level.
5. More than usual.
6. Principal spawning grounds in upper district, particularly Alford and Kildrummy.

Kelts—

1. About the end of March.
2. About the middle of April.
3. Never quite free, but most free at end of June.
4. Normal.

Smolts—

1. Middle of April.
2. Fairly good.

Artificial Propagation of Salmon—

Small hatchery at Fish Street, capable of receiving 60,000 ova. Ova actually put in 1898, 55,000, of which over 40,000 were hatched, and put half into the Dee and half into the Don, 16 to 18 miles above Aberdeen.

Proportion of Male to Female Salmon—
No specific information as to this, but proportions believed to be about equal.

General Question—
One very special grievance on the Don is at Stonywood Paper Mills, belonging to Messrs. Pirie & Sons, Limited, where, at the normal level of the river, by reason of the abstraction of water for the mills, about 250 yards of the river is practically *completely dried* night and day during the six working days of the week, and partially so even on Sundays.

THE DISTRICT OF THE RIVER YTHAN.

Take of Fish—
1. (*a*), (*b*), (*c*), and (*d*) Below the average.
2. (*a*) and (*b*) No ; (*c*) about 70 salmon.
3. (*a*) 25th February; (*b*) and (*c*) August.
4. The tenants will not give information on these points.
5. (*a*) The tenants will not give information on these points ; (*b*) 41 lbs. salmon, 10¾ lbs. sea-trout ; (*c*) 26 lbs. salmon.

Protection—
1. £1,298 10s.
2. £·121759 per £ (a little over 2s. 5d.).
3. One all the year round. Four assistants from autumn to spring.
4. Five—and in each case a conviction was obtained. Two were for being in possession of foul fish ; one for "burning the water," and two for trying to catch fish by means of a spear or gaff.

Obstructions to the Passage of Fish—
1. None.
2. We have no cruives.
3. None.
4. The intake on Ebrie Burn at Meal Mill of Kinharrachy does not afford a free passage to salmon wishing to ascend.
5. None.
6. None.

Pollutions—
1. None.
2. Unnecessary to take any steps.

The Salmon Disease—
1. Yes ; December, 1897 ; January, 1898. April.
2. River was very low during disease.

The Spawning Season—
1. 2nd November, 1897.
2. From 15th December to 1st January.
3. About beginning of February.
4. The river was high during first part of spawning season.
5. About same as usual.
6. Ythan, Fordoun, Little Water, Ebrie, and Bronie.

Kelts—
3. May.

Smolts—
1. First week of May.
2. Very good.

Artificial Propagation of Salmon—
None.

Proportion of Male to Female Salmon—
Upon estimate, I would say 5 male to 4 female.

General Question—
No.

THE DISTRICT OF THE RIVER UGIE.

Take of Fish—
1. (*a*), (*b*), (*c*), and (*d*) Below the average.
2. The number of fish caught is approximately as follows :—(*a*) About 1,300 sea-trout; (*b*) about 1,700 salmon and grilse ; (*c*) about 43 salmon and grilse.
3. (*a*) March 10th ; (*b*) From the middle of August till 9th September ; (*c*) During July and August.
4. The salmon fishings are in the hands of private enterprise, and the tacksmen still decline to keep any record or give information.
5. (*a*) No record ; (*b*) salmon, 34 lbs. ; (*c*) salmon, 18 lbs.

Protection—
1. £507 10s.
2. 1s. 1¼d. per £.
3. Five.
4. There were no prosecutions.

Obstructions to the Passage of Fish—
1. There have been no alterations on the dams during the year 1898, and no new ones have been built.
2. The dams are worked in accordance with the provisions of the bye-laws (Schedules F and G) regulating the same. The cruives are not worked at all, except for the catching of fish for the hatchery.
3. No fish-passes have been built or altered.
4. The existing fish-passes afford a free passage to salmon at half-flood.
5. None that I know of.
6. None.

Pollutions—
1 and 2. There have been no causes of pollution during the year 1898.

The Salmon Disease—
1. The salmon disease first appeared on 17th January, 1898. It seemed worst towards the end of February. The last diseased fish was taken from the river on 23rd May.
2. Low.
3. January—10 males and 3 females ; February—18 males and 25 females ; March—11 males and 15 females; April—2 males and 3 females ; and May—1 male. All kelts.
4. None.

The Spawning Season—
1. November 27th 1897.
2. Between 10th and 20th December 1897.
3. About the end of December.
4. Low.
5. Average.
6. About Stonemill and on the North Ugie.

Kelts—
1. 24th January.
2. First week of February
3. End of May.
4. Half-flood.

Smolts—

1. Between the middle of April and the end of May.
2. Fair.

Artificial Propagation of Salmon—

An old hatchery at Inverugie was last year repaired and put in working order, but owing to heavy flooding of the river during the spawning season no salmon could be caught, and consequently no ova were got. 30 Loch Leven trout ova were bought and put into the hatchery, and have been all successfully hatched.

Proportion of Male to Female Salmon—

Five males to three females, based on estimate.

General Questions—

None.

THE DISTRICT OF THE RIVER DEVERON.

Take of Fish—

1. (*d*) Below the average.
2. No.
3. (*a*) 11th February; (*b*) February, March, and August; (*c*) July.
5. (*a*) 31 lbs.; (*b*) 46$\frac{1}{2}$ lbs.; (*c*) 29 lbs.

Protection—

1. £2,979 2s. 7d.
2. For protection, 2s. 2$\frac{5}{7}$d.; for repayment of loan and interest, 3s. 5$\frac{2}{7}$d; in all, 5s. 8d. per £.
3. Nine.
4. Three cases of illegal fishing. Fined 30s. with 7s. of expenses each, and implements forfeited.

Obstructions to the Passage of Fish—

The cruive dyke belonging to His Grace the Duke of Fife was removed on 11th February, 1898. The early net fishing was not prejudicially affected thereby. Later in the season the net fishing was not so successful. A few early fish were caught by the rod in the upper reaches. The autumn rod fishing was a failure throughout the entire river.

Pollutions.

The sewage of Keith and the discharges of some distilleries and a cloth factory falling into the Isla, have led to complaints of the pollution of that tributary of the Deveron, but its effect was never visible on the river. A new system of drainage for the town, which will include the disposal of the distillery and other refuse referred to, will be adopted early, and any ground of complaint will thus be removed.

The Salmon Disease—

1. Yes, very little.
2. Low.
3. December, 66; January, 47; February, 40; March, 20. 10 per cent. female.

The Spawning Season—

1. 20th October.
2. 1st November and 31st December.
3. 31st January.
4. Flood, half-flood, and low.
5. About the average.
6. Generally throughout the district.

Kelts—
1. Middle of November.
2. April.
3. 1st May.
4. Half-flood.

Smolts—
1. 19th April; 9th May.
2. Fair.

Artificial Propagation of Salmon—
Yes, but not used during past season.

Proportion of Male to Female Salmon—
Five female to one male. On actual enumeration of fish killed in river by net.

General Question—

THE DISTRICT OF THE RIVER SPEY.

Take of Fish—
1. (*a*), (*b*), (*c*), and (*d*) Below.
2. No.
3. (*a*) 11th February; (*b*) Scarce all the season; (*c*) July sea-trout, May grilse, very scarce.
4. No statistics available.
5. (*a*) 35 lbs.; (*b*) 35 lbs.; (*c*) 34 lbs.

Protection—
1. Assessable rental, £11,633.
2. Assessment at 2s. 2½d. per £=£1,284 9s. 6d.
3. One superintendent, one inspector, and forty-four bailiffs; also two special bailiffs for pollution detection.
4. See Superintendent's Annual Report herewith sent.

Obstructions to the Passage of Fish—
1 See Report.
2. None used in district last year.
3. See Report.
4. See Report.
5. No.

Pollutions—
1. Two or three new distilleries.
2. Action in Court of Session—Lady Seafield and others against R. Kemp, Macallan Distillery. Pollution found proved by Lord Kyllachy. Time given for remedial measures, failing which, interdict may be moved for. Judgment appealed to Inner House, but substantially affirmed.

The Salmon Disease—
1. See Report.
2. Various.
3 and 4. See Report.

The Spawning Season—
1. 4th October.
2. 1st November and 31st December.
3. April.

4. Various.
5 and 6. See Report.

Kelts—
2. December.
3. July.
4. Various.

Smolts—
1. April, May, June, July, and August.
2. See Report.

Artificial Propagation of Salmon—
See Report.

Proportion of Male to Female Salmon—
See Report.

General Question—
No.

The following is a copy of the Superintendent's Annual Report for the year ending 26th August 1898, submitted to the Meeting of the Spey District Board held at Elgin on 21st October, 1898 :—

I.—*Salmon Spawning.*

The following Table shows the dates of the first appearance of Salmon Spawning Beds, and the number seen by bailiffs during the last three spawning seasons on the following named streams or tributaries :—

1895.

Name of Stream.	Spawning Commenced.	No. of Beds for Season.
Fiddich - - -	1st October	715
Avon - - -	15th ”	1550
Livet - - -	16th ”	1300
Conglass - - -	14th ”	273
Lochy - - -	14th ”	90
Dulnain - - -	15th ”	420
Nethy - - -	11th ”	429
Druie - - -	15th ”	153
Feshie - - -	14th ”	812
Tromie - - -	16th ”	158
Truim - - -	17th ”	159
Spey (above Laggan, Badenoch)	15th ”	144
	Total, - - -	6203 Spawning Beds.

1896.

Name of Stream.	Spawning Commenced.	No. of Beds for Season.
Fiddich - - -	6th October	292
Avon - - -	10th ”	754
Livet - - -	14th ”	773
Conglass - - -	14th ”	189
Lochy - - -	22nd ”	74
Dulnain - - -	13th ”	868
Nethy - - -	15th ”	418
Druie - - -	13th ”	215
Feshie - - -	12th ”	636
Tromie - - -	17th ”	210
Truim - -	14th ”	198
Spey (above Laggan, Badenoch)	10th ”	151
	Total, - - -	4778 Spawning Beds

1897.

Name of Stream.	Spawning Commenced.	No. of Beds for Season.
Fiddich - - -	7th October	657
Avon - - -	6th ,,	1200
Livet - - -	14th ,,	1534
Conglass - - -	18th ,,	312
Lochy - - -	18th ,,	104
Dulnain - - -	14th ,,	464
Nethy - - -	19th ,,	185
Druie - - -	12th ,,	200
Feshie - - -	13th ,,	528
Tromie - - -	21st ,,	154
Truim - - -	20th ,,	119
Spey (above Laggan, Badenoch)	4th ,,	204
Total, - - -		5661 Spawning Beds.

Table of Eleven Years' Spawning Beds.

Total number of Beds for year		1887 - - -	3,849
Do.	do.	1888 - - -	5,637
Do.	do.	1889 - - -	2,932
Do.	do.	1890 - - -	2,768
Do.	do.	1891 - - -	4,591
Do.	do.	1892 - - -	5,287
Do.	do.	1893 - - -	4,635
Do.	do.	1894 - - -	7,214
Do.	do.	1895 - - -	6,203
Do.	do.	1896 - - -	4,778
Do.	do.	1897 - - -	5,661

The spawning season of last year shows an increase of 883 spawning beds when compared with the previous season of 1896-97. At the end of September, and during the whole of October last year (1897), an unusually heavy run of fish ascended the river Spey, and many of these, especially grilse and sea-trout, found their way into the Avon and Avon tributaries. At end of October in the upper district of Livet and its tributaries grilse and sea-trout were literally swarming, and the stream channels all but wholly trenched over with their spawning beds. I witnessed this myself on 31st October on the higher reaches of Livet and on the Bly, at which time these streams, in consequence of a spell of dry weather, were in their normal size, thus making it arduous work for the district bailiffs to protect and preserve such a large number of fish, which had in many cases on several spawning fords scarcely enough water to cover them. At this time a somewhat similar state of things prevailed in the upper Avon and its tributaries, which I visited on 1st November investigating a poaching case. Last season's results on Fiddich are somewhat astonishing, considering that during the late summer and early autumn months the channel of this stream in the Dufftown and downward district was more like an open sewer or cesspool than that of a pellucid stream such as Fiddich used to be. The number of spawning beds for the season upon this stream was 657, compared with 292 beds for the previous season. To account for this it must be understood that some 400 of last year's spawning beds were those of sea trout, and all spawned in the Auchindoun and Glenfiddich upper reaches. The other 257 beds were principally made up of grilse which also spawned in the Auchindoun district. The spawning in the Fiddich district was practically over last year by the end of December, at which date in former years, or until within the last three or four years—in plain speaking, during the ante-distillery pollution days—was the middle of or principal season of the Fiddich salmon spawning season over that stretch lying between Tullochallum and Fiddich mouth, and which in those days continued on to end of January, when there would have been at least 500 or 600 salmon spawning beds counted yearly between Dufftown and the mouth of Fiddich. The greater number of the few salmon which spawned in Fiddich below Dufftown last season died of disease and were buried by the bailiffs, and their deposited ova, owing to the polluted state of the stream, will in all probability be poisoned, and thus be rendered useless through the pollution. The comparative figures giving increase or decrease of spawning beds for last two spawning seasons over the tributaries are as follows:—Increase for last season—Fiddich, 365 beds; Avon, 446 beds; Livet, 761 beds; Conglass, 123 beds; Lochy, 30 beds; and Spey (above Laggan, Badenoch), 53 beds. The tributaries, on the other hand, showing a decrease of spawning beds were—Dulnain, 404 beds; Nethy, 233 beds; Druie, 15 beds; Feshie, 108 beds; Tromie, 56 beds; and Truim, 79 beds. It will thus be seen that there was a big increase of beds in the lower tributaries and a large falling off upon the upper or higher reaches of Spey tributaries, with the one exception of Crathie, Laggan, top reach of Spey, which as an upper stretch alone shows an increase over the previous season, this district being clear of pollution from distilleries. The first-named big increase was, as I have already stated, the result of a heavy run of autumn fish. The falling off in the upper Spey tributaries I consider to have been caused by the run of summer fish not being so numerous as they were during the previous summer of 1896, more especially grilse, which were during the summer months of said year very scarce in sea and river, but which in the late autumn showed themselves pretty numerous upon the spawning beds on the lower tributaries. The spawning upon the river Spey from Carron to Grantown was a very good average, and salmon continued upon the redds in the Cromdale district up till 5th March. I do not consider that spawning beds formed and worked upon by spawning fish over the whole of the district last season have suffered or been injured by high spates or ice floes, with the one exception of that of the Feshie, which suffered somewhat through the result of a rapid local spate which took place in that district about the second week of November, and which uprooted a number of spawning beds in the middle reaches of the river.

Notes by the Bailiffs, same as last year, by order of the Board, were kept, giving the number of spawning beds counted on the river Spey on that part of the river lying between Boat o' Brig and Carron Bridge. The Bailiffs' respective records were as follows:—On Aberlour beat, Carron Bridge to Tunnel Pool, 82 beds; Craigellachie beat, Tunnel Pool to Bulwark, 108 beds; Rothes beat, Bulwark to Hollybush, 366 beds; Boat o' Brig beat, Hollybush to Boat o' Brig, 252 beds; and Mulben Burn, 40 beds—total, 848 spawning beds, being a decrease of 415 beds when compared with the number counted upon the same ground during the previous season of 1896-97. No discrepancy in the equal matching of male and female spawning fish while upon the spawning redds was observable by the Bailiffs during the season.

The carrying out a cut through the shingle bank or beach to permit of a new or direct run of the river into the sea at Speymouth near Tugnet, which was sanctioned by the Board at their meeting held at Elgin on 22nd October, 1897, was proceeded with, subject to all the necessary legal proceedings and sanction having been carried through and obtained. The work was commenced about the 20th November last by a large force of some sixty workmen, and the river turned into a new run on the 18th of the following month—December, 1897. The diversion of the river mouth has now given a direct run into the sea, and has given every satisfaction. Tacksmen of salmon net fishings and their fishermen along the coast to the east of Portgordon have expressed themselves to the effect that the new mouth will benefit them by increasing the attraction to fish to come inshore. I visited the old mouth on 10th September last, and found that the action of the sea has now completely closed up the old outlet with a high beach of shingle. I understand that the expense of carrying out the new cut somewhat exceeded the estimated £200.

II.—*Smolt Season.*

The appearance of descending smolts during the spring and summer months upon the river and tributaries was a fair average one. During the principal migrating season, April to June, eight Bailiffs were carrying out the special duty of protecting smolts or salmon fry from 25th April till 4th June, a period of six weeks. The Bailiffs in question were stationed as follows:—One in Speymouth district, one at Rothes, one at Dufftown, one at Aberlour, one on Upper Avon and Livet, one at Ballindalloch, one at Grantown, and one at Duthil. Twenty-eight dozen of printed notices cautioning persons against killing smolts, parr, or salmon fry were posted up along the sides of the river and tributaries all over the district. All of the trout anglers met with by the Bailiffs were found agreeable and willing to show their respective "takes" for inspection. A force of Bailiffs again went on parr or salmon fry protection duty at the begining of August.

III.—*Disease among Fish.*

The following is a detail of mortality or disease among spawning fish, which, during the last ten years, I have noted or tabulated in my yearly report as resulting among fish in the Fiddich during each spawning season. During the ten years in question (1889 to 1898) I have given the death percentage of fish, the percentage being the number of deaths to the number of spawning beds counted upon the stream during the season. During the last year, 1897-98, the number of spawning beds counted was 657, and the number of dead fish removed from the stream and buried by the Bailiffs was 113, or somewhat over 17 per cent., or 10 per cent. above the previous year's mortality, and two per cent. above the average percentage during seven years previous to last year. The death percentages for last ten years were as follows :—1889, 13 per cent. ; 1890, 13 per cent. ; 1891, 18 per cent. ; 1892, 16 per cent. ; 1893, 19 per cent. ; 1894, 8 per cent. ; 1895, 9 per cent. ; 1896, 21 per cent. ; 1897, 7 per cent. ; 1898, 17 per cent. The first dead fish was found on 30th October, and the heaviest death rate was during the month of January, among the fish which had spawned during the preceding month. With a very few exceptions, the dead fish were spawned, and were composed as follows :—Male sea trout, 2 ; female do., 8 ; male grilse, 62 ; female do., 1 ; male salmon, 31 ; female do., 9—total, 113.

IV.—*Poaching during the Year.*

Three cases of salmon poaching during the close time, implicating five persons, were detected during the season. The accused in one of the cases was tried and convicted before the Sheriff Court at Inverness, and sentenced to pay a fine of 10s., with £2 4s. 10d. of expenses, or fourteen days' imprisonment. The accused person in another case was convicted before the Sheriff Court at Banff, and sentenced to pay a fine of £2, with £1 7s. 6d. of expenses, or seven days' imprisonment. Three accused in another case were brought before a J.P., and admonished. During the open time two persons were found angling on Spey and having smolts or salmon fry in their possession. They were taken before a J.P., and cautioned and admonished.

V.—*Bye-Laws.*

The Bye-laws relating to dam dykes, mill lades, sluices, hecks, &c., were fairly well attended to during the season. The mill lade, sluices, and dam dyke at Dell of Druie Sawmill at Rothiemurchus have not been kept quite in conformity with the requirements of the Bye-laws for some seasons back, but some improvements have been made upon them during the last few weeks which will have the effect of improving matters for the coming season. A new dam dyke on the Dullan at Dufftown is to be erected for a lade to give driving power to the Mortlach Distillery. This new dyke is to take the place of the present dam dyke erected some ten years ago, and which will be removed on completion of the new one, which will be situated some 300 yards further up the stream, and which is to be constructed in accordance with the requirements of the Bye-laws.

VI.—*General Remarks.*

I advocated strongly in a report to the Spey Board last year as to the advisability of opening up the mouth of the river Druie to permit of a run for spawning fish getting up to fine spawning redds on the Druie and its tributaries. The present state of the mouth is all but a complete obstruction to fish. I am of opinion that there would now be no objections or conditions placed in the way of having this essential piece of work carried out.

The river and sea coast net salmon fishing opened on 11th February, and closed again for the season on 26th August. The observance given by the tacksmen of fishings and their respective managers and fishermen in carrying out the observance of the weekly close times all over the district during the season was all that could in reason be desired, the "slapping" of nets being on all occasions strictly attended to when the same was practicable, or, in other words, when then there was no danger or risk to life in carrying out the work. The carrying out of this work during the season was regularly inspected by the Superintendent, the Inspector, and Sergeant Alex. Mackintosh.

During the early months of last summer, 840,000 salmon fry were transferred from His Grace the Duke of Richmond and Gordon's Hatchery at Fochabers and deposited in the river Spey. This is now the sixth enormous consignment of fry placed in the river from this Hatchery. I visited it on two or three occasions during the spring and early summer months, and the show of fry in the boxes was in no way inferior to the high class quality of the fry of former seasons at this place, the only difference being an increase of some 300,000 fry over the last year and previous years. This was the result of the Hatchery premises being duplicated in size during last autumn. The extension of the house embraces eight new ova boxes with the latest improved enamelled tile lining, and capable of hatching 240,000 ova, also a large concrete impounding tank, well supplied with pure fresh water, and capable of keeping 100 salmon. This last mentioned acquisition is of material importance in lessening the otherwise laborious work of securing ripe ova to stock the boxes. Fishing for male and female salmon for the purpose of obtaining ova from the same on the spot means no end of toil and disappointment, as the fish in question must necessarily be just ripe for spawning, and, where such an enormous quantity of ova is required, it is only those who have taken part in such work who actually know the amount of labour and expense incurred. Fish about ready or almost ripe are not so difficult to obtain. This last mentioned class are consequently retained and deposited within the Hatchery impounding pond, when in the course of a few days they will allow of being stripped, and the ova thus secured placed in the boxes and the stripped fish returned alive to the river. An impounding pond on a large scale for the retention of the hatched fry for the culture in the parr stages after they leave the Hatchery would certainly entail much work and expense, but, should a suitable place for such be selected, it would put this Hatchery in the first rank with any Hatchery in the country.

The full force of Bailiffs or Spey Police is constituted as follows:—The Superintendent, residing at Aberlour; the Inspector, stationed at Grantown; eight Sergeants and thirty-seven Constables.

GEORGE K. MACGREGOR, *Superintendent.*

THE DISTRICT OF THE RIVER FINDHORN.

Take of Fish—

1. (*a*), (*b*), (*c*), and (*d*) Below average.
2. (*a*), (*b*), and (*c*) I can give no information.
3. (*a*) 11th February; (*b*) April and May; (*c*) May, June and July, fine trout may be got throughout the season.
4. (*a*) and (*b*) I can give no information.
5. (*a*) Salmon 36 lbs.; trout 3 lbs; (*b*) salmon 44 lbs.; (*c*) salmon 16 lbs.

Protection—

1. £3,436.
2. £345.
3. Three permanent watchers and thirteen watchers employed during spawning season.
4. No.

Obstructions to the Passage of Fish—

1. No obstruction to the passage of fish on the river Findhorn.
2. No dams, &c.
3. No fish-passes.

4, 5, and 6. No.

Pollutions—
1. No pollutions.
2. No.

The Salmon Disease—
1, 2, 3 and 4. No salmon disease.

The Spawning Season—
1. Upper district, 11th October; lower district, 18th November.
2. Upper district, between 24th October and 24th November ; lower district, December and January.
3. Upper district, 1st December ; lower, end of January.
4. Above the ordinary level during the whole season.
5. About the average.
6. Upper district, between Drynachan and Coignafeam; lower, between Waterford and Sluie.

Kelts—
1. Kelts begin to migrate seaward after the spawning season is over.
2. January and February.
3. May.
4. Same time flood, half-flood, and ordinary.

Smolts—
1. From the middle of March to the end of May.
2. A good average.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
I cannot tell.

General Question—
No.

THE DISTRICT OF THE RIVER NAIRN.

Take of Fish—
1. Below the average all over.
2. (*a*) Approximately ; (*b*) about 4600 ; (*c*) about 105.
3. (*a*) February 11th ; (*b*) April ; (*c*) grilse, August and September ; sea trout, June.
4. The question of the run of fish being early or late depends here mainly on the season. If season dry and water continues low, they are late. The following is thought to be approximately a correct statement of the fish taken each month by fixed engines :—

	February.	March.	April.	May.	June.	July.	August.	Total.
Salmon.........	95	205	500	400	200	150	160	1710
Grilse..........	...	...	...	6	300	2000	584	2890

5. (*b*) 36 lbs.; (*c*) $19\frac{1}{2}$ lbs.

Protection—
1. £1135 10s.
2. 1s. 4d. per £.
3. One regularly, with one assistant regularly in autumn, besides casual assistance.
4. No.

Obstructions to the Passage of Fish—
1. None.
2. Yes.
3. No.

4. Yes; unless for a time in summer when water very low.
5. No.
6. No.

Pollutions—
1. No.
2. No steps taken.

The Salmon Disease—
1. No.
4. No.

The Spawning Season—
1. November 8th.
2. Between November 20th and December 25th.
3. About January 12th.
4. Between low and half-flood.
5. About an average.
6. The Nairn and Inverern.

Kelts—
1. About 1st February.
2. In March.
3. About 1st April.
4. Half-flood.

Smolts—
1. From 20th April to 1st June.
2. No.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
Upon an estimate there are 5 per cent. more female than male salmon.

General Question—
Attention may be drawn to the destruction done to the smolts by wild birds in small rivers when migrating to the sea.
(The birds referred to are the black-headed gull, the black-backed gull, and the water ousel.)

THE DISTRICT OF THE RIVER NESS.

Take of Fish—
1. (*a*), (*b*), (*c*), and (*d*) About the average.
2. About 33,000. (*a*), (*b*), and (*c*) No details.
3. (*a*) 11th February; (*b*) February and March; (*c*) June, July and August.
4. Information cannot be obtained.
5. (*a*) Salmon, 42 lbs.; (*b*) salmon, 40 lbs.; (*c*) salmon, 39 lbs.

Protection—
1. £3510 5s..
2. 1s. 9d. per £.
3. One superintendent, three permanent, and three temporary watchers.
4. Yes; against a crew of Cromarty fishermen for fishing with a small-meshed sweep-net and killing fish of the salmon kind. Conviction obtained, and crew fined £3 each, with 16s. expenses, or fourteen days' imprisonment.

Obstructions to the Passage of Fish—
1. No dams destroyed or built.
2. No cruives.
3. None.

4. No. Dochfour fish-pass with low water does not afford a free passage for salmon ascending.
5. None.
6. Nothing has been done.

Pollutions—
1. None.
2. None.

The Salmon Disease—
1. No disease in the district last season.

The Spawning Season—
1. End of October.
2. November and January.
3. End of January.
4. Cannot say.
5. About the average.
6. Ness, Garry, Morrison, Enerick, Oich, Kingie, and Quoich.

Kelts—
1. 11th February.
2. March and April.
3. Middle of May.
4. Cannot say.

Smolts—
1. April.
2. Average.

Artificial Propagation of Salmon—
There is a private hatchery at Glenquoich, supported by Lord Burton. No salmon ova are hatched in it.

Proportion of Male to Female Salmon—
In the month of December and early in January there are four males to one female.

General Question—
Nothing to add.

THE DISTRICT OF THE RIVER ALNESS.

Take of Fish—
1. (*a*), (*b*), (*c*), and (*d*) Below the average.
2. (*a*), (*b*), and (*c*) Impossible to obtain information on this subject from the lessees of the fishings.
3. (*a*) About beginning of net fishing on 11th February; (*b*) from 1st July to middle of August; (*c*) from June to end of August.
4. (*a*) and (*b*) Unable to furnish you with number of fish taken each month, but July always the best month here for both net and coble.
5. (*a*) About 25 lbs.; (*c*) about 15 lbs.

Protection—
1. £607 10s.
2. 6s. per £.
3. One permanent inspector and four temporary bailiffs.
4. None.

Obstructions to the Passage of Fish—
1. No dams built or altered.
2. Yes.
3. No fish-passes built or altered in 1898.
4. Yes.
5. No.

6. The net fishing at mouth of river was closed on 12th instead of 26th August with the view of improving the river, but, owing to the lowness of the river at that time, it did not do much good.

Pollutions—
1. None.
2. No case of river pollution in our district.

The Salmon Disease—
No salmon disease in Alness district.

The Spawning Season—
1. 25th October.
2. 1st November and 15th December.
3. About 25th December.
4. About half-flood.
5. Less.
6. Upper reaches of Alness River.

Kelts—
1. About 1st March.
2. From the middle of March to the end of April.
3. In the beginning of June.
4. Flood and half-flood.

Smolts—
1. From beginning of April to middle of June.
2. Fair.

Artificial Propagation of Salmon—
There is a hatchery at Balnacraig belonging to the Alness Board, which can hatch out over 100,000 ova. This year we secured about 30,000 ova, which have hatched out very well.

Proportion of Male to Female Salmon—
The water-bailiff cannot give definite information regarding this, except that he noticed, while fishing to secure ova during the spawning season, about six males for every female were landed.

THE DISTRICT OF THE RIVER CONON.

Take of Fish—
1. (*a*) and (*b*) Salmon and grilse below the average; (*c*) below the average; (*d*) salmon caught with the rod in the Brahan Castle waters, considerably above the average; in the Fairburn angling waters, about the average; other angling waters, below the average.
3. (*a*) 13th February; (*b*) March, April, May, and June; (*c*) grilse ran from the middle of May to the close of the fishing. The main run of sea-trout is in March and April. Clean sea-trout in tidal waters of Conon at all seasons.
5. (*a*) Several were caught weighing over 20 lbs.; (*b*) about 29 lbs.; (*c*) 27 lbs.

Protection—
3. One permanent inspector and four temporary bailiffs.

Obstructions to the Passage of Fish—
2. There is one dam in this district; it is not worked in accordance with the bye-law, Schedule F. There are two cruives in this district; they are worked in accordance with the bye-law, Schedule G, regulating the same.
3. No.
4. Yes; at all times
6. The Brahan net and cruive fishing have not been worked during the last nine seasons, whereby large numbers of salmon and grilse have ascended to the angling waters.

Pollutions—

1. Yes; the distillery at the Muir of Ord has been enlarged to about four times its original size in 1898, thereby sending down to the river Conon large quantities of burnt ale.
2. No.

The Spawning Season—

1. About the 6th of October.
2. Between the 1st and 10th November.
3. About the end of November.
4. The river was in high flood from the 1st of November until the 9th. During the rest of the month the river was in half-flood.
5. The number of spawning fish on the beds was less than usual.
6. There are good spawning grounds in the River Conon from the tidal waters, and in the tributaries Blackwater, Orrin, and Meig.

Kelts—

1. In the beginning of March.
2. From the middle of March to the end of April.
3. About the beginning of June.
4. Flood, half-flood, and low.

Smolts—

1. The lattter end of March, April, May, and June.
2. Yes; fairly good.

Artificial Propagation of Salmon—

There is a salmon hatchery in this district at Conon Bridge. It partly belongs to Colonel Mackenzie of Seaforth, and partly to the District Board. It is capable of hatching about 200,000 salmon ova. During the last two seasons I have sent a number of Conon ova to Brawl Castle, and got in exchange a like number of Thurso ova. When the salmon fry are seven weeks old, they are transferred to the lower reaches of the River Conon.

THE DISTRICT OF THE KYLE OF SUTHERLAND.

Take of Fish—

1. Much below the average.
2. No accurate information obtainable.
3. (*a*) On the 11th February; (*b*) May and June; (*c*) June and July.
4. No information.
5. 45 lbs.; by net and coble.

Protection—

1. £2838.
2. 1s. 5d. per £=£201 0s. 6d.
3. Fifteen watchers.
4. One, for allowing bag-net leader to remain in the sea during the weekly close time. Result, conviction.

Obstructions to the Passage of Fish—

1. None.
2. As far as possible.
3. No.
4. There is usually sufficient water to afford a free passage.
5. No.
6. No change since 1897.

Pollutions—

1. No.
2. No.

The Salmon Disease—
1. No.

The Spawning Season—
1. 3rd September.
2. 9th October and 5th December.
3. 25th December.
4. High.
5. Somewhat more than usual.
6. Rivers Shin, Oykell, Carron, Blackwater, and Evelix.

Kelts—
2. March.
3. May.
4. In flood.

Smolts—
1. 20th May.
2. Yes.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
No.

General Question—
For the better regulation and development of the fisheries the Kyle net-fishings are now carried on by a syndicate.

SUTHERLAND, EAST AND WEST COAST DISTRICTS.

Take of Fish—
1. (*a*), (*b*), (*c*), and (*d*) Below average.
2. (*a*) 1022 salmon, 349 grilse, 230 trout ; (*b*) 3037 salmon, 8066 grilse, 949 trout ; (*c*) Helmsdale, 667 fish ; Brora, 380 fish ; Fleet, 40 fish.
3. (*a*) January; (*b*) March ; (*c*) June and July.
4. (*a*) February, salmon 17·61 per cent.; March, salmon 37·78 per cent.; April, salmon 14·78 per cent.; May, salmon 10·18 per cent., grilse 0·86 per cent.; June, salmon 13·40 per cent., grilse 36·96 per cent., trout 56·96 per cent.; July, salmon 3·42 per cent., grilse 38·97 per cent., trout 16·09 per cent.; August, salmon 2·83 per cent., grilse 23·21 per cent., trout 26·95 per cent. (*b*) February, salmon 1·32 per cent. ; March, salmon 4·34 per cent.; April, salmon 10·21 per cent., grilse 0·01 per cent., trout 6·75 per cent.; May, salmon 20·97 per cent., grilse 0·46 per cent., trout 10·23 per cent.; June, salmon 32·20 per cent., grilse 34·07 per cent.; trout 35·91 per cent.; July, salmon 25·33 per cent., grilse 58·40 per cent., trout 40·47 per cent.; August, salmon 5·63 per cent., grilse 7·06 per cent., trout 6·64 per cent.
5. (*a*) 34 lbs.; (*b*) not known ; (*c*) 24 lbs.

Protection—
1. £1855.
2. No assessment.
3. Four, in addition to keepers, who are bound to assist in watching.
4. None.

Obstructions to the Passage of Fish—
1. None.
3. No.
4. Yes.
5. No.
6. No.

Pollutions—
1. No.
2. No.

The Salmon Disease—
1. Very slight; slightly in February and March and again in July, disappearing end of August.
2. Very low.
3. No.
4. No.

The Spawning Season—
1. 10th October.
2. 22d October and 4th November. } Varies a little in the different rivers.
3. 15th to 20th November. }
4. First part of season low, afterwards very high.
5. Under average, but more than previous year.
6. Brora, Helmsdale, Fleet, Inver, Kirkaig, Laxford, and Inchard, with their tributaries.

Kelts—
1. 11th February.
2. End of February and March.
3. About end of May; on one or two of the rivers a little earlier.

Smolts—
1. Towards end of April.
2. Fairly good.

Artificial Propagation of Salmon—
One on the Brora and another on the Helmsdale, recently erected, belonging to the Duke of Sutherland. In the Brora 60,000 to 70,000 salmon and 60,000 Lochleven trout, and Helmsdale about 100,000 salmon.

Proportion of Male to Female Salmon—
Cannot state proportion, but from Bailiff's estimates, males predominate.

General Question—
No river should be open for angling after 30th September.

SUTHERLAND, NORTH COAST DISTRICT.

Take of Fish—
1. Much below the average.
2. (*a*) and (*b*) Salmon, 1199; grilse, 5885; trout, 164; cannot separate. (*c*) about 850 fish, no certainty.
3. (*a*) February; (*b*) May to August; (*c*) grilse, May-July; sea-trout, March-September.
4. Not known.
5. (*a*) 27 lbs.; (*b*) 38 lbs.; (*c*) 24 lbs.

Protection—
1 and 2. No assessments.
3. Six.
4. One, poaching, fined by Sheriff.

Obstructions to the Passage of Fish—
1. None.
2. None fished.
3. No.
4. Yes.

Pollutions—
1 and 2. None.

The Salmon Disease—
No Disease.

The Spawning Season—
1. October 24.
2. October 30-November 15.
3. December 1.
4. Medium.
5. Less.
6. Halladale to Grudie.

Kelts—
1. End of March.
2. April.
3. May.
4. Floods occasionally.

Smolts—
1. From 10th May.
2. No.

Artificial Propagation of Salmon—
No, but one near Sandside, Caithness, capable of hatching 40,000 salmon and 30,000 trout.

Proportion of Male to Female Salmon—
Slight preponderance of males.

DISTRICT OF THE RIVER KENNART.

Take of Fish—
1. (*c*) and (*d*) Below.
2. (*a*) 10 ; (*b*) 2143 ; (*c*) 38.
3. (*a*) March ; (*b*) and (*c*) July.
4. (*a*) and (*b*) No special record kept.
5. (*a*) 19 lbs. ; (*b*) 29 lbs. ; (*c*) 17 lbs.

Protection—
1. £.
2. None.
3. Two.
4. None.

Obstructions to the Passage of Fish.
1. None either way.
2. No dams.
3 and 4. No passes.
5. No.
6. None.

Pollutions—
1 and 2. No.

The Salmon Disease—
1, 2, 3, and 4. No.

The Spawning Season—
1. 1st November.
2. Between 15th November and 7th December.
3. About 15th December.
4. Mid level generally.
Fully an average.
6. Ullapool River.

Kelts—
1. 1st April.
2. During April
3. 1st May.
4. Flood.

Smolts—
1. Early in May if spring mild.
2. Good.

Artificial Propagation of Salmon.
No hatchery.

Proportion of Male to Female Salmon—
Cannot state proportion, but females appear more plentiful, as appears from the preponderance of females caught by rod.

General Question—
None.

THE DISTRICT OF THE RIVER TORRIDON.

Take of Fish—
No fish at all taken in 1898. Salmon fishing quite ruined by the outside nets.

Protection—
1. £20.
2. No formal assessment. Expenses paid by proprietors.
3. None.
4. No.

THE DISTRICT OF THE RIVER BALGAY.

Take of Fish—
1. The take of salmon here was below the average. The take of sea-trout about the former average. (*b*) In fresh waters by rods.
3. The main body or bulk of sea-trout and grilse ran from the last week of June to the (*c*) middle of July.

Protection—
1. £20.
2. No formal assessment. Expenses paid equally by the proprietors.
3. One.
4. There was one prosecution and parties convicted.

Obstructions to the Passage of Fish—
3. None.
5. None.

The Salmon Disease—
1. None.

The Spawning Season—
1. About 20th October, but sea-trout had begun spawning ten days or a fortnight earlier than the salmon.
2. Between the 6th October and 20th November including salmon and sea-trout.
3. The spawning season finished about Christmas.
4. High as a rule.
5. I should say they were less than usual.
6. The rivers Balgay and Kinloch.

Kelts—
4. High.

General Question—
I am certain that both salmon and sea-trout are becoming scarcer every year in this district. I think the cause is owing to the bag nets along the coast and leased by tacksmen, and also owing to the sea-trout nets used by the majority of crofters and cotters in all the little townships and hamlets along the coasts, and who can never be quelled by a few local officials unless Government interferes.

DISTRICT OF THE RIVER PENNYGOWN OR GLENFORSA AND AROS (MULL).

No records are kept.

THE DISTRICT OF THE RIVER LUSSA (MULL), &c.

Take of Fish—
No record is kept of fish taken in the district.

Protection—
1. No assessment roll has been made up yet, nor any assessment levied.
4. No prosecution.

Obstructions to the Passage of Fish—
There are two natural obstructions—one in the River Lussa, known as the Lussa Falls, the other in the River Houran, which falls from Loch Houran, known as the Loch Houran Falls. They might be much improved at a small cost. The former divides the Duart and Lochbuie estates; the latter is entirely on the Lochbuie estate.

Pollutions—
No pollution in any of the Mull rivers.

The Salmon Disease—
No salmon disease reported.

The Spawning Season—
The spawning season has been a very good one.
6. The Lussa, Coleader, Baa, Forsa, Uisk, and Awe.

General Question—
An amalgamation is contemplated with the Awe, Mull, and other existing Fishery Boards to hire a powerful steam launch during the salmon-fishing season, in order to observe that the leaders are removed from bag-nets during the weekly close time, and if possible to prevent that infamous destruction to *Salmonidae*—viz., scringing.
Water bailiffs have been appointed throughout the Island of Mull.

THE DISTRICT OF THE RIVER BAA AND GLENCOILLEADER (MULL).

Take of Fish—
No record is kept of fish taken in district, but the following statements refer to the fishings in Lochs Baa and Assapol.
1. (*a*) Above average.
3. (*b*) In Loch Baa sea-trout early in March, salmon middle of July; in Loch Assapol sea-trout and salmon early in July. (*b*) In both lochs August and September.
5. (*c*) In Loch Baa, 16 lbs. salmon; in Loch Assapol salmon 12 lbs., sea-trout 6 lbs.

Protection—

No assessment roll has been made up for this Board, nor has any assessment been levied yet.

4. No prosecution.

The Spawning Season—Loch Baa—

1. 10th November, but believed to spawn earlier.
2. From 1st to 30th November.
3. About middle of December.
4. Low.
5. About usual.
6. Baa, Clachaig, Cannel, Derryguaig, Dishaig, and smaller streams from Benmore.

Kelts—Loch Baa—

1. 1st April.
2. In April.
3. 1st May.
4. High.

THE DISTRICT OF THE RIVER LOCHY.

Take of Fish—

1. (*b*) and (*d*) Below the average ; (*c*) no fixed engines.
2. (*a*) and (*b*) None caught by net or coble and fixed engines ; (*c*) 222 salmon, 357 grilse, 1742 sea trout.
3. (*a*) 1st April ; (*b*) main take of salmon in September and of grilse in July ; (*c*) June.
4. (*a*) and (*b*) None.
5. (*c*) 41½ lbs.

Protection—

1. £2239
2. No assessment.
3. Twelve.
4. No.

Obstructions to the Passage of Fish—

1. None.
2. None.
3. No.
4. At all times.
5. No.
6. No.

Pollutions—

1. No.
2. No.

The Salmon Disease—

1 No.

The Spawning Season—

1. About 20th October on tributaries ; second week of November on main rivers.
2. Middle to end of November.
3. End of December.
4. About average.
5. Rather less.
6. Roy, Cour, Loy, Nevis, and Spean.

Kelts—

1. Not noticed.

Smolts—

1. Beginning of May
2. No.

Artificial Propagation of Salmon—
Yes; hatchery on Cour, kept up by Lord Abinger; 50,000 to 60,000 ova.

Proportion of Male to Female Salmon—
About one-fourth more females than males.

General Question—
It is believed that there are more fixed nets outside the estuary than previously, and that this has a rather injurious effect.

THE DISTRICT OF THE RIVER AWE.

Take of Fish—
No record is kept of fish taken in the district. The tenants of fishings will give no information as to catch, especially tenants of nets. Should say 1898 was a good average year. Some proprietors who have the right of nets in river and loch (Awe) do not exercise that right. One does on the loch. I think there was a 54-lb. fish taken in nets at mouth of river last year. Fancy first run is about middle of March; they are Urchy fish.

Protection—
1. £877 15s. 0d.
2. £109 11s. 1d.
3. One.
4. No prosecutions.

Obstructions to the Passage of Fish—
1. No alteration in the district.
2. Only Inverawe cruive, and that is in strict order. A grating should be placed on mill-lade on the Lussagan; many young fish (smolts) killed by wheel going down. There was a sort of dam placed on the mill-lade on Awe some years ago.

Pollutions—
1. Pollution for many years by Connel Mill on Lussagan Burn.
2. Nothing ever done to put that right.

The Salmon Disease—
No disease in district.

The Spawning Season—
4. Too high.
5. More, I think.

Artificial Propagation of Salmon—
No hatchery in district.

THE DISTRICT OF THE RIVER AYR.

Take of Fish—
1. The take of fish last year was below the average both in the sea and fresh water.

There are no fixed engines, and the river is not netted.

2. It is quite impossible to ascertain number of fish taken, as the tacksman of the sea fishings will not give the information, and what rod fishers kill cannot be ascertained.
3. There are no spring salmon in the Ayr, and the sea trout commence to run in June, and the grilse about July.
4. There are no nets and cobles used, only nets on the sea-shore. There is only one tacksman, and no information can be had from him.
5. Impossible to ascertain.

Protection—

1. £110.
2. 8s. per £.
3. One.
4. One prosecution for fishing without leave, and £2 towards expenses was paid.

Obstructions to the Passage of Fish—

1. No change.
2. There are no cruives, and the dams are being improved.

3, 4, and 5. No.

6. The Board are giving attention to the dam dykes, and have got an order from the Court to form a ladder in the worst one, at Overmills, Ayr.

Pollutions—

1. No.
2. No ground of complaint.

The Salmon Disease—

1. No.
4. No.

The Spawning Season—

Impossible to ascertain.

Kelts—

The kelts return to sea between the months of January and June.

Smolts—

1. About the month of April.
2. The smolts were better protected than formerly.

Artificial Propagation of Salmon—

No.

Proportion of Male to Female Salmon—

No.

General Question—

No.

THE DISTRICT OF THE RIVER DOON.

Take of Fish—

1. The take of salmon last year was below the average, both in the sea and in the fresh water. The take of sea-trout was above the average. There are nets along the sea coast, and the mouth of the river is dragged with a net also.
2. It is quite impossible to ascertain number of fish taken, as tacksmen of the sea and river fishings will not give the information, and what the rod fishers kill cannot be ascertained.
3. (*a*) The Doon contains spring salmon, and they were commenced to be taken the first day of the opening. (*b*) The main take of salmon was in August. (*c*) Sea-trout commenced to run in June and grilse about July.
4. There are no nets and cobles used—only nets on the seashore, and the mouth of the river dragged. There is only one tacksman, and no information can be had from him.
5. Impossible to ascertain.

Protection—

1. £437.
2. One shilling and sixpence per £.
3. Two, mainly paid by the proprietors.
4. Two convictions obtained for netting the river at night and for destroying sea-trout in spawning streams.

Obstructions to the Passage of Fish—
1. The dam dykes at the Doon-foot and at Alloway Mill were both repaired and the salmon passes improved.
2. There are no cruives, and all the dams contain slaps or passages for salmon.
3. See answer to No. 1.
4. Fish can always now get up.
5. No obstruction.

Pollution—
1 and 2. No.

The Salmon Disease—
No disease.

The Spawning Season—
1. Salmon commenced to spawn in November.
5. The spawning fish were about the usual number.
6. The Doon affords good spawning streams.

Kelts—
1. The kelts come down the river in the months of February, March, and April.
3. The river is generally free from kelts by June.

Smolts—
1. April is the principal month.
2. No.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
No.

General Question—
No.

THE DISTRICT OF THE RIVER GIRVAN.

Take of Fish—
1. (*a*) None ; (*b*), (*c*), and (*d*) below.
2. (*a*) None ; (*b*) about 250 salmon, 700 grilse, 2,500 trout ; (*c*) cannot say, (supposed about 3 or 4 salmon only).
3. (*a*) 1st April ; (*b*) August ; (*c*) about June 15th.
5. (*a*) None ; (*b*) 40 lbs. ; (*c*) cannot tell.

Protection—
1. £544.
2. None.
3. Two.
4. Yes. Two prosecutions of fishing with rod and line during annual close time. Accused fined in 30s. each.

Obstructions to the Passage of Fish—
1. None.
2. Yes.
3. No.
4. Yes, when in flood.
5. No.
6. Nothing done.

Pollutions—
1 and 2. No.

The Salmon Disease—
1. No salmon disease.

The Spawning Season—
1. Latter end of December.

Kelts—
6. Upper reaches of river.

Smolts—
1. 1st May.
2. Average.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
No.

THE DISTRICT OF THE RIVER STINCHAR.

Take of Fish—
1. Below the average.
2. No.
3. (*a*) Last week in March ; (*b*) last week in July ; (*c*) 1st August.
4. Cannot say.
5. (*b*) 62 lbs. ; (*c*) 29 lbs.

Protection—
1. £300.
2, 3 and 4. None.

Obstructions to the Passage of Fish—
1. None.
2. Yes.
3. One.
4. Yes.
5 and 6. No.

Pollutions—
1 and 2. No.

The Salmon Disease—
1. Yes. 25th January. Cannot say. Last of March.
2. Large.
3. 20th January, 2 ; February-March, 3 males, 2 females—all kelts.
4. No.

The Spawning Season—
1. 28th November.
2. December.
3. First week in January.
4. Heavy.
5. Less.
6. Stinchar.

Kelts—
1. In February.
2. March.
3. 15th April.
4. Large.

Smolts—
1. 1st April.
2. Yes.

Artificial Propagation of Salmon—
No.

Proportion of Male to Female Salmon—
No.

General Question—
No.

THE DISTRICT OF THE RIVER CREE.

Take of Fish—
1. No special information, but the general opinion is that the take has been much below the average.
2. No.
3, 4, and 5. No information.

Protection—
1. £796.
2. £59 14s., being the assessment at 1s. 6d. per £.
3. Two.
4. No.

Obstructions to the Passage of Fish—
1. The old dam dyke above Douglas High School, Newton-Stewart, has been rebuilt and raised in height, but it does not extend across the whole river.
2. Yes.
3. No.
4. Yes.
5. No.

Pollutions—
1. No.
2. Towards the end of 1898 operations were commenced in connection with the new drainage scheme of Newton-Stewart. The sewage is to be conveyed in pipes to filtration tanks situated about half a mile below the town, and after passing through the tanks will come out purified so that no pollution shall pass into the river, and the river will be freed from all possible pollution.

The Salmon Disease—
1. No disease.

The Spawning Season—
No information.

Kelts—
No information.

Smolts—
No information.

Artificial Propagation of Salm
No.

Proportion of Male to Female Salmon—
No.

General Question—
No.

THE DISTRICT OF THE RIVER DEE (SOLWAY).

Take of Fish—
1. (*a*) In tidal waters, below the average; (*b*) in fresh water, do.; (*c*) by fixed engines, do.; (*d*) generally throughout the district, do.
2. (*a*), (*b*), and (*c*) I could not say.

3. (*a*) 1st of March; (*b*) month of July; (*c*) grilse and trout about the 1st of June.
4. (*a*) and (*b*) Below the average.
5. (*a*) The heaviest salmon was 30 lbs.; trout, 7 lbs.

Protection—
1. £1603.
2. £80 3s.
3. Fourteen to sixteen watchers.
4. None.

Obstructions to the Passage of Fish—
1. None.
2. No dams or cruives in our district on the Dee.
3. None that I know of.
4. Free passage at all times.
5. None.
6. No changes that I know of.

Pollutions—
1 and 2. Not that I know of.

The Salmon Disease—
1 and 2. No disease in our district this year.
3. We had no disease in our river.
4. No remarks to make.

The Spawning Season—
1. The 7th of November.
2. Between the 7th November and end of December.
3. The 1st of January 1899.
4. I took no observations.
5. Below the average.
6. Tarff, Dee, and Ken.

Kelts—
1. The month of March.
2. The end of March.
3. End of April.
4. I could not say.

Smolts—
1. From April to the end of May.
2. No.

Artificial Propagation of Salmon—
Messrs. Anderson & Son, 29 Castle Street, Edinburgh, have a hatchery on the Dee at Tongland for the propagation of salmon; in 1897 there were 120,000, in 1898 200,000, and this year 150,000.

General Question—
I have no other remarks to make. A net may be drawn occasionally by a proprietor in the upper water, but no fishing of any consequence by this means.

THE DISTRICT OF THE RIVER NITH.

Take of Fish—
1. (*a*), (*b*), (*c*), and (*d*) Much below the average.
2. (*a*), (*b*), and (*c*) Cannot be given.
3. Clean fish are caught as soon as the fishings open on 24th February; but afterwards, from about middle of March, no clean fish are got till the sea-trout begin to run in April.
4. (*a*) and (*b*) Cannot be got.
5. (*a*) 43 lbs.; (*b*) 25 lbs.; (*c*) 25 lbs.

Protection—

1. £781 5s.
2. No assessment imposed for this year.
3. One man employed and paid by the Board, and over twenty gamekeepers sworn in as special watchers.
4. Yes. (1) Fishing during annual close time—one man fined £3 10s., or 21 days' imprisonment; two men, £2 10s. each, or 14 days; one man, £4 10s., or a month's imprisonment; one man, case withdrawn. (2) Using drag hooks—One man fined £6 10s., or a month. (3) Having gaff hook in possession with intent—One man fined £2 14s., or 14 days; case withdrawn against a second. (4) Contravention of Solway Act—*i.e.*, fishing without leave—Three men, but case withdrawn on a contention of civil right.

Obstructions to the Passage of Fish—

1. No alteration.
2. One cruive in the district is substantially in accordance with the bye-law; most of the dams are not.
3. No.
4. Yes, when the fish are running, after a flood; but, when the rivers are low, the passes do not facilitate the passage of fish.

5 and 6. No.

Pollutions—

1. Pollution may be increasing owing to extension of the town (Dumfries), the sewage from it all running into the river.
2. No.

The Salmon Disease—

1. Very little; it was only in March, and a few kelts were affected.
2. Low, when it was seen.
3. None taken.
4. No.

The Spawning Season—

1. In October.
2. From middle of December to middle of February.
3. About end of March.
4. Fish only spawn after a flood, and not when river is low.
5. Much less.
6. There are spawning streams all along its course.

Kelts—

1. March.
2. May.
3. In beginning of June.
4. Kelts only go to the sea when the river is rising to a flood, or at least, rising.

Smolts—

1. April and May.
2. No.

Artificial Propagation of Salmon—

None belonging to the Board; but there is Mr Armistead's private hatchery at Newabbey.

Proportion of Male to Female Salmon—

Cannot be given.

General Question—

No.

THE DISTRICT OF THE RIVER ANNAN.

Take of Fish—

1 (*a*), (*b*), (*c*), and (*d*) Below average ; worst on record.
2. The lessees of the different fishings say they do not keep a record of the number caught, therefore this cannot be given.
3. (*a*) 25th February, opening day ; (*b*) week ending 3rd September ; (*c*) sea trout main run, middle of June to 23rd July; grilse main run during July—very poor takes.
4. With exception of Newbie Fishery, no record is kept of fish caught each month, therefore this cannot be given ; only it was looked upon as being a late season.
5. (*a*) No net and coble fishing in district ; (*b*) 52 lbs. (on Annan burgh fishings) ; (*c*) 29½ lbs. (in Newbie portion of the Annan).

Protection—

1. £3,181 10s.
2. 3s. 6d. per £=£556 15s. 3d.
3. Four (three at Annan and one at Lochmaben).
4. For offences in Annan Division, proceedings were taken against fifteen persons as follows :—One, contravention of bye-law, Schedule G, withdrawn ; eleven for contravention of 33rd Section of Annan Act, 1841, by fishing between high and low water mark without permission —diet deserted against three, others fined 10s. each, one 35s. 6d., five 21s., and two 25s. 6d. of expenses, or 14 days each ; three, fishing during annual close time—one fined £2 19s., or a month, the other two £5 19s., or two months.

Obstructions to the Passage of Fish—

1. None have been destroyed or disused.
2. No cruives in district. Dams, yes, with the following exceptions :— On the Annan there is no heck at tail of mill race at Brydekirk Mill, belonging to Francis Henry Wilson, residing there ; on the Kirtle, at Beltemont Mill, belonging to Miss Ann Beattie, 13 Church Street, Annan, and at Kirtlebridge Mill, belonging to the trustees of the late John Irving per Herbert Cavan Irving, Esquire of Burnfoot, Ecclefechan ; on the Mein at Mein Mill, belonging to the Duke of Buccleuch, have no fish passes, nor hecks at intake or tail of mill races, and never have had.
3. Yes ; new fish basin at Brydekirk Mill dam, on the Annan, and a new fish-pass at Rigg dam, on the Kirtle, which have greatly improved the free passage of salmon wishing to ascend.
4. Yes.
5. No alteration.
6. No alteration.

Pollutions—

None.

The Salmon Disease—

1. First observed 8th November ; at its height last fortnight of January; disappeared middle of March.
2. Medium.
3. January, 40 males and 47 females, of which 54 had spawned and 53 unspawned ; February, 11 males and 17 females, of which 26 had spawned and 2 unspawned ; March, 2 males and 2 females, all spawned.
4. None.

The Spawning Season—

1. 12th November.
2. 15th December to 19th January.
3. End of February.
4. Medium.
5. A good average.
6. Northfield, Mount Annan, Luce, Meinfoot, Hoddam Bridge, Mainholm, and Rotchell, in the Annan.

Kelts—
1. 19th January.
2. Last week of January and first week of February.
3. About middle of April.
4. Medium.

Smolts—
1. End of April and during May.
2. About the average.

Artificial Propagation of Salmon—
None in district.

Proportion of Male to Female Salmon—
This cannot be accurately given, as notes are not taken at the different fisheries.

General Question—
Nothing further than it would be well to keep in view the complicated state of the Acts referring to the Solway Firth.

NOTE II.

REPORT BY MR. WALTER E. ARCHER, ON A SCHEME FOR THE IMPROVEMENT OF THE SALMON FISHINGS IN THE RIVER EARN.

I have the honour to report that by the direction of the Fishery Board for Scotland, and at the request of the Tay District Board, I inspected the river Earn, a tributary of the Tay, on the 15th April, and on the 15th and 16th June last, for the purpose of considering and reporting on a scheme for the improvement of the fishings, proposed by Sir Robert Moncreiffe in a memorandum to the salmon fishery proprietors, dated November 1897.

This memorandum was considered at a meeting of the proprietors and tenants held in Perth on 22nd November, and it was subsequently formally resolved, *inter alia*, by those representing fishings to the value of £1325, out of a total of £2005, (1) that I should be asked, through the Tay District Board, to consider and report on the scheme; and (2) that, in the event of my reporting on it favourably, a committee, chosen from eight of their number, should have powers, under certain specified conditions, to carry it out.

The question, therefore, which I have to deal with in my present report is the question of whether it is desirable that the scheme should be carried out, as until this question is decided the powers of the said committee are in abeyance.

It would appear, from the memorandum referred to, that Sir Robert Moncreiffe proposes that a committee of proprietors and tenants of salmon fishings should be empowered to negotiate with the proprietors of the net and cruive fishings to rent their fishings for a period of ten years, so that by arranging for a longer weekly "slap" or otherwise, a greater number of fish might be allowed to ascend the river.

It may be explained that the Earn is a river of 52 miles in length, with a drainage area of 376 square miles. In point of size, therefore, it ranks with such rivers as the Beauly, Annan, and Border Esk, being considerably larger than such streams as the Helmsdale, Brora, and Thurso. It has also excellent natural capabilities for the production of fish. But notwithstanding its natural capabilities, its productiveness is much impaired by the efficiency of the nets in the lower waters and by the obstruction to the passage of fish caused by several dam and cruive dykes throughout its course. So great is the obstruction caused by these nets and dykes that, I am informed, but few fish succeed in reaching the upper waters until after the close of the netting season, and then only in times of great flood. This I can readily believe, in view of the great obstacle which Dupplin dyke forms to the passage of fish and the opportunities of netting which the pools below it afford. I had an opportunity of seeing this dyke when the river was in flood and also when it was at an ordinary summer level, and I am convinced, from the great pressure of water rushing through the cruives, and the great length of the dyke and consequent shallowness of the water flowing over it, that, except in times of great flood, it must form an almost, if not quite, insurmountable obstacle to the fish.

Under these circumstances it is evident that one of the primary conditions towards developing the capacity of a river for the production of fish is not given effect to—a condition advocated both in the Fishery Board for Scotland's Reports (11th Annual Report, Part II., page x.; 12th Annual Report, Part II., page xiii.) and in the recent Report of the Royal Commission on Tweed and Solway, page 18—since no provision is made for the protection of a certain proportion of every run of salmon during the open season. On the contrary, the case of the Earn would seem to be an example of those cases referred to in the Board's 11th Annual Report, in which the opposition to proposals to make such a provision is due to the divided interests in the district, and to the care with which each proprietor naturally guards his own rights. With regard to such cases the Board state that the evidence given in their Reports shows that "the improvement in the fisheries which has followed " in those cases where the general interests have been studied, instead " of the individual, appears to indicate that the salmon fisheries are " capable of development, not only to the benefit of each proprietor, but " also to the increase of the food supply, if united action were more " generally adopted." Since it would seem that the scheme outlined by Sir Robert Moncreiffe is in effect a scheme to amalgamate the conflicting interests with a view of taking united action for the improvement of the fisheries, I have no hesitation in approving of it.

I would, however, venture to point out that it is desirable, if possible, that such an experiment should not be limited to a period of ten years, as the full results can hardly become apparent in so short a time. The evidence with regard to this point is referred to on page 11 of the 16th Annual Report, Part II., in the following terms, viz.:—"Nothing seems " to be surer with regard to the effect of regulations for the improve- " ment of the fisheries than that the result only shows itself by good " years becoming better and bad years not so bad; and, further, that " the full benefit of such regulations is not felt until eight or ten years " after their introduction. Thus, if the statement of number and weight " of the fish caught at the salmon fishings belonging to the Aberdeen " Harbour Commissioners be studied, it will be seen that in only two " out of the first nine years after the new regulations were adopted did " the yield of fish exceed 100,000 lbs., whereas in the subsequent seven- " teen years it only fell short of the quantity in four years (p. x., *ante*). " On the Ballisodare River in Ireland, where an entirely new salmon " fishery was created by opening up the obstructions at the mouth " and allowing the fish to have free access to the spawning grounds " above, it seems to have been eleven years before the fisheries were " fully established (10th Annual Report, page 11). On the Galway " River, where Mr. Thomas Ashworth enormously increased the value " of an existing fishery by opening up a large extent of spawning ground " by means of ladders, it was nine years before the marked increase " became apparent (10th Annual Report, page 13). On Sand's River in " Norway, the average annual take of fish in the years following the " adoption of the new regulations was not half what it has been in sub- " sequent years (11th Annual Report, page 59)."

The evidence afforded by these examples would seem to show that, although regulations may be introduced at once for the more equal distribution of the present stock of fish, nine or ten years may elapse before any material increase in such stock may become apparent, and that to limit, therefore, the experiment to a period of ten years would probably be to bring it to a close just before the greatest benefit might be expected to accrue.—I am, &c.,

(Signed) WALTER E. ARCHER.

The Fishery Board for Scotland,
Edinburgh, 29th June 1898.

NOTE III.

REPORT BY MR. W. L. CALDERWOOD, INSPECTOR OF SALMON FISHERIES, ON THE CRUIVE DYKES AND CRUIVE FISHINGS OF SCOTLAND.

Following the judgment of the Court with reference to the construction and alteration of the cruives of the river Deveron (34 Scottish Reporter, p. 440), and the ultimate agreement between the Duke of Fife and the District Fishery Board to have the cruive dyke removed altogether, it becomes of interest to ascertain the present condition of cruive fishing in Scotland.

The case referred to is of special interest, because it places on record the first judicial decision upon the effect of the Commissioners appointed under the Salmon Fisheries (Scotland) Acts (25 & 26 Vict. cap. 97; 26 & 27 Vict. cap. 50; 27 & 28 Vict. cap. 118), so far as the regulations regarding cruives are concerned (Schedule F of the 1868 Act), and it fully upholds the requirements of the Commissioners' bye-law. Previous to this decision the case of Kennedy *v.* Murray (1869, 7 Macph., 1001) could be cited as a guide to the proper interpretation of the statute; but the case dealt rather with the powers of the Commissioners as expressed in the 1862 Act, and 1868 Act, with reference to mill dams and hecks, than to cruives.

The right of fishing by means of cruives was granted by the Crown in ancient times, and is distinct in law from all other methods of catching salmon. By the memorandum dealing with the law as to the regulation of the fishing and the construction of cruives, published in 13th Annual Report, Part II., Appendix Note III., p. 67, it is evident that in all probability cruive fishing was fully established before the time of William the Lion (12th century); indeed, the system of catching fish in cruives may be considered as only a modification of the most primitive method of fishing by means of loosely built pools, which has been common to many races, and is exemplified still to some extent by the old yairs of the shores of the West Highlands, or the doaches of Tongland.

In all the early Acts bearing upon the subject of cruive fishing provision is made for the keeping open of what is termed "a mid-stream." For instance, an Act of James III., 1447, cap. 73, requires "that the mid streme be left free the space of six fute." It has since been argued in more than one case that the provision for the mid-stream has now lapsed. Mr. Archer and Messrs. Carmichael & Miller, W.S., in the memorandum above referred to, call attention to this when dealing with the case of the Heritors of Don *v.* Town of Aberdeen, 1667 (M. 10,840), as follows:—"In judgment," the Lords, "considering that the mid-stream "has been long in desuetude, and that this late ratification was passed "without notice, therefore ordained the parties to adduce witnesses "whether the middle streams was accustomed in any cruives in Scot- "land." "This seems a high-handed way of riding over an Act of Parlia- "ment; but, in point of fact, the statute would seem to have been totally "disregarded in the law courts." It would appear that in Scotland, in view of the provision which was made for a mid-stream gap in mill dam dykes to provide for the ascent of fish, the "mid-streams" in cruive dykes are said to have lapsed; a sufficiently illogical position. In this connection it is of interest to notice the law regarding the cruives or fishing weirs of England. The Salmon Fishery Act of 1861 provides (sec. 27. Restrictions as to Fishing Weirs):—"Where any fishing weir extends more than half-way across any stream at its lowest state of "water, it shall have a free gap or opening in accordance with the regu- "tions following, unless otherwise authorised by the Home Office, under "the powers of this Act; that is to say—

"(1) The free gap shall be situate in the deepest part of the stream "between the points where it is intercepted by the weir;
"(2) The sides of the gap shall be in a line with and parallel to the "direction of the stream at the weir;
"(3) The bottom of the gap shall be level with the natural bed of "the stream above and below the gap;
"(4) The width of the gap in its narrowest part shall be not less "than one-tenth part of the width of the stream; provided "always that such gap shall not be required to be wider "than forty feet, and shall not in any case be narrower than "three feet."

Willis Bund, in his *Law of Salmon Fisheries in England and Wales,* points out (p. 312) that in cases where the fishing weir does not extend half-way across the river they may be fished without gaps, provided they were in use on 6th August 1861.

It is further worthy of remark that, with regard to what in England are termed Fishing Mill Dams, the 1861 Act provides (24 & 25 Vict. sec. 12), *inter alia,* that "no fishing mill-dam, although law- "fully in use as aforesaid, shall be used for the purposes of catching "salmon unless it have attached thereto a fish-pass of such form and "dimensions as shall be approved of by the Home Office, nor unless "such fish-pass has constantly running through it such a flow of water "as will enable salmon to pass up and down such pass, but so neverthe- "less that such pass shall not be larger nor deeper than requisite for "the above purposes."

It will be noticed, therefore, that in process of time, in Scotland, the enforcement of the mid-stream has been allowed to lapse; cruive dykes have been permitted rightly or wrongly to intercept the entire flow of rivers; whereas in England the provision for a "mid-stream" in cruives has remained. To those who hold rights of cruive fishing and netting below, the absence of any "mid-stream" is naturally of great pecuniary advantage; but to others who may hold rights of ordinary salmon fishing in rivers where cruives are fished, the matter may naturally be viewed from an opposite standpoint, since the cruive frequently gains the monopoly of the fishing and seriously injures the adequate distribution of fish in the district.

In preparing the present report as to the cruives of Scotland, I have communicated with upwards of a hundred districts, and have received information as to the presence or absence of cruives, &c., from every salmon-frequented district in the country.

In rivers held entirely by one proprietor, it appears that for many years no cruive fishing has been carried on. The reason for the discontinuance of the cruive fishing seems invariably to have been in order to benefit the rod fishings, which are in the majority of cases let on short or long lease. Further, the decision to abandon this form of fishing has in all cases, except one, been followed by the removal or partial decay of the cruive dykes. In the Thurso river, for instance, the cruives were removed many years ago by Sir J. G. T. Sinclair, Bart., of Ulbster, to whom the river belongs, and in addition to this improvement, it was resolved that no netting of the estuary be permitted before June. In the case of the Brora, a flood of great height, which occurred about twenty-eight years ago, seriously damaged the cruive dyke, which, I understand, contained four boxes; in the interests of the river fishings no effort was made to rebuild the structure, and subsequent floods have gradually demolished it. I am informed by the Duke of Sutherland's factor at Golspie that no cruives now exist in any of His Grace's rivers. The one case in which a sole proprietor maintains his cruive dykes, although no fishing of the boxes has been carried on for upwards of twenty years, is that of the River Beauly. The rod fishing of the upper river is let, but the dykes are maintained in order to secure a good supply of fish in the private fishings of the beautiful pools below. The dykes are two in number, and meet above a small island, at Beaufort Castle, so as to form a widely spread V. The dyke from the right bank has four boxes, that from the left bank has three boxes. At no cruives in Scotland are there so many boxes as here. An advantage secured to the general fishings of the river, however, is evident from the presence of the seven openings in the dykes and from the breadth of the openings; the rush of water is distributed, and no one box passes a foaming race of water such as may be seen at some other cruives, and which forms an impenetrable obstacle to so many fish during certain conditions of water flow. The dykes themselves are most substantial. Each arm of the V measures about 170 yards in length, and during summer level of the river, stands from four to five feet above the surface of the water on the upper side, and is broad and flat on the top. Except during high floods, the dykes form a convenient causeway by which the river may be crossed. In former times the cruives of the Beauly were situated lower down the river, at a place still named Cruivend, near the new Lovat Bridge. Here the fish used to be boiled in huge coppers previous to being packed in flat circular tubs of small size. The ancient apparatus still remains, but, probably through increased facilities of transit, the practice of boiling was discontinued some sixty or seventy years ago.

Turning now to rivers in which the interests of many proprietors are concerned, we may first simply mention that on important rivers such as Spey and the Aberdeenshire Dee, cruives have for very many years been cleared away.

In the Ewe district a cruive was removed about forty years ago in order, I am informed by Sir Kenneth Mackenzie of Gairloch, to lower the level of Loch Maree. In the neighbouring district of Bedachro and Kerry, also, a cruive has been allowed to disappear under the influence of floods.

In the Alness district at Ardros, the cruive was broken down about thirty years ago and has not since been repaired.

In the district of the Conon, at Brahan Castle, near the mouth of the river, are extensive cruives somewhat similar to those of the Beauly. Immediately above an island about seventy acres in extent, the V-shaped dykes unite. In this case the dyke from the left bank is very much longer than the other. It slants down the river a long distance and contains three boxes of a width of twelve feet; the middle box is at present boarded up so that water does not flow through it. The right dyke is short and contains one box. The dykes are not so widely built as is the case at Beaufort Castle, nor are they constructed so as to stand so high above the ordinary level of the river. They are built after the manner of ordinary weirs. I am informed by the Clerk of the District Fishery Board that the cruives have not been fished for nine years.

In the district of Aylort a cruive existed in early days. I am informed that no structure of the kind exists now. Mr Young, in the Third Annual Report, p. 146, refers to the remains of an old cruive on the Aylort while describing the rivers in the west of Inverness-shire.

In the district of the river Ugie, at Inverugie, a dyke containing two boxes exists in an efficient condition, but the fishing has not been carried on for many years. Three years ago a new arrangement as to the leasing of the rod fishing came into force and there seems no likelihood of the cruives being again fished, except to obtain fish from which to stock a neighbouring hatchery with ova.

In the South Esk district a dyke with two boxes existed at Brechin Castle. In 1865, however, an agreement seems to have been come to between the Earl of Dalhousie and the Town Council of Brechin, who hold certain milling interests, by which the cruive should be done away with. I am informed by the Clerk to the District Fishery Board that the Earl of Dalhousie retains full power to restore the cruives and recommence the fishing.

In the district of the river Forth two cruives have fortunately fallen into disuse. At Kippenross on the Allan, a tributary of the Forth, the cruive has not been fished, I am informed by the District Superintendent, for a period of 36 years. The other cruive existed at Doune on the Teith tributary. It was carried away by a flood which occurred about 20 years ago, and has not since been repaired.

Records of cruives discarded in earlier times come from the following rivers :—Forss, a small structure used to intercept yellow trout ; Hope ; Loch-na-Ciste, in North Uist ; Wick ; and Ythan.

With reference now to the crnives which are fished at the present time, I have the honour to submit the following table :—

List of Localities where Cruive Fishing is regularly carried on.

(A single cruive dyke exists in each case.)

Locality.	River.	District.	No. of boxes in dyke.
1. Inverawe -	Awe.	Awe.	Two.
2. Cluden Mills -	Cluden.	Nith.	One.
3. Gordon's Mills	Don.	Don.	Four.
4. Dupplin - -	Earn.	Tay.	One.
5. Strathallan -	Earn.	Tay.	One.
6. Craigforth -	Forth.	Forth.	One.

1. The cruive in the Awe district is situated about half a mile above the mouth of the river. The cruive fishings and the rod fishings are let together.

2. Cluden Water is the first tributary of any importance on the river Nith. It joins the main river at Lincluden Abbey, about a mile above the town of Dumfries. No reference seems to have been made to this cruive in descriptive accounts of the fisheries of the Nith district. The cruive, or more properly, and as it is known in the district, "the creel," is fitted in a wooden staging which crosses the river at an island situated between the two Cluden Mills. The creel is fixed in the channel to the

left of the island. It is an iron cage of an elongated pyramidal shape with an inverted mouth of similar form. The principle of the trap is precisely that of the lobster-pot. The apex of the inner pyramid is open, and through this the fish swim into the cage, from which there is no exit. A small iron crane about 9 feet high is erected in the staging above the creel, and by it the latter is raised and lowered. Fish are extracted through a hinged door in the cage. The measurements of the creel are as follows:—Extreme length, 6′ 6″; the mouth or broadest part of the cage, 2′ 9″ × 2′ 4″, with bars 2″ apart; sloping side of inverted mouth, 3′; entrance to cage at apex of inverted mouth, 6 inches by 4 inches. When the creel is being fished, the staging is closed to the passage of fish of any size by the insertion of a series of wooden hecks, the spars of which are vertical and 3 inches apart. The staging is 3 feet 4 inches above the stream-bed where the creel is fitted; the space between the posts which support the creel on either side being 3 feet 2½ inches. No exception can be taken to the hecks, which represent, in this case, the cruive dyke, but I venture to think that the "creel" or cruive box is as illegal as the old baskets formerly used at the Falls of Tummel, and that fishing by means of it should be entirely discontinued.

3. The cruives of Don at Gordon's Mills are upwards of two miles from the sea, by the course of the river. The dyke is sickle-shaped, the cruive boxes being in the handle part of the sickle on the left side of the river. Mr. Young, in the First Annual Report, p. 21, describes the cruives as the worst in Scotland. A considerable alteration in the condition of the river seems, however, to have occurred since this description was written in 1883, "the objectionable appurtenance" of the Baron's Grain—a *cul-de-sac* beneath the blade-part of the sickle—having become entirely filled up. This old pool, which was complained of as a trap for salmon, presents now the appearance of a large irregular grass-covered bank, only separated from the island upon which the neck or angle of the dyke rests by a shallow channel which may be filled with water at times of flood. The curved portion of the dyke has apparently been heightened, and is now smooth with a covering of cement. The four cruive boxes are arranged in two pairs, and between the two pairs, below the dyke, a "tail" of debris has formed and is now grass-covered for a distance of about forty yards. The pool below, into which this bank extends, is still fished from the original island which separated this pool, known as the Lebby Pot, from the Baron's Grain. The imperfect dam across the channel at the low end of the Lebby Pot is maintained for the purpose of keeping up the water level, since the netting of the Pot rather than the inscales of the cruive boxes are looked to for the purpose of remuneration in the fishing. In my general Report to the Board I have referred (p. 7) to this check-dyke as in all probability an illegal structure. I am informed by the local inspector that hardly any fish are taken in the inscales, and that of late years even the netting of the water below has not been a success, and this in spite of the fact that the injurious habit of netting close up to the races coming from the cruive boxes has been constantly practised. The cruives are of the minimum size permitted by Schedule F of the Salmon Fisheries (Scotland) Act, 1868. A view of two of them will be found in Plate I. appended. The fishings connected with the cruives are held by eight individuals, whose interests differ to a considerable extent. The condition, so far as I am aware, is unique in Scotland. In all other localities the right of cruive fishing seems vested in an individual. Just below the cruives on the left bank is the outflow of the lade which supplies the Grandholm Mills. There is now a most substantial heck upon it. The intake of this lade

is about a mile further up the river. The intake for the lade supplying Gordon's Mill passes off from the right bank of the river immediately above the curved part of the cruive dyke. During normal flow of the river the upper water-level at the dyke is about ten or twelve inches below the top of the dyke, and the dyke itself is only between three and four feet above the level of the lower pool, so that, even including the netting of the Lebby Pot as part of the cruive fishing, the structure is not so serious as to be now described as the worst cruive obstruction in Scotland, or by any means the worst obstruction in the river Don (*vide* p. 8).

4. In the Tay district, as has been shown by the above Table, two cruives exist on the river Earn. The Dupplin dyke is about 200 yards long, stretching obliquely across the river from bank to bank. In vertical height it is about 10 feet. The one box is situated between two small islands and is 10 feet wide. Owing to the steep gradient, the height of the dyke, and the volume of water confined in the river above the dyke, the current through the box is very great, so that even during the weekly and annual close times, when the hecks and inscales are removed, fish cannot readily pass the dyke except during floods, when they ascend over the face rather than through the box in the dyke. To permit of a fair passage of fish, as is intended by the requirements for the weekly slap, mentioned in all Acts referring to cruives, a salmon pass would require to be erected by means of subsidiary dykes thrown across the channel between the right bank and that portion of the cruive dyke which is to the right of the cruive box.

5. About eight miles further up the river, Strathallan cruive dyke occurs. It is, at normal levels, about 5 feet high, but the face of the dyke rises most abruptly. One box also causes a great flow of water, but more passes over the sill of the dyke than at Dupplin, and the fall is not so great, hence the passage through the box is more negotiable for ascending fish when that passage is passable. If the matter could be arranged, however, great benefit would result to the sport of the river if a salmon pass could be introduced.

6. The only other cruive dyke which remains to be mentioned is that on the Forth, at Craigforth, about a mile below the mouth of the Teith. It is an example of the large type of cruive as found also at Dupplin and Strathallan on the Earn. It measures 6 feet broad by 13 feet long. A view of it is given in Plate II. The long levers seen in the illustration above the cruive box are used for raising the wooden blinds which shut off the water when the fish are removed, or when the inscales are being adjusted. One of the inscales can be seen in the photograph, the blinds being up and the water flowing through the box. Entrance for the fisherman is obtained by a wooden hatchway communicating with iron steps fixed in the concrete wall. The box is supported against the action of floods by heavy iron shores set in the stonework of the apron. When the photograph was taken, the tide being out, the depth of water at the sill of the box was 4 feet 3 inches. The current passing through the box is, however, by no means heavy, and sea-trout and small salmon should be able to pass through the heck in ordinary conditions of water-flow. The objection applicable to both Dupplin and Strathallan cruives is therefore not present at Craigforth. The weir is very long, is *f*-shaped, and quite perpendicular, the water immediately below being very shallow and broken. It varies in height owing to the difference in level of the bed of the stream below. The highest point is furthest down stream. I estimated the elevation to be between 8 and 9 feet, the tide being out. A view of the weir will be found in Plate III. The cruive is near the left bank, where the dyke is 4½ to 5 feet. Near the right bank the rocky ledges, upon which the masonry is

PLATE I.

A pair of Cruive Boxes of the minimum size in the Fishing Mill Dam at Gordon's Mills, river Don.

PLATE II.

Example of large-sized Cruive Box in the Craigforth Cruive Dyke, river Forth.

PLATE III.

Craigforth Cruive Dyke river Forth. Continuing the line of the dyke to the right hand leads up to the Cruive Box.

based, become more apparent and project down stream a short distance, so as to reduce the height to from $3\frac{1}{2}$ to 4 feet. At this point during floods fish might probably ascend, even when the tide is out, but the main channel is on the opposite side of an island, which is situated below the weir. The main channel leads up to the cruive. The ascent of fish, however, is only possible at high tide as a rule, and then it is comparatively easy. A meal mill is situated on the right bank opposite the cruive box. The tail-lade enters the river just below the cruive dyke at its extreme right. The intake is not influenced by the weir on which the cruive is situated, but by a smaller dyke largely composed of natural ledges of rock. This structure is about 150 yards above the cruive, and does not materially influence the flow of the river. Netting is carried on above the mill dam and below the cruive dam, where, between the island and the left bank, a large pool exits.

In order that a proper view of the cruive may be obtained, it is necessary to visit the locality while the river is unaffected by tide. To remark this is tantamount to a statement that the Craigforth cruive seems to be situated where, to use the expression of the old Acts which govern the legal situation of cruives, "the sea fillis and ebbis," and where in terms of these Acts (Robert I., 1318, c. 12; James I., 1424, c. 11; James III., 1477, c. 73) no cruive should remain. The clause of the last-mentioned Act reads as follows:—"That the Act maid of before, be King James I., anent cruives set in waters be observed and keiped. The quhilk beires in effect that all cruives set in waters, quhair the sea fillis and ebbis, destroyis the frye of all fisches, be put away and destroyed for ever mair, notwithstanding any freedom or priviledge given in the contrair . . ." I find, by consulting the tide tables, that at Stirling the time of high water is 1 hour 22 minutes later than at Leith, and that a rise of $7\frac{1}{2}$ feet is set down as that of spring tides in this locality. The Craigforth cruive is fully two miles by the river above the bridge at Stirling, and is no doubt subject to a rise of less than $7\frac{1}{2}$ feet, yet on inquiry I am informed that spring tides rise to within a foot of the top of the dam-dyke, and that if the blinds of the cruive be shut down, so that practically no water passes through the box from above, the cruive box is filled up with water from below, by the action of the rising tide.

I would therefore venture to draw the attention of the Board to the conditions under which the Craigforth cruive exists.

NOTE IV.

(*From the "Scottish Law Reporter.*")

Friday, January 20, 1899.

FIRST DIVISION.

[Lord Kyllachy, Ordinary.

COUNTESS-DOWAGER OF SEAFIELD AND OTHERS *v.* KEMP.

DECISION.

Lord President—The main question in this case is a jury question, and my judgment is with the Lord Ordinary. The condition of the Ringorm and of the Spey, immediately below the confluence of the Ringorm, forty years ago, and the condition of those waters now, are matters of plain fact. There is, I think, abundant evidence to establish that those waters were (to use the Lord Ordinary's phrase), until a period well within the prescriptive period, unaffected by artificial impurities and fit for the primary uses. Their present condition, as spoken to by credible witnesses, is one of manifest pollution. That the defender's distillery materially contributes to this pollution is proved by very conclusive evidence. The Ringorm Burn affords the sharpest test of this last fact, for to the artificial pollution of that stream there has never been any other contributor, but the influence of the defender's discharges on the water of the Spey is distinctly traced. These general propositions rest upon evidence which in quality and in amount leaves no reasonable doubt.

It is necessary, however, to distinguish between the pollution before and the pollution after the execution of the defender's remedial works. These works have apparently made some differences, although it cannot be said that those differences are all for the better. What is quite certain is that the water continues to be polluted from this distillery to a material extent. It matters little whether since those works were executed less stuff goes into the Ringorm and more directly into the Spey, or whether there is now less of one offensive substance and more of another. The scientific evidence, led at enormous length, does not prove, and does not even go towards proving, that the nuisance has been abated.

Accordingly I hold that the illegal act of polluting these waters is brought home to the defender. There remains, however, the question whether the pursuers have proved that they have been injured, and I agree with the defender that the case of each pursuer must be considered separately. The position of Mr. Grant of Wester Elchies is the narrowest geographically but the strongest argumentatively. He is proprietor of the right bank of the Ringorm, and of so much of the Spey as is *ex adverso* of the west half of the channel of the Ringorm. He is therefore directly interested both in the polluted part of the

Ringorm and the polluted part of the Spey, and no exception can be taken to his title. As regards the proprietor of Aberlour, I hold with the Lord Ordinary that it is proved in fact that the Spey *ex adverso* of his lands has been materially polluted by the defender's discharges. That Lady Seafield's estate has been injured, if there be pollution at all, cannot be disputed as matter of fact, as regards both the Ringorm and the Spey, her lands extending *ex adverso* of both streams on their left banks. The argument against her Ladyship is founded on a feu contract entered into between her and the defender's predecessor in 1886, and it is said that she is barred from insisting in the present action. I am happy to know that Lord Kinnear will discuss this branch of the case more fully, but I may say that although the feu-contract commits Lady Seafield to the use of the ground as a distillery and the use of the Ringorm water for the purposes of the distillery, it confers no license to pollute, unless that is implied in those uses. That a distillery may be carried on at the place in question, and may use the Ringorm water without pollution, is not only credible but is proved in this case—for forty years ago there was a distillery, and the water was not the less fit for primary purposes. Accordingly it was for the defender, if he had a case of that kind, to prove that the distillery could only be carried on and could only use the water on condition of polluting the two streams, and that, in fact, this was being done in 1886. This, however, has not been proved. Indeed, evidence to this effect would have been inconsistent with the defender's general case, and inconsistent also with the salient fact that the enormous increase in the size of the distillery after 1886 has been the true origin of the gross pollution which is now complained of. Accordingly I think that Lady Seafield is not barred by the feu-contract.

The position of Mrs. Kinloch Grant of Arndilly is different from that of any other of the pursuers, for her property is much further down the Spey. Now I find it impossible to affirm anything about the condition of the Spey at Arndilly, either forty years ago or now, for there is no evidence on the subject. For anything I know, the Spey may have rid itself of the defender's pollution before it reaches Arndilly, and be perfectly potable; and on the other hand, the water may have been hopelessly polluted for generations from other quarters. In the potability or the pollution of the water *ex adverso* of other people's lands this lady cannot acquire an interest merely by joining them as a pursuer, and she can only prevail in the action in so far as she has proved injury to herself. Now I think that Mrs. Kinloch Grant has done so in the single article of salmon fishing. Every proprietor of salmon-fishings is injured if the spawning-beds are spoiled, even in a part of the river away from his fishings. The community of interest among the proprietors of salmon-fishings in a river is recognised by law, and it is a fact. Now in the present case there is adequate evidence that these discharges are deleterious to the bed of the river for spawning purposes. The summons contains a conclusion appropriate to the protection of Mrs. Kinloch Grant, and to this extent, and to this extent only, I think she is entitled to declarator. The matter is not of much practical importance, but as it is challenged, I do not think we could allow the general decree of declarator about primary uses to stand in Mrs. Kinloch Grant's favour, and I propose that our judgment on the whole matter should be to adhere to the findings and decrees of declarator in the two first heads of the interlocutor, in so far as those relate to the pursuers, other than Mrs. Kinloch Grant of Arndilly, and in regard to the said Mrs. Kinloch Grant, in place of the said findings and declarators, find and declare that the defender has no right or title to discharge into the Ringorm Burn, and through it into the river Spey, any impure matter or liquid prejudicial to the salmon-fishings of the said pursuer Mrs. Kinloch Grant, and decern; *quoad ultra* adhere to the said interlocutor as regards all pursuers.

Lord Adam and Lord M'Laren concurred.

Lord Kinnear—I also concur with your Lordships. I think the main questions to be considered in this case are pure questions of fact, and upon these I agree entirely with your Lordship and with the Lord Ordinary, and therefore I think it would be an idle encroachment on the time of the Court if I were to add anything to what your Lordship has said.

But there is a separate point which raises a different kind of question altogether—the defence that is rested on the defender's construction of the feu-contract of 1886—and upon that I may state the reasons for which I have come to the same conclusion as your Lordship has. I think the defender's construction of that feu-contract cannot be maintained. This raises quite a different question from that which has been considered in various cases where it has been proposed to make a landlord responsible for the nuisance created by his tenant because of his having let this land for a special purpose, which in ordinary course of business would probably create a nuisance. In these cases it has been maintained that a heritor complaining of nuisance is entitled to the same remedy against the landlord as against the tenant, because the landlord must be responsible for the direct consequences of his own act which he could not lawfully do by another; that is, by the tenant, if he could not lawfully do it himself. But the relation between Lady Seafield and the other parties to the feu-contract of 1886 is not that of landlord and tenant, but of vendor and purchaser, and the purchaser who becomes the vassal acquires under that title an absolute right of property in the use of which he cannot be controlled by the superior so long as he performs the conditions on which he holds the land, so as to give the superior no right to put an end to the feu. It would be quite impossible to interdict Lady Seafield (which the argument implies would be the right of the other pursuers) from polluting the Ringorm Burn or the river Spey by discharges from the defender's distillery, because she could do nothing whatever to carry out the order of the Court except by obtaining an interdict herself against the defender, which, *ex hypothesi* of the argument, she is not entitled to do. But then it is said, at least so I understand the argument, that treating the case as one of superior and vassal, by the terms of the deed Lady Seafield expressly confers on her vassal the right to use the water of the Ringorm Burn so as to pollute both that stream and the river Spey in the manner complained of, or at all events, that she expressly surrenders her own right to complain if the stream should be so polluted. That is rested on two clauses of the feu-contract—first, the dispositive clause, by which the superior "sells and in feu-farm dispones . . . . to James Stuart . . . the distillery of Macallan, with the right to take water for the use thereof from the Burn of Ringorm by pipes laid or to be laid from the said burn through the farm of Overton;" and the clause by which it is declared "that it shall not be lawful to nor in the power of the said James Stuart or his foresaids to erect or carry on upon the piece of ground hereby disponed any manufactures or operations which may be legally deemed a nuisance, or be dangerous or injurious to the amenity of the neighbourhood, but which declaration shall not apply to the carrying on of the said distillery." Now, I think that those two clauses must be considered separately, because they raise different questions, both as regards construction and legal effect. The first is said to be an express grant of the right to use the water of the Ringorm Burn in the very manner of which the pursuer now complains. I do not think it can be so construed. It is a right to take water from the burn, and that is expressed certainly in very general terms, and I do not at all doubt in terms wide enough to cover all the right to take water from the burn for that purpose which the granter possessed. But in any fair construction of the words of grant it cannot mean more than that. It is a grant of a special right along with a conveyance of land, and it is covered just as much as the grant of the land by the warrandice clause, and therefore Lady Seafield gives right and warrants it to the grantee in general terms to take water from this burn. Now, there can be no question at all as to the nature and extent of the right she herself possessed, and which alone she could give to anybody else. She was not the sole riparian proprietor, and therefore though she was entitled to divert water from the stream for the purpose of any manufacture if she chose to do so, she could only do it upon the condition and obligation of returning all the water which she did not consume for primary purposes to its channel within her own ground, undiminished in quantity and undeteriorated in quality. She had no right whatever, as against the lower heritors, to pollute either the Ringorm Burn or the River Spey, and therefore the grant of all the right she had or could pretend to have would not enable her grantee to pollute this stream either. I think it the more difficult to put a wider construction on the terms of the contract so as to make them cover rights which she did not possess and could not dispone, because the warrandice must be equally comprehensive, and the defender's argument, if it were carried to its logical conclusion, would mean that Lady Seafield is not only precluded from complaining of pollution herself, but is bound to protect him against complaints of lower heritors, and to make good to him any loss that may be occasioned by their interference with the right which she has conferred. I cannot put that construction on the clause, and cannot read into it words which are not there, so as to make it mean that the superior grants to the vassal the right to take and use the water of the burn free from any condition or obligation affecting the superior herself to restore it unpolluted lower down the stream. Lady Seafield could not grant that right, and I do not think that, if it had been expressed in clear terms, any superior would have signed the feu-contract, and therefore I am unable to import by implication words which would have so serious an effect on the rights of parties when they are not expressed. But then it is said that this is implied by the specification of the use for which the water may be taken. It is to be taken for the use of the distillery, but that appears to me to add nothing to the meaning, fairly read, of the words of grant, unless it could be maintained that as matter of fact the distillery could not be carried on in the ordinary course of business without polluting the stream in the manner complained of. Now that is not alleged, and it certainly is not proved, and it therefore appears to me that these words add nothing to the fair meaning of the words of grant taken apart from them. Another view was suggested—that at all events the feu-contract must be read with reference to the condition of the burn at the time it was executed, and therefore that the vassal must have right to continue the same kind of pollution to the same effect as existed in 1886—the doctrine invoked being that the contract must be construed with reference to the facts to which it relates. Now I think it would be extremely difficult to apply that method of construction to such a title as this, because it is a grant of land in perpetuity, and a special heritable right is granted along with the land, and as a pertinent of it; and I think it would be extremely difficult to hold that the character and measure of that grant, into whose hands soever the lands may come at any distance of time, has to be determined, not by reference to anything expressed in the title, or preserved on record, but by reference to an extrinsic state of facts known *ex hypothesi* to the granter and grantee at the time, but which their singular successors could not possibly know anything about at a distance of time, because there is no record of evidence to explain it. But if such a method of construction were applicable at all, then I agree with an observation that was made by your Lordship, that it lies with the defender—maintaining that the words of a feu-contract are to carry a wider meaning than that which, if construed alone, they would bear by implication from a specific state of facts—to aver on record that state of facts, and to establish it by evidence. Now there is no such averment on record, and there is no evidence—no specific evidence—of the actual condition of the water in 1886, which would enable us to say what is the measure of the right conferred on the vassal by the feu-contract. There is no attempt to clear up the contract in that way by evidence, if it was possible to clear it up; and I am of opinion, therefore, that this clause at all events cannot be so construed as to confer on the vassal any higher right than Lady Seafield possessed.

But then it is said that the second clause, to which I adverted, bars the superior from the present complaint. That is an exception from the clause for the prevention of nuisance. It is declared that the vassal shall not be entitled to carry on manufactures which may be deemed a nuisance—excepting from that declaration the carrying on of the said distillery—and as I understand the argument, it is said that is an express permission to carry on the distillery, and that therefore the pursuer cannot complain on the maxim *volenti non fit injuria*. I think that would be a very good answer to an action at the pursuer's instance to put down a distillery as a nuisance. I do not think that she would be in a position to maintain that the distillery as such is a nuisance prohibited by this clause. But the only purpose of the exception is to take the distillery out of the scope of the clause prohibiting nuisances, and when it has served that purpose there appears to me to be no other meaning that can be given to it, and therefore on this branch of the contract also, as on the other, it would be indispensable for the defender to show that the distillery could not in fact be carried on without producing this particular nuisance of which the pursuer complains; and as your Lordship has pointed out, that has not been proved. Indeed, it is not consistent with the defender's case to maintain it. That there may have been a discharge of impurities into the Ringorm Burn at the time the contract was granted, or that such a discharge may be very probably, if not necessarily, a consequence of carrying on the distillery, is a very different matter, because in all these cases the question is not one of degree. It cannot be alleged of any running stream that it is absolutely free from impurities at any time, and therefore the question always is, whether the person complained of has discharged into the river impurities so much greater in character and degree than what had been discharged within the prescriptive period as to create a nuisance. I think that is the true question in the present case, and that it is proved that the defenders have polluted the stream to a much greater extent than had ever been done before, and therefore if the clause in question were held to contemplate that some degree of impurity may be discharged into the stream, it does not follow that it contemplates what the defender is now doing. It appears to me that the condition of the contract which is founded on, by which the carrying on of the distillery is excepted from the general prohibition of nuisances, cannot be carried further than to bar the superior from complaining of the distillery as such being necessarily in itself a nuisance. That she does not do in this action, and therefore I think the plea of bar falls.

On all the other points in the case, as I have said, I entirely agree with your Lordships.

The Court pronounced the following interlocutor:—

> "Adhere to the findings and decrees of declarator in the two first heads of the interlocutor reclaimed against, in so far as these relate to the pursuers other than Mrs. Kinloch Grant, Arndilly: And in regard to the said Mrs. Kinloch Grant, in place of the said findings and declarators, Find and declare that the defender has no right or title to discharge into the Ringorm Burn, and through it into the river Spey, any impure matter or liquid prejudicial to the salmon-fishings of the said Mrs. Kinloch Grant: *Quoad ultra* adhere to the said interlocutor as regards all the pursuers," &c.

NOTE V.

FOUR TABLES, showing the AVERAGE WEIGHT OF THE AMOUNT OF SALMON carried by Railway Companies and Steamship Owners from Stations and Ports of Scotland during the quinquennial period, 1894-1898.

TABLE I.

Berwick to Cairnbulg Point—Total, 1166 tons, 18cwts., 1Qr, 4½lbs.

Railway Station or Port.	Tons.	Cwts.	Qrs.	Lbs.
FORTH DISTRICT.				
Stirling	18	10	3	17
Kincardine	8	19	—	26
Causewayhead	—	9	3	13
Alloa	12	12	1	13
Airth	4	19	2	11
Cambus	—	—	—	—
Kinghorn	—	—	—	—
Kirkcaldy	—	—	—	—
Longniddry	—	18	—	18
Leven	—	—	—	—
Largo	8	1	2	16
Elie	3	—	2	4
St. Monan's	3	5	2	22
Dysart...	—	—	—	—
Anstruther	50	18	—	23
Buckhaven	2	7	1	17
Crail	—	17	—	20
Dalmeny...	—	2	3	13
Edinburgh	10	—	3	6
Kilconquhar	2	19	1	4
Bridge-of-Allan	—	1	1	17
Cockburnspath	13	14	2	2

TABLE I.—*continued.*

Railway Station or Port.	Tons.	Cwts.	Qrs.	Lbs.
Forth District—*continued.*				
Dunbar	—	4	2	25
Grangemouth	—	2	—	16
Granton	—	2	—	7
TWEED DISTRICT.				
Reston	10	10	3	9
Eyemouth	2	3	2	5
Berwick	—	—	—	—
Burnmouth	15	12	2	10
Roxburgh	—	—	—	2
TAY DISTRICT.				
Grantully	—	1	3	7
Murthly	—	—	1	3
Dunkeld	—	1	—	3
Boarhills...	1	14	1	25
Cargill	—	—	—	—
Kingsbarnes	4	9	—	27
Stanley	18	4	2	11
Crieff	—	2	1	17
Strathord	—	9	—	22
Luncarty...	1	9	3	6
Perth	13	9	2	12
Kinfauns...	42	18	1	17
Glencarse	4	10	2	11
Errol ... ... —	...	3	1	22
Invergowrie	—	—	—	—
Dundee	2	15	3	—
Wormit	6	19	1	3
Abernethy	1	12	1	11
Newburgh	208	17	2	21
Newport	—	2	2	21
Tayport...	8	9	3	26

TABLE I—*continued.*

Railway Station or Port.	Tons.	Cwts.	Qrs.	Lbs.
Tay District—*continued.*				
Guardbridge	—	1	2	8
St. Andrews	—	—	—	—
West Ferry	3	—	—	22
Broughty Ferry	1	10	2	17
Monifieth	9	11	—	14
Barry	—	10	1	21
Carnoustie	7	13	2	25
Easthaven	6	—	1	6
Elliot Junction	1	16	—	15
Killin	—	14	—	19
SOUTH ESK DISTRICT.				
Montrose	79	11	1	23
NORTH ESK DISTRICT.				
Montrose	95	1	2	17
BERVIE DISTRICT.				
Lunan Bay	1	5	1	23
Craigo	—	6	—	22
St. Cyrus	15	—	3	22
Lauriston	10	1	2	—
Johnshaven	8	15	3	12
Gourdon	1	13	—	3
Bervie	58	19	3	26
DEE, DON, YTHAN, AND UGIE DISTRICTS.				
Portlethen	—	—	—	—
Aberdeen	336	14	3	22½
Newtonhill	8	17	3	16
Stonehaven	2	7	3	6
Peterhead	44	11	—	22
Boddam	—	17	—	22
Cruden Bay	5	1	3	22

TABLE II.

Cairnbulg Point to Cape Wrath—Total, 900 tons, 17 cwts, 3 qrs, 8 lbs.

Railway Station or Port.	Tons.	Cwts.	Qrs.	Lbs.
DEVERON DISTRICT.				
Fraserburgh	6	8	3	22
Ladysbridge	8	18	2	—
Macduff...	—	—	—	—
Banff	3	8	1	—
SPEY AND LOSSIE DISTRICTS.				
Kincraig	—	19	2	6
Dunphail	—	—	2	26
Aviemore	—	—	—	—
Fochabers	210	15	1	4
Orbliston...	—	—	3	2
Portsoy	35	17	3	—
Cullen	7	11	2	17
Findochty	5	12	1	17
Buckie	3	10	2	6
Buckpool	15	4	1	—
Lossiemouth	40	9	—	17
Portgordon	—	—	—	—
FINDHORN DISTRICT.				
Nairn	62	19	2	—
Forres	6	13	3	12
Kinloss	61	5	2	17
Burghead	33	2	2	17
Hopeman	—	19	1	22
NESS AND BEAULY DISTRICTS.				
Fortrose	24	15	—	—
Fort George	—	—	—	—
Inverness	18	2	3	11
Beauly	2	19	—	13
Muir of Ord	2	17	—	4

TABLE II.—*continued.*

Railway Station or Port.	Tons.	Cwts.	Qrs.	Lbs.
CONON AND ALNESS DISTRICTS.				
Conon	—	—	—	—
Dingwall...	16	14	3	14
Novar	1	14	1	22
Alness	11	17	2	14
Invergordon	20	6	3	5
Delny	—	—	—	—
KYLE OF SUTHERLAND DISTRICT.				
Tain	1	6	2	16
Fearn	23	16	1	16
Bonarbridge	40	—	1	
Invershin	1	8	3	—
Lairg	—	—	—	—
FLEET OR BRORA DISTRICT.				
Brora	12	12	3	27
Loth	2	3	1	24
Golspie	1	17	1	16
HELMSDALE AND WICK DISTRICTS.				
Helmsdale	32	8	1	26
Kildonan	1	5	1	19
Wick	44	10	—	18
Forsinard	29	18	2	22
Halkirk	—	—	—	—
Thurso	56	9	1	16
Kinbrace...	—	—	3	—

TABLE III.

Cape Wrath to Glasgow—Total 403 tons, 7cwt., 1qr., 20lbs.

Railway Station, Port, or Steamer.	Tons.	Cwts.	Qrs.	Lbs.
CAPE WRATH TO GLASGOW.				
Stornoway	26	11	2	11
Portree	75	13	—	—
Attadale	—	2	1	11
Garve	21	11	—	2
Auchnasheen	—	14	2	2
Glenelg	—	—	—	—
Strome Ferry	41	7	2	1
Kyle of Lochalsh	8	6	2	11
"Claymore" or "Clansman"	29	15	—	25
Glasgow Steam Packet Co. ...	2	14	1	20
"Dunara Castle"... ...	—	—	—	—
Other Steamers	—	4	2	11
Fort-William	4	—	—	2
Speanbridge	—	—	—	—
Tobermory	—	2	3	9
Banavie	—	1	1	16
Oban	78	16	1	17
Connelferry	—	9	1	17
Taynuilt	16	18	—	22
Gourock	—	15	—	—
Dumbarton	—	2	2	2
Glasgow (Central)... ...	32	5	3	22
Glasgow (St. Enoch) ...	56	11	—	17
Glasgow (Queen Street) ...	2	—	1	11

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TABLE IV.

Glasgow to the Border—Total 259 tons, 3cwt., 2qrs., 5lbs.

Railway Station or Port.	Tons.	Cwts.	Qrs.	Lbs.
AYR DISTRICT.				
Ayr	3	9	3	10
GIRVAN DISTRICT.				
Girvan	10	—	2	17
STINCHAR DISTRICT.				
Pinwherry	6	18	2	11
Stranraer	3	17	2	2
NITH DISTRICT.				
Dumfries	17	1	3	27
ANNAN DISTRICT.				
Gretna Green	1	11	2	24
Annan	124	16	—	..
Dornoch	18	1	1	11
Bowness	13	18	—	22
CREE DISTRICT.				
Creetown	9	10	—	25
Newton Stewart	5	11	—	10
FLEET DISTRICT.				
Dromore	1	2	—	1
BLADENOCH DISTRICT.				
Garliestown	10	7	—	13
Wigtown	—	16	—	26
Whithorn	—	—	1	18
LUCE DISTRICT.				
Glenluce	3	16	—	11
URR DISTRICT.				
Dalbeattie	2	1	3	6
DEE (Solway) DISTRICT.				
Castle Douglas	—	6	—	22
Bridge of Dee	—	—	—	—
Tarff	—	—	—	—
Kirkcudbright	26	13	2	11
DOON DISTRICT.				
Maybole	—	2	3	6

NOTE VI.

ANNUAL CLOSE TIME APPLICABLE TO THE SALMON RIVERS IN SCOTLAND.

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

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

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

NOTE VII.

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

DISTRICT.	Name and Address of Chairman.	Name and Address of Clerk.
Alness, . . .	Col. Alex. J. C. Warrand, Ryefield House, Conon Bridge, Dingwall.	William J. Duncan, Solicitor, Dingwall.
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Broom, . . .	Sir Arthur George Ramsay Mackenzie of Coul. Bart., Coul House, Strathpeffer.	W. R. T. Middleton, Solicitor, Dingwall.
Conon, . . .	John Little Mounsey, Esq., W.S., 5 Thistle Street, Edinburgh, Commissioner for Col. J. A. F. H. Stewart Mackenzie of Seaforth.	Edmund J. Gunn, Solicitor, Dingwall.
Cree, ...	The Earl of Galloway, Cumloden, Newton-Stewart.	A. B. Matthews, Solicitor, Newton-Stewart.
Dee (Aberdeen),	The Lord Provost of Aberdeen.	Alex. Duffus, Advocate, Aberdeen.
Dee (Solway), .	H. G. Murray Stewart, Esq. of Broughton, Gatehouse.	W. Nicholson, Sheriff-Clerk, Kirkcudbright.
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Don, ...	George Falconer, Esq., as mandatory for the Aberdeen Shipmasters' Society.	Alex. Duffus, Advocate, Aberdeen.
Doon, . . .	Marquis of Ailsa, Culzean Castle, Maybole.	W. Macrorie, Solicitor, Ayr.
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Esk (South), .	James Johnston, Esq., Montrose.	James Don and David G. Shiel, Solicitors, Brechin.
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NOTE VII. (*continued*)—LIST OF CHAIRMEN AND CLERKS OF SALMON FISHERY DISTRICT BOARDS IN SCOTLAND.

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Snizort, Orley, Oze, and Drynock (Skye), .	Kenneth Macdonald, Esq., as mandatory for L. Macdonald, Esq., of Skeabost.	Kenneth Macrae, Sheriff-Clerk, Portree.
Spey, . . .	The Duke of Richmond and Gordon, Gordon Castle, Fochabers.	John Wink and George A. Cooper, Solicitors, Elgin.
Stinchar, . .	The Earl of Stair, Lochinch, Wigtownshire.	Thomas C. Greig, Rephad, Stranraer.
Tay, ...	Sir Robert Moncreiffe of Moncreiffe, Bart., Moncreiffe House, Perthshire, as mandatory for the Hon. F. J. Moncreiff, curator bonis of E. B. Balfour Kay, Esq. of Mugdrum.	Mackenzie & Dickson, Solicitors, Perth.
Torridon, . .	C. R. Manners, Esq., C.E., 12 Lombard Street, Inverness.	Duncan Shaw, W.S., 42 High Street, Inverness.
Ugie, . . .	Lieut.-Col. Ferguson, of Pitfour, Mintlaw.	Robert Gray, Solicitor, Peterhead.
Ythan, . . .	Earl of Errol, Slains Castle, Aberdeenshire.	D. M. A. Chalmers, Advocate, Aberdeen.
Tweed (Police Committee of the Commissioners),	Sir William Crossman, Cheswick, Beal, Northumberland.	James and David W. B. Tait, W.S., Kelso.

Note.—In addition to the districts specified above, the Duke of Sutherland is sole proprietor of the districts of the following rivers, viz. :—Helmsdale, Brora, Fleet, Kirkaig, Inver, Laxford, and Inchard (under the charge of his factor, Mr Donald M'Lean, Dunrobin Office, Golspie); and the Halladale, Strathy, Naver, Borgie, Kinloch, Hope, Polla or Strathbeg, and Dionard or Grudie (under the charge of his factor, Mr John Box, Tongue); and the Countess of Cromartie is sole proprietrix of the district of the river Kennart (under the charge of her factor, Mr William Gunn, Cromartie Estate Office, Strathpeffer).

Fishery Board for Scotland,
Edinburgh, 3rd April 1899

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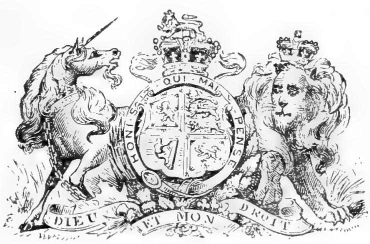

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SCIENTIFIC REPORTS.

SEVENTEENTH ANNUAL REPORT.

TO THE RIGHT HONOURABLE

LORD BALFOUR OF BURLEIGH.

Her Majesty's Secretary for Scotland

OFFICE OF THE FISHERY BOARD
FOR SCOTLAND,
EDINBURGH, 1*st May* 1899.

MY LORD,

In continuation of our Seventeenth Annual Report, we have the honour to submit—

PART III.—SCIENTIFIC INVESTIGATIONS.

GENERAL STATEMENT.

THIS part of the Seventeenth Annual Report contains an account of the principal scientific investigations conducted by the Board during 1898, in connection with the sea fisheries. Besides the researches on the life-history and habits of the food fishes, and on the invertebrate fauna, the results of which are set forth in this Report, a number of other enquiries have been in progress, but are not yet completed. Among these may be mentioned the migrations of the food fishes, especially of the herring, the life-history of the edible crab, and the distribution of spawning fishes and of immature fishes in the Firth of Clyde and the Moray Firth.

A considerable part of the scientific investigations have been carried on by means of the "Garland," the small steamer which the Board possesses for this work. As explained in previous Reports, the scope and the extent of the investigations have been restricted for the most part to the territorial waters and to the firths and bays, owing to the small size of the "Garland." Her registered tonnage is 36·4 tons, her length 84 feet 7 inches between perpendiculars, and her breadth 15 feet, and she is only adapted to carry a 25-feet beam trawl. Were the "Garland" replaced by an efficient sea-going vessel, capable of using a large trawl, as recommended by the Parliamentary Committee of 1893, it would be possible to conduct the trawling investigations more satisfactorily, and at the same time to extend the observations to the important fishing grounds lying at some distance from the shore, where the principal spawning areas are situated. It is in this direction that we must look in future for the greatest advances in the scientific knowledge of the problems connected with the regulation and conservation of the sea fisheries.

The Influence of Trawling.

The results of the trawling investigations carried on in 1898, together with the various Tables embodying the detailed observations, are given in a special report (p. 17). In the course of the year the stations in the Moray Firth and the Firth of Clyde were examined in May, June, August, September, October, November, and December, and the stations in Aberdeen Bay in April and May. The work in the latter part of the year was much interrupted by stormy weather. So far as the observations go, they show that in the Moray Firth the average number of flat-fishes captured in each haul of the net increased from 149 in 1897 to 167·7 last year. The increase was confined to dabs. Common dabs increased from an average per haul of 100·2 in the previous year to an average of 120·9. Long rough dabs also slightly increased in numbers from an average of 18·8 in 1897 to 19·1 last year. On the other hand, the averages for plaice and lemon soles decreased to a slight extent—plaice from 19·7 to 18·3, and lemon soles from 6·3 to 5·4. Among round-fishes the average per haul for the whole area was 48·8, as compared with 32·8 in the previous year, and 49·4 in 1896. The increase was principally in gurnards.

As explained in previous Reports, the trawling investigations in the Moray Fifth have not been carried on for a period sufficiently long or on a scale sufficiently extensive to enable conclusions to be drawn from them with any degree of certainty as to the results of the closure of the Firth. The extent of the Firth is great, and the number of hauls which have been made at the various stations within it is but little over 200, most of which have been made since the whole Firth was closed in 1892.

The special statistics of the fish caught by line fishermen within the Moray Firth since 1894 are of considerable interest, especially in relation to the abundance of round-fishes in the various years. They show the number of "shots" of the line made by the large and small boats within the closed waters, the quantities of the various kinds of fishes caught in this way, and the average weight of the catches for each shot of the line. The following figures indicate the quantities and the averages per "shot" in each of the districts :—

	1894.		1895.		1896.		1897.		1898.	
District.	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.
Wick, . .	19,008	2·47	23,009	4·03	31,556	5·40	44,258	6·16	31,383	6·49
Lybster, . .	4,408	4·91	3,977	3·77	4,241	2·87	7,118	4·22	4,438	3·26
Helmsdale, .	15,826	3·52	16,669	4·15	18,360	4·71	17,148	4·91	13,143	3·84
Cromarty, .	21.346	3·07	19,193	2·93	15,317	2·51	14,736	2·48	12,428	2·065
Findhorn, .	60,074	4·04	68,761	4·86	63,521	4·46	46,694	2·66	30,770	2·088
Buckie, . .	48,540	4·21	50,489	4·66	57,450	5·05	50,067	4·77	41,102	4·24
Banff, . .	49,292	2·94	76,441	4·77	66,471	3·82	61,329	3·70	36,057	2·13
	218,494	3·05	258,589	4·43	256,916	4·26	241,350	3·83	169,321	3·244

Comparison of these figures with those given in the ordinary statistical Tables published in Part I. of the Annual Report shows that by far the greater amount of the line-caught fish landed in the Moray Firth districts is taken from the Firth itself. Of a total of 207,318 cwts. landed in these districts last year, 169,321 cwts. were obtained within the closed waters, and 37,997 cwts. outside the Firth. Thus over 80 per cent. was caught within the closed area, a proportion almost the same as in the previous year. In some of the districts—namely, Lybster, Helmsdale, and Cromarty—all the fish landed by line fishermen were captured in the Firth.

Last year the extent to which line fishing was carried on in the Moray Firth was much less than in the previous year, the total number of shots of the line having decreased from 62,875 to 52,183, a diminution of more than ten thousand, and the lowest since the Firth was closed. For the first time also since the Firth was closed the number of trips or shots of the large boats exhibited a falling-off—namely, from 14,039 in 1897 to 10,330. In 1894 the number was 7082, in 1895 7710, in 1896 11,917. The number of trips or shots of the small-line boats fell from 48,836 to 41,853—the lowest since 1894.

With respect to the fluctuations in the quantities of fish taken by line in the Moray Firth in the various years, it will be seen from the figures in the above Table that the total quantity landed in 1898 is the lowest in the series, and the average per shot is lower than in any year since 1894. The decrease in the quantity as compared with 1897 amounted to 72,029 cwts., the diminution of the average being from 3·83 cwts. to 3·24 cwts. The decrease in the quantity of line-caught fish in 1898 was not peculiar to the Moray Firth, but was common to the East Coast and to the whole coast of Scotland. In the Moray Firth it was most marked in the Banff district, in which the total quantity landed from the closed waters in 1898 was 36,057 cwts.,as against 61,329 cwts. in the previous year. In the Buckie district the decrease was from 50,067 cwts. to 41,102 cwts.; in the Helmsdale and Cromarty districts it was less marked. The average catch per shot of the line fell in all the districts except Wick; in the Banff district it was reduced from 3·7 cwts. in 1897 to 2·13 cwts. last year.

The quantity of all kinds of fish, except saithe, caught by line within the closed waters was less last year than in 1897; but the decrease was by far the greatest in cod and haddocks, as may be seen from the following Table:—

FISH.	1894.		1895.		1896.		1897.		1898.	
	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.
Cod - - -	32,571	0·52	47,646	0·81	64,663	1·07	79,731	1·26	56,208	1·07
Ling - - -	2,169	0·035	2,937	0·005	3,868	0·062	3,544	0·056	2,567	0·049
Torsk - - -	25	0·002	24	—	94	—	25	—	43	—
Saithe - - -	6,120	0·09	5,083	0·087	10,636	0·17	11,761	0·18	14,881	0·28
Haddock - -	153,529	2·47	178,370	3·056	156,703	2·6	126,031	2·004	81,098	1·554
Whiting - -	5,845	0·094	5,114	0·087	4,836	0·08	3,319	0·052	1,535	0·029
Turbot - - -	5	—	—	—	15	—	16	—	13	—
Halibut - -	254	0·004	403	0·007	691	0·011	707	0·011	730	0·013
Lemon Sole - -	—	—	—	—	19	—	14	—	1	—
"Flounder, Plaice, and Brill" - -	5,477	0·088	5,765	0·09	3,402	0·056	3,978	0·063	3,425	0·065
Conger - -	1,244	0·02	777	0·013	823	0·013	1,533	0·024	826	0·015
Skate, - - -	3,281	0·053	3,014	0·051	3,683	0·061	3,999	0·063	3,273	0·062
Other kinds of White Fish -	7,976	0·128	9,456	0·16	7,483	0·12	6,663	0·105	4,574	0·087

The quantity of cod—which had been increasing each year from 1894 to 1897—fell from 79,731 cwts. in 1897 to 56,208 cwts. in 1898, a decrease of 23,523 cwts. The average per "shot" also fell from 1·26 cwts. to 1·07 cwts. The diminution in the abundance of haddocks was even more marked. The quantity landed from the Moray Firth in 1897 was 126,031 cwts.; last year it amounted only to 81,098 cwts., or nearly 45,000 cwts. less. In 1895 the quantity was more than double what it was last year. The fluctuations in the abundance of cod and haddocks were common to the other districts on the East Coast and were not peculiar to the Moray Firth. There was also a diminution in the quantity of flat-fishes landed by line fishermen from the closed waters, as well as in the quantity of ling, whitings, and skates. The only fish which showed an increase was saithe, the quantity of which has gradually increased each year since 1894.

The trawling investigations in the Firth of Clyde, when compared with those of previous years, show that, taking all the stations together and all kinds of fish, the average number per haul of the net has generally increased over the period comprised, although considerable fluctuations occurred in different years. In 1888 the general average for the closed area was 109·7 fishes per haul; in 1890 it was 99·5 per haul; in 1895 it was 113·4; in 1896 it was 120·7; in 1897, 112·5; and last year it rose to 189·3 fishes per haul. The rise in the average has been most marked in the flat-fishes, the figures for the respective years being 61·2, 61·1, 64·7, 75·5, 84·8, and 94·7. The increase was due for the most part to an increased abundance of witches and long rough dabs, plaice and lemon soles having rather diminished in numbers over the period. But as stated in previous Reports, inferences as to changes in the abundance or relative proportions of the fishes in the closed area of the Clyde can only be provisional, inasmuch as the observations comprise only ten series of hauls at the various stations. It will require much more extended observations both in the Firth of Clyde and the Moray Firth before conclusions can be drawn with any degree of certainty as to the results of the closure. In the Firth of Forth and St. Andrews Bay it was found, after ten years' investigation, that the most important change that occurred in the relative abundance of the food fishes in the closed waters was a diminution of the more valuable flat-fishes, plaice and lemon soles, which spawn offshore and not in the closed waters, and an increase in the comparatively worthless dabs, which spawn copiously in the closed waters. The figures referring to these species are as follows:—

	No. of Hauls.	Plaice and Lemon Soles Caught.	Dabs Caught.	Total.
1st Period—1886-90,	325	29,869	19,825	49,694
2nd Period—1891-95,	466	28,044	29,483	57,527
Totals,	791	57,913	49,308	107,221

It will be observed that in the second period of five years, while 141 more hauls of the trawl were made within the closed waters than in the first period, the number of plaice and lemon soles caught was less by nearly 2000, and the number of dabs caught was greater by nearly 10,000. The same result was found whether the whole year was contrasted in the two periods, or the cold months against the cold months, or the warm months against the warm months.

	No. of Hauls.	Plaice and Lemon Soles.			Dabs.		
		No. Caught.	Average per Haul.	Percentage of Total.	No. Caught.	Average per Haul.	Percentage of Total.
Six Cold Months: November—April.							
1st Period—1886-90,	128	6346	49·6	69·3	2808	21·9	30·7
2nd Period—1891-95,	238	8735	36·7	52·0	8066	33·9	48·0
Six Warm Months: May—October							
1st Period—1886-90,	197	23,523	119·4	58·0	17,017	86·3	42·0
2nd Period—1891-95,	228	19,309	84·7	47·4	21,417	93·9	52·6

It may be noticed from these figures that while each hundred of flat-fishes caught in the closed waters in the colder months consisted in the first period of 69 plaice and lemon soles, and 31 dabs, each hundred in the corresponding months of the second period consisted of 52 plaice and lemon soles, and 48 dabs. In the warmer months of the first period each hundred consisted of 58 plaice and lemon soles, and 42 dabs; while each hundred in the same months of the second period consisted of 47 plaice and lemon soles, and 53 dabs. The inshore-spawning dabs, therefore, to a very large extent supplanted the offshore-spawning plaice and lemon soles in the closed waters. A more detailed analysis (pp. 25, 26) shows that these changes were common to each of the individual species, plaice, lemon soles, common dabs, and long rough dabs, and that they occurred in nearly every month in the year, when the months of the two quinquennial periods are contrasted.

The Hatching and Rearing of Food Fishes.

The operations at the Marine Hatchery at Dunbar last year consisted in the hatching of the fertilised eggs of plaice, the same methods as in previous years being employed. Adult plaice, to serve as spawners for the supply of eggs, were procured by the "Garland" from trawlers in February and March, a little over 700 males and females being thus obtained. Owing to the method of capture a considerable number of the fishes exhibited the characteristic features which have been described in previous Reports, and many of them subsequently succumbed to the injuries they had received.

The collection of fertilised eggs from the spawning pond commenced on 15th February and continued until 7th May, when altogether 21,510,000 had been procured and placed in the hatching apparatus. The largest numbers were obtained at the end of March and the beginning of April. The number of fry successfully hatched was 19,200,000, which were transferred to Loch Fyne at various dates between 1st April and 20th May, and liberated in the upper loch, principally off Inveraray.

The numbers of fry of the various species of marine food fishes which have been hatched at the establishment since the work was commenced are as follows:—

	Plaice.	Cod.	Lemon Soles.	Turbot.	Others.	Total.
1894	26,060,000	500,000	...	...	...	26,560,000
1895	38,615,000	2,760,000	4,145,000	3,800,000	1,050,000	50,370,000
1896	11,350,000	750,000	1,580,000	1,360,000	950,000	15,990,000
1897	24,370,000	...	...	...	...	24,370,000
1898	19,200,000	...	...	...	...	19 200,000
	119,595,000	4,010,000	5,725,000	5,160,000	2,000,000	136,490,000

As has been pointed out in preceding Reports, the hatching work at Dunbar has been much impeded and restricted from the absence of a large sea-water enclosure in which the adult fishes to be used as spawners could be gradually collected and retained from one season to another, instead of requiring to be obtained from trawlers at the beginning of each season. With the object of obtaining this facility it was decided to remove the hatchery, as explained in last year's Report, to the Bay of Nigg, near Aberdeen, where a suitable site for the purpose was obtained from the Town Council of Aberdeen. The construction of a large concrete tank, ninety feet in length by thirty-five feet in breadth, and with an average depth of seven and a half feet, was begun at the new site in the spring of the year, the object being to have the tank sunk sufficiently deep in the ground adjoining the beach as to have a mean depth within it of four feet of water at high-water of ordinary neap tides. It was, however, found necessary to suspend the construction of the tank in September, and to continue the hatchery at Dunbar for another season. When the concrete tank is completed during the ensuing year, the hatching house at Dunbar, with the apparatus, pumps, and plant will be removed to the new site, and the necessary supply of sea-water will also then be available for the Marine Laboratory which was erected on the site last autumn, and whose equipment has for the same reason been delayed.

The Pelagic Fish Eggs and Larval and Post-Larval Fishes of Loch Fyne.

In the present Report will be found a paper by Mr. H. C. Williamson describing the results of an investigation into the occurrence and abundance of the pelagic eggs of fishes and the young fishes in Loch Fyne. Tow-net collections were made once a month from January to August at five localities in the upper and lower lochs at various depths from the surface to fifteen fathoms. The pelagic eggs of about thirty species were procured, principally in March, April, May, and June, including those of the common food fishes, and the spawning period of most of these has been deduced from the presence or absence of the eggs in the monthly collections. The degree of development of the various eggs was ascertained, and calculations are made to indicate in an approximate manner the numbers of pelagic fish eggs floating in the waters of Loch Fyne during the first eight months of the year.

Nearly three thousand larval and post-larval fishes were taken in the tow-nets, most of them belonging to species with demersal eggs, such as the gobies and the bimaculated sucker. Among them are forms which have been identified as the young of the mackerel. The abundance of the pelagic invertebrate fauna, especially the Copepoda, which constitute a considerable part of the food of the herring in Loch Fyne, was also determined in the various months. The paper is accompanied by a number of Tables and by five Charts and Plates.

The Invertebrate Fauna of the Inland Waters of Scotland.

For a few years past investigations have been carried on by Mr. Thomas Scott, F.L.S., on the invertebrate fauna of a number of Scottish lochs, and in the present Report the results are given of the investigation of a number of them, including Loch Lomond, Loch Arklet, Loch Katrine, Loch Achray, Loch Leven, Loch Doon, and Lochs Ness, Oich, and Lochy. One object of the enquiry was to ascertain the effect produced on the invertebrate fauna by the changes incident to the different seasons of the year, and the examination of each loch was made at intervals, the temperature and other physical conditions being also noted. The number of species obtained was 132, of which 115 belong to the Crustacea and 17 to the Mollusca; and the invertebrate fauna of some of the lochs, as Loch Lomond, Loch Leven, Loch Doon, and Loch Achray, was found to be much richer in species than others. Notes are appended on the seasonal distribution of the organisms in each loch, on the local distribution of certain species, and on the variations in the forms of Daphnia.

In another paper Mr. Scott describes the collections of micro-crustacea obtained from the Firth of Clyde and the Moray Firth, including a number of new species and two new genera of Copepoda. The paper is illustrated by a series of drawings.

The Migratory Movements and Rate of Growth of the Common Gurnard.

In a paper on this subject, by Dr. T. Wemyss Fulton, it is shown that the gurnard is practically absent from the inshore waters of the Firth of Forth and St. Andrews Bay during the winter months. When the temperature of the bottom water inshore begins to fall in the autumn the gurnards migrate to the offshore grounds in the open sea, where the temperature is higher, and where they pass the winter. When the temperature inshore begins again to rise, usually about the end of March, gurnards reappear at the mouth of the Firth of Forth; in April, with a slightly higher temperature, the influx is considerable, and it reaches its maximnm in May. It is shown that the initial shoals are composed almost entirely o adult gurnards, and that the migratory movement towards the inshore waters is primarily associated with reproduction. Later, immature and young gurnards move in in great numbers, and these immature forms are the first to leave in autumn. This movement appears to be dependent on the changes in the temperature of the bottom water. On the other hand, in the deeper waters of the Clyde and the Moray Firth, where the winter temperature is much higher than in the Firth of Forth or St. Andrews Bay, gurnards may be found all the year round. Tables and Diagrams are given showing the proportions of adult and immature gurnards in the various months, and the relations between the migratory movements, the spawning period, and the changes in the temperature of the water.

Seine-Net Fishing for Herrings.

The alleged injurious action of the seine-net in the herring fishing has been for some time under investigation with the view of ascertaining whether the two principal objections urged against this mode of fishing—namely, the wasteful destruction of the herring spawn deposited on the bottom, and of immature herrings—are well founded. For several years, as stated in previous Reports, arrangements were made to conduct an investigation on the former point at the well-known spawning ground, Ballantrae Bank, off the coast of Ayrshire, but, owing to the very poor fishing, seine-net boats scarcely took part in it. In the spring of this year the herrings reappeared on the bank in considerable numbers, and a few seine-net boats for a short time took part in the fishing. So far as the limited opportunity offered, no evidence was found to prove that the seine-net caused wasteful destruction of the spawn deposited on the bottom. On the other hand, a considerable proportion of small herrings were captured, much more than by the trammel-nets. In Loch Fyne the capture of immature herrings by the seine-net was investigated during the last two seasons, very numerous catches being examined at various periods and parts of the loch. While it was found that in many cases the proportion of small herrings taken was considerable, and that occasionally quite immature herrings may be destroyed by this mode of fishing, the evidence does not point to the destruction being unnecessarily wasteful or injurious to the permanence of the supply of herrings in the loch. Such results are incident to all modes of fishing; and the almost unprecedented abundance of herrings in Loch Fyne during the last two seasons shows that the operation of the seine-net in past years has not had the injurious effects on the permanence of the supply that have sometimes been attributed to it.

The Rate of Growth of Plaice.

In the present Report Mr. H. Dannevig describes the results of an enquiry into the rate of growth of the plaice, based upon measurements of a large number of specimens of different sizes captured at various periods of the year. It is shown that the average growth of the plaice is about three inches each year, so that at the end of the first year it attains a length of three inches, in the second year an average length of six and a quarter inches, and in the third year a length of nine and a quarter inches. It was also found that growth is practically arrested during the winter months, the fishes increasing in size chiefly from May to October.

On the Natural History of the Herring.

In the present Report Mr. Kyle gives an account of the prolonged and laborious investigations of Professor Heincke, of the

Biological Institute, Heligoland, into the natural history of the herring, and especially into the question of the races and varieties of the herrings which frequent the seas of Western Europe.

We have the honour to be,

Your Lordship's most obedient Servants,

ANGUS SUTHERLAND, *Chairman*
D. CRAWFORD, *Deputy-Chairman.*
D'ARCY W. THOMPSON.
J. RITCHIE WELCH.
W. R. DUGUID.
ARCHIBALD JAMESON.
L. MILLOY.

WM. C. ROBERTSON, *Secretary.*

SCIENTIFIC REPORTS.

I. REPORT ON THE TRAWLING EXPERIMENTS OF THE "GARLAND," AND ON THE FISHERY STATISTICS RELATING THERETO. (PLATE I.)

INTRODUCTORY.

During the year trawling operations of the "Garland" were conducted in the Moray Firth, the Firth of Clyde, and Aberdeen Bay. The number of hauls of the trawl made in these areas was 130, of which 56 were made in the Moray Firth in May, June, October, and November; 66 in the Firth of Clyde and Loch Fyne in August, September, and December; and 8 in Aberdeen Bay in April and May. The work at each station consists in (1) trawling along a selected line for a specified distance, all the fish caught being enumerated, measured, and recorded; (2) observations on the temperature, salinity, and transparency of the water, on the condition of the weather, &c.; (3) the determination of the invertebrate fauna caught in the trawl-net; (4) the determination of the pelagic fauna floating in the water. The Tables relating to the chief of these investigations will be found appended to this Report. In addition, special observations were made on the occurrence and distribution of pelagic fish eggs and larvæ in Loch Fyne, and on the distribution of immature and spawning fishes.

The "Garland" was also employed in the spring in procuring adult plaice for the sea-fish hatchery at Dunbar, and in connection with enquiries into the herring fishing in Loch Fyne.

The fishery statistics which have been collected in the districts of the Moray Firth in connection with the trawling experiments there, and which show the quantities of the various kinds of fish caught by line fishermen within the closed waters in each month of the year and for the whole year, are appended to this Report, and are discussed below. These statistics were collected by the Fishery Officers of the respective districts, or by their correspondents. The trawling records were made by Mr. F. G. Pearcey, the naturalist on board the "Garland."

1. The Trawling Investigations in the Moray Firth.

The means taken to ascertain the influence of the closure of the Moray Firth to beam trawlers with respect to the abundance of the food fishes within it have consisted, first, of trawling observations of the "Garland" at the sixteen stations, offshore and inshore; and, secondly, the collection of special statistics around the coast of the firth to show the quantities of fish caught within the closed area by line fishermen in each month of the year, and the number of "shots" of the lines by which these fishes were captured. During last year the trawling investigations were made in May, June, October, and November. The work in the latter months was much interrupted by stormy weather, many of the stations lying at a considerable distance from shore, where the "Garland" requires fairly settled weather in order to be able to carry on the work. The details of the various hauls will be found in the Tables appended (Table C, A.).

The average numbers of the various kinds of flat-fishes caught per haul of the net are as follows:—

Station.	Plaice.	Lemon Soles.	Witches.	Common Dab.	L. Rough Dab.	Turbot.	Brill.	Total.
1	25·3	0·3	...	124·0	...	...	...	149·7
2	11·0	2·3	2·3	17·4	5·0	...	...	38·0
3	23·3	4·0	...	4·3	...	...	...	31·7
4	97·3	1·0	...	264·3	...	...	...	362·7
5	37·7	3·3	0·3	188·7	3·0	...	...	233·0
6	36·7	1·0	...	116·3	...	0·3	...	154·3
7	...	5·0	3·0	123·0	24·3	...	...	155·3
8	1·3	5·0	13·7	243·0	48·0	...	...	311·0
9	1·7	5·0	28·7	227·7	52·7	...	...	315·7
10	2·0	12·7	4·3	111·7	61·7	...	...	192·3
11	3·5	9·0	...	98·0	1·5	...	...	112·0
12	4·5	12·0	...	57·5	...	...	...	74·0
13	10·0	10·5	...	24·0	...	0·5	...	45·0
14	6·5	16·5	...	31·5	8·5	...	1·0	64·0
15	4·5	10·0	...	100·0	6·5	...	...	121·0
16	...	...	1·0	96·5	92·5	...	...	190·0

When compared with the hauls made in June and November in the previous year, these figures show that the average for flat-fishes in the closed waters generally rose from 149·0 to 167·7 per haul. The increase was confined to dabs. Common dabs increased from an average per haul of 100·2 in 1897 to an average of 120·9 in 1898. Long rough dabs increased from an average per haul of 18·8 to 19·1. The average per haul of plaice declined from 19·7 to 18·3, and the average of lemon soles from 6·3 to 5·4. Witches also showed a trifling decline—viz., from 4 to 3·8. Among round-fishes the average per haul for the whole area was 48·8, as compared with 32·8 in the preceding year, the increase being principally in gurnards. The trawling investigations of the "Garland" in the closed waters of the Moray Firth are not yet sufficient in amount or in time to enable any definite conclusion to be drawn as to the results of the closure.

The special statistics of the fish caught by line fishermen in the closed area of the Moray Firth, and landed on the contiguous coasts, have been collected for the past five years. The total quantities and the average per "shot" of the line for each year in the various districts are as follows:—

District.	1894.		1895.		1896.		1897.		1898.	
	Cwts.	Average.	Cwts.	Average.	Cwts	Average	Cwts.	Average.	Cwts.	Average.
Wick,	19,008	2·47	23,009	4·03	31,556	5·40	44,258	6·16	31,383	6·49
Lybster,	4,408	4·91	3,977	3·77	4,241	2·87	7,118	4·22	4,438	3·26
Helmsdale,	15,826	3·52	16,669	4·15	18,360	4·71	17,148	4·93	13,143	3·84
Cromarty,	21,346	3·07	19,193	2·93	15,317	2·51	14,736	2·48	12,428	2·065
Findhorn,	60,074	4·04	68,761	4·86	63,521	4·46	46,694	2·66	30,770	2·088
Buckie,	48,540	4·21	50,489	4·66	57,450	5·05	50,067	4·77	41,102	4·24
Banff,	49,292	2·94	76 491	4·77	66,471	3·82	61,329	3·70	36,057	2·13
Total,	218,494	3·05	258,589	4·43	256,916	4·26	241,350	3·83	169,321	3·244

These figures refer exclusively to the quantities of fish caught by line in the closed waters of the Moray Firth, and it is interesting to compare them with the total quantities of the same kinds of fish landed in each district, and caught by line both without and within the closed area. Thus, excluding herrings, sprats, and mackerel, which are not comprised in the special statistics referred to, the total quantities, in cwts., of white fish landed in each district in 1898 were as follows, the gross quantity amounting to 207,318 cwts.:—

Wick.	Lybster.	Helmsdale.	Cromarty.	Findhorn.	Buckie.	Banff.
67,791.	4,438.	13,143.	12,428.	30,857.	42,092.	36,569.

When these totals are compared with those given in the Table, it will be seen that a very large proportion of the line-caught fish landed in those districts were obtained from the Moray Firth—namely, 169,321 cwts. out of a total of 207,318 cwts. In three of the seven districts comprising the coasts of the Moray Firth—namely, Lybster, Helmsdale, and Cromarty—all the fish which were landed were captured within the closed waters. In the other districts the proportion of such fish is very considerable. Thus, in the Banff district only 512 cwts. of the 36,569 cwts. landed were caught beyond the limits of the firth. In the Findhorn district, of 30,857 cwts. landed, all but 87 cwts. were obtained from the Moray Firth. Of 42,092 cwts. landed in the Buckie district, 41,102 cwts. were caught in the Moray Firth. In the Wick district, which comprises only a small part of the coast of the Moray Firth, nearly half of the fish landed were obtained from the closed waters—namely, 31,383 cwts. out of a total quantity of 67,791 cwts.

With respect to the fluctuations in the quantities captured by line in the Moray Firth in the various years, it will be noticed from the Table that the gross quantity taken in 1898 is less than in any of the previous years, and that the average catch per "shot" of the lines is also smaller than in any year since 1894. The decrease in the quantity last year, as compared with 1897, amounted to no less than 72,029 cwts.; as compared with 1896, the figures show a falling-off to the extent of 87,595 cwts., while it is lessby 89,268 cwts. than the quantity landed in 1895. The average catch per "shot" fell from 4·43 cwts. in 1895, 4·26 cwts. in 1896, and 3·83 cwts. in 1897, to 3·244 cwts. in 1898. It might be supposed that this large diminution in the quantity of fish caught by line in the Moray Firth during the last year or two was owing to special causes, such as the operation of foreign trawlers which have been working there, sometimes in considerable numbers; and it is probable that this conclusion would be to some extent true. But an examination of the statistics of the fish caught by line on the whole of the East Coast, and, indeed, around the whole coast of Scotland, shows that the falling-off has not been peculiar to the Moray Firth, but was general. Thus, while in 1897 the total quantity of line-caught fish landed on the East Coast amounted to 959,566 cwts., it was only 686,694 cwts. last year—a decrease of 272,872 cwts. The figures for the whole coast of Scotland are 1,416,237 cwts. for 1897 and 1,058,993 cwts. for 1898. The diminution referred to was common to all the districts around the Moray Firth, but in different degrees. It was most marked in the Banff district, in which the total quantity landed from the closed waters amounted to 36,057 cwts., as compared with 61,329 cwts. in the previous year. In Lybster district the total fell from 7,118 cwts. in 1897 to 4438 cwts. in 1898; in the Buckie district the decrease was from 50,067 cwts. in the former year to 41,102 cwts. in the latter; in the Helmsdale and Cromarty districts the diminution was less marked. The diminution in the average catch per "shot" was also shared among the several districts, with one exception—namely, Wick, where a slight rise is indicated, although the total quantity was less. In the Banff district the average catch per "shot" fell from 3·7 cwts. in 1897 to 2·13 cwts. last year.

With respect to the various kinds of fish caught by line within the closed waters of the Moray Firth, the quantities and the average catch per "shot" of the line for each of the five years are given in the following Table:—

FISH.	1894.		1895.		1896.		1897.		1898.	
	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.	Cwts.	Av'rage.
Cod - - - - -	32,571	0·52	47,646	0·81	64,663	1·07	79,731	1·26	56,208	1·07
Ling - - - - -	2,169	0·035	2,937	0·005	3,868	0·062	3,544	0·056	2,567	0·049
Torsk - - - - -	25	0·002	24	—	94	—	25	—	43	—
Saithe - - - - -	6,120	0·09	5,083	0·087	10,636	0·17	11,761	0·18	14,881	0·28
Haddock - - - - -	153,529	2·47	178,370	3·056	156,703	2·6	126,031	2·004	81,098	1·554
Whiting - - - -	5,845	0·094	5,114	0·087	4,836	0·08	3,319	0·052	1,535	0·029
Turbot - - - - -	5	—	—	—	15	—	16	—	13	—
Halibut - - - - -	254	0·004	403	0·007	691	0·011	707	0·011	730	0·013
Lemon Sole - - - -	—	—	—	—	19	—	14	—	1	—
'Flounder, Plaice, and Brill'*	5,477	0·088	5,765	0·09	3,402	0·056	3,978	0·063	3,425	0·065
Conger - - - - -	1,244	0·02	777	0·013	823	0·013	1,533	0·024	826	0·015
Skates - - - - -	3,281	0·053	3,014	0·051	3,683	0·061	3,999	0·063	3,273	0·062
Other kinds of White Fish	7,976	0·128	9,456	0·16	7,483	0·12	6,663	0·105	4,574	0·087

* The fish included under this head comprise, for the most part, plaice and dabs.

It is obvious from this Table that the great bulk of the fish caught by line within the whole area consists of cod and haddock, which together make up about four-fifths of the quantity landed last year. As in previous years, the greater proportion of haddocks was taken on the south coast, and landed in the districts of Banff, Buckie, and Findhorn; in the districts of Wick, Lybster, and Helmsdale the quantity of cod exceeded the quantity of haddocks. Ling, conger, torsk, and halibut were caught in comparatively small quantities.

It is to be noted that the quantity of flat-fishes caught by line in the Moray Firth is small. Last year the total weight of the halibut, turbot, plaice, flounders, and all other varieties, did not exceed 4169 cwts. Only 13 cwts. of turbot and 1 cwt. of lemon soles were obtained, the quantity, of halibut was 730 cwts., while 3425 cwts. of "flounders, plaice, and brill"—which consisted chiefly of plaice and dabs—were taken. The quantities of flat-fishes landed in each of the years and the percentages of the total are as follows:—

	1894.	1895.	1896.	1897.	1898.
Cwts.	5736	6170	4127	4715	4169
Percentage of Total Catch, - -	2·6	2·3	1·6	1·9	2·5

It will be noticed that although the total quantity slightly diminished in 1898, the percentage was increased; in other words, the diminution of flat-fishes was less marked than the diminution of round-fishes. The quantity of turbot, lemon soles, and "flounders, plaice, and brill," decreased as compared with the previous year, while there was a slight increase in the take of halibut.

Turning to the figures referring to the round-fishes, it will be seen that, with the exception of saithe, all kinds were caught last year in diminished numbers. The decrease in cod and in haddocks is especially noteworthy. The quantity of cod--which had been increasing each year from 1894 to 1897—fell in 1898 to 56,208 cwts., as compared with 79,731 cwts. in the previous year—a decrease of 23,523 cwts. The falling-off, which was common to all the districts except Cromarty, where a slight increase took place, was most marked in the Wick district, the total there declining from 29,871 cwts. to 15,633 cwts., or little more than half. The average weight of cod taken per "shot" of the lines also diminished in most districts, but not in all. The averages for each district in each of the years are as follows:—

District.	1894.	1895.	1896.	1897.	1898.
Wick, - -	0·99	1·83	3·22	4·16	3·23
Lybster, - -	1·92	1·79	1·71	2·47	1·89
Helmsdale, -	0·75	1·31	2·01	2·39	1·90
Cromarty, -	0·59	0·617	0·74	0·61	0·63
Findhorn, -	0·48	0·75	0·85	0·52	0·55
Buckie, - -	0·55	1·0	1·3	1·68	1·34
Banff, - -	0·13	0·2	0·22	0·41	0·53

The diminution in the quantity of haddocks landed from the Moray Firth is still more striking; the figures indeed show how great are the fluctuations in the abundance of this fish from year to year. In 1894 the quantity of haddocks caught by line in the closed waters was 153,529 cwts.; in 1895 it rose to 178,370 cwts., and since then it has progressively declined to 156,703 cwts. in 1896, to 126,031 cwts. in 1897, and to 81,098 cwts. last year, or to less than half the quantity landed in 1895. The decrease last year as compared with the previous year amounted to nearly 45,000 cwts., and it was common to all the districts, being, however, most marked in the districts of Banff, Findhorn, and Buckie. The quantity landed at Banff fell from 46,782 cwts. to 23,637 cwts.; at Findhorn the decrease was from 33,860 cwts. to 19,772 cwts. The average per "shot" also fell from 2·0 cwts. in 1897 to 1·55 cwts. last year; and the diminution of the average was also common to all the districts except Wick, where a slight increase was experienced. The figures are as follows:—

District.	1894.	1895.	1896.	1897.	1898.
Wick, - -	0·54	0·508	0·22	0·19	0·27
Lybster, - -	1·63	1·29	0·69	1·028	0·77
Helmsdale, -	2·16	2·11	2·2	1·59	1·33
Cromarty, -	2·18	1·96	1·51	1·54	1·10
Findhorn, -	3·31	3·73	3·32	1·92	1·34
Buckie, - -	3·178	3·19	3·16	2·62	2·49
Banff, - -	2·47	4·07	3·06	2·82	1·93

The next most abundant line-caught fish is the saithe or coal-fish, and it occupies a peculiar position in the returns, inasmuch as it is the only round-fish which shows a substantial increase in the quantity caught in 1898, compared with the previous years. In 1894 the quantity taken from the closed waters by line fishermen was 6120 cwts.; in the following year the total was 5083 cwts., since which period there has been a gradual rise to 10,636 cwts. in 1896, 11,761 cwts. in 1897, and to 14,881 cwts. in 1898. The average weight caught per "shot" has also increased from 0·08 cwt. in 1895 to 0·17 cwt. in 1896, 0·18 cwt. in 1897, and to 0·28 cwt. last year. The quantity of saithe has therefore increased just as haddock has diminished. Comparatively few saithe are caught by the trawl. There was a general increase in the quantity caught by line last year around the coast.

During the five years there has been a continual decrease in the quantity of whitings captured in the closed waters, and likewise a continuous decrease in the average per "shot" of the line. In 1894 the quantity amounted to 5845 cwts., and the average per "shot" to 0·09 cwt. Last year the weight landed had fallen to 1535 cwts., and the average to 0·029 cwt.; in 1897 they were, respectively, 3319 cwts. and 0·052 cwt. The decrease was common to all the districts.

The quantity of conger landed in 1898 was somewhat less than in the previous year, as was also the average per "shot." There was also a diminution in the total quantity of skates landed, but the average quantity caught per "shot" of the lines remained about the same as in the previous year; the figures for the two years are respectively 3999 cwts. and 3273 cwts., and the average 0·063 and 0·062. Of "other kinds of white fish" caught by line, besides those specially mentioned in the Tables, the falling-off in quantity amounted to over 2000 cwts., and the average per "shot" likewise fell from 0·105 cwt. to 0·087 cwt.

When we compare the fluctuations in the quantities of the fish caught by line in the Moray Firth with the statistics referring to the whole East Coast, and the whole of Scotland, we find that the decrease has been general. It has been shown that in the Moray Firth the diminution was for the most part in haddocks and cod; so also there was a very large decrease in the quantities of these fishes landed elsewhere in Scotland. The quantity of cod landed on the East Coast of Scotland amounted in 1897 to 304,303 cwts., while last year it reached only 263,838 cwts., or a falling-off of 40,465 cwts. The corresponding quantities for the whole of Scotland were 461,339 cwts. and 390,589 cwts., a decrease of over 70,000 cwts. So also with haddocks—in 1897 456,062 cwts. of haddocks were landed on the East Coast, as compared with 240,306 cwts. last year; on the whole coast of Scotland 515,927 cwts. were landed in 1897, while in 1898 the quantity did not gross more than 287,120 cwts., or not very much more than half of the total in the preceding year. The same observation applies to the other species enumerated in the statistics; that is to say, where a falling-off occurred in the Moray Firth—of ling, whitings, conger, halibut, skate, and "other kinds of white fish"—it also occurred at other parts of the coast. In like manner, the increase in the quantity of saithe caught in the Moray Firth was associated with an increased catch of that fish at other parts of the coast: the quantity landed on the East Coast in 1897 was 33,448 cwts., while last year it rose to 39,981 cwts. It is thus evident that the fluctuations in the quantities of fish taken in the Moray Firth last year were not due to causes peculiar to that area, since similar fluctuations were common to the whole coast.

If we now consider the operations of the boats which prosecuted line-fishing in the Moray Firth, we shall find that there has been a very considerable falling-off in the number of "shots" or visits to the fishing grounds. The figures for each district are given in the following Table:—

Year.	Wick.		Lybster.		Helmsdale.		Cromarty.		Findhorn.		Buckie.		Banff.	
	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.	Large.	Small.
1894	396	7,295	22	876	199	4,288	83	6,871	3,132	10,544	2,422	9,104	828	15,888
1895	1,553	4,155	90	965	366	3,614	12	6,561	2,653	11,481	1,929	8,907	1,107	14,930
1896	2,774	3,063	208	1,266	363	3,535	13	6,078	3,772	10,450	2,935	8,420	1,850	15,534
1897	3,911	3,266	264	1,440	466	3,010	3	5,918	4,738	12,810	2,537	7,943	2,120	14,449
1898	1,918	2,846	148	1,211	448	2,971	2	6,015	4,148	10,577	1,958	7,727	1,708	10,506

It will be observed that the total number of "shots" made in each district was considerably less in 1898 than in the preceding year. In all the districts except Cromarty—in which a slight increase occurred—the number of "shots" of the small-line boats diminished; and in each district the number of "shots" of the great-line boats was also less than in 1897. The total number of "shots" of the line made in the closed waters last year was 52,183, as compared with a total of 62,875 in 1897, or a decline of more than 10,000; the "shots" made by the great-line boats were 3709 and those made by the small boats were 6983 less than in the year before.

2. The Firth of Clyde.

During last year the stations in the Firth of Clyde were examined twice in August and September and in December. The stations in Loch Fyne (XIII.—XVII.) were trawled in August and December, and a number of hauls were made along selected lines to determine the distribution of spawning fish and of immature fish at various parts of the closed waters. The results of these various hauls will be found in the Tables appended to this Report.

Comparison of the results obtained in the various years in which trawling investigations were made in the Firth of Clyde shows that, taking all the stations together and all kinds of fish, the average number per haul of the net has generally increased over the period comprised, although considerable fluctuations occurred in different years. In 1888 the general average for the closed area was 109·7 per haul; in 1890 it was 99·5 per haul; in 1895 it was 113·4; in 1896 it was 120·7; in 1897, 112·5, and last year the average rose to 189·3 per haul. The averages for the two groups of flat-fishes and round-fishes show that the rise in flat-fishes has been fairly steady. The averages are as follows:—

	1888.	1890.	1895.	1896.	1897.	1898.
Flat-Fishes, - -	61·2	61·1	64·7	75·5	84·8	94·7
Round-Fishes, - -	44·7	35·1	43·6	35·1	27·8	49·9

An examination of the statistics relating to the different kinds of flat-fishes captured shows that the increase of flat-fishes over the period has been due to an increase in witches and long rough dabs; the averages for plaice and lemon soles, neither of which are abundant in the area, have, on the whole, somewhat diminished. The figures are as follow:—

	1888.	1890.	1895.	1896.	1897.	1898.
Plaice, - - - - -	5·3	3·4	2·3	2·1	2·5	3·0
Lemon Soles, - -	7·4	5·6	2·8	7·2	5·3	4·1
Witches, - - - -	12·7	19·7	25·7	35·9	47·1	36·5
Common Dabs, - -	23·8	13·8	14·0	15·7	12·7	13·6
Long Rough Dabs, -	5·3	17·7	20·0	15·1	16·8	37·3

But, as stated in previous Reports, inferences as to changes in the abundance or relative proportions of the fishes in the closed area of the Clyde must be provisional, inasmuch as the observations comprise only ten series of hauls at the various stations. It will require much more extended observations both in the Firth of Clyde and in the Moray Firth before conclusions can be drawn with any degree of certainty as to the results of the closure. In the Firth of Forth and St. Andrews Bay it was found, after ten years' investigation, that the most important change that occurred in the relative abundance of the food fishes in the closed waters was a diminution of the more valuable flat-fishes, plaice and lemon soles, which spawn offshore and not in the closed waters, and an increase in the comparatively worthless dabs, which spawn copiously in the closed waters; and the figures referring to these species are considerable, as shown in the accompanying Table:—

	No. of Hauls.	Plaice and Lemon Soles Caught.	Dabs Caught.	Total.
1st Period— 1886–90, -	325	29,869	19,825	49,694
2nd Period— 1891–95, -	466	28,044	29,483	57,527
	791	57,913	49,308	107,221

It will be observed that in the second period, while 141 more hauls of the trawl were made within the closed waters than in the first period, the number of plaice and lemon soles caught was less by nearly 2000, and the number of dabs caught was greater by nearly 10,000. The same result was found whether the whole year was contrasted in the two periods, or the cold months against the cold months, or the warm months against the warm months.

		Plaice and Lemon Soles.			Dabs.		
	No. of Hauls.	No. Caught.	Average per Haul.	Percentage of Total.	No. Caught.	Average per Haul.	Percentage of Total.
Six Cold Months: November—April.							
1st Period— 1886–90,	128	6346	49·6	69·3	2808	21·9	30·7
2nd Period— 1891–95,	238	8735	36·7	52·0	8066	33·9	48·0
Six Warm Months: May—October.							
1st Period— 1886–90,	197	23,523	119·4	58·0	17,017	86·3	42·0
2nd Period— 1891–95,	228	19,309	84·7	47·4	21,417	93·9	52·6

The number and averages for each species show the same change—viz., an increase in dabs, and a diminution in plaice and lemon soles:—

Cold Months: November—April.									
	No. of Hauls.	Plaice.		Lemon Soles.		Common Dabs.		Long Rough Dabs.	
		No.	Aver.	No.	Aver.	No.	Aver.	No.	Aver.
1st Period—1886-90,	128	5580	43·6	766	6·0	1530	11·9	1278	9·9
2nd Period—1891-95,	238	7591	31·9	1144	4·8	4611	19·3	3455	14·5
Warm Months: May—October.									
1st Period—1886-90,	197	19,844	100·7	3679	18·7	14,237	72·2	2780	14·1
2nd Period—1891-95,	228	15,362	67·3	3947	17·3	16,878	74·0	4539	19·9

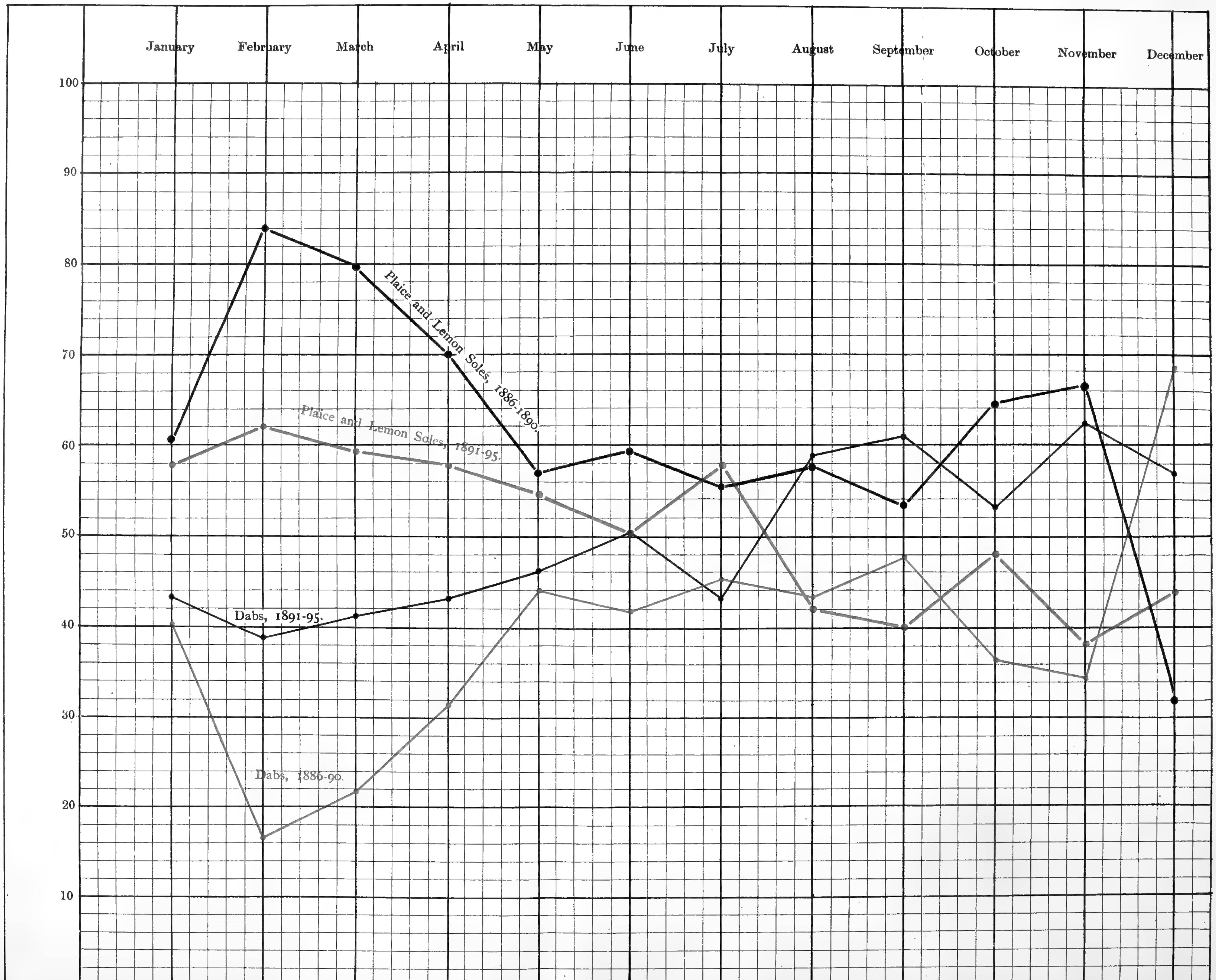
The change in the relative abundance of the offshore-spawning plaice and lemon soles, and of the inshore-spawning dabs was common to almost every month of the year, as the following analysis shows :—

Month.	Plaice and Lemon Soles.						Dabs.					
	1st Period—1886-90.			2nd Period—1891-95.			1st Period—1886-90.			2nd Period—1891-95.		
	No. of Hauls.	Average.	Per Cent.	No. of Hauls.	Average.	Per Cent.	No. of Hauls.	Average.	Per Cent.	No. of Hauls.	Average.	Per Cent.
Jan.,	10	14·6	60·3	31	30·7	56·6	10	9·6	39·7	31	23·5	43·4
Feb.,	14	46·8	84·2	50	32·2	61·2	14	8·8	15·8	50	20·4	38·8
Mar.,	26	63·1	79·7	38	45·7	58·3	26	16·1	20·3	38	32·6	41·7
April,	25	70·8	69·9	40	53·4	56·8	25	30·6	30·2	40	40·7	43·2
May,	23	68·8	56·8	39	62·1	53·9	23	52·4	43·2	39	53·0	46·1
June,	40	110·9	59·3	40	95·0	49·6	40	76·0	40·7	40	96·2	50·4
Jnly,	21	93·5	55·8	38	105·3	57·2	21	74·1	44·2	38	78·6	42·8
Aug.,	44	193·9	57·6	34	82·6	41·3	44	142·6	42·4	34	117·4	58·7
Sept.,	30	109·8	53·5	37	91·4	39·0	30	95·6	46·5	37	142·4	61·0
Oct.,	39	95·2	64·2	40	72·2	47·2	39	53·0	35·8	40	81·0	52·8
Nov.,	31	62·5	66·2	37	35·2	37·8	31	31·9	33·8	37	57·8	62·2
Dec.,	22	8·9	32·0	42	23·6	43·2	22	18·9	68·0	42	31·1	58·8

It may be also noticed from this Table that in one month in the two periods, namely June, the same number of hauls (40) were made, and that in October of the two periods the number of hauls was nearly equal, 39 in

Showing the percentage proportions of the offshore-spawning Plaice and Lemon Soles, and the inshore-spawning Dabs, in the *Closed Waters* of the Firth of Forth and St. Andrews Bay, in each month of the two quinquennial periods—1886-1890 and 1891-1895.

PLATE I.



the first period, and 40 in the second periods; and in both cases the actual number of plaice and lemon soles captured in the second period was diminished, while the actual number of dabs increased—the figures being: for June, 4435 of the former and 3041 of the latter in the first period; and for the second period 3800 and 3848 respectively. In October, in the first period, the numbers are 3713 plaice and lemon soles, and 2069 dabs; in the second period, with an additional haul, the figures are 2888 and 3239 respectively. An examination of the percentages in the above Tables shows that, while each hundred of flat-fishes caught in the closed waters in the colder months in the first period of five years consisted of 69 plaice and lemon soles, and 31 dabs; each hundred in the corresponding months of the second period of five years consisted of 52 plaice and lemon soles, and 48 dabs. In the warmer months of the first period each hundred consisted of 58 plaice and lemon soles, and 42 dabs; while each hundred in the same months of the second period consisted of 47 plaice and lemon soles, and 53 dabs. The inshore-spawning dabs, therefore, to a very large extent supplanted the offshore-spawning plaice and lemon soles in the closed waters.

T. WEMYSS FULTON,
Scientific Superintendent

TABLE A.—Showing Summary of Fish taken by the 'Garland' in Trawling Operations in 1898.

Station and Date.	Flat-Fish.									Round-Fish.							
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.	Skate.	Other Fish.	Total.
Moray Firth—																	
Station I.																	
May 24, .	23	1	.	16	.	.	.	.	40	.	.	.	13	13	4	.	57
June 7, .	8	.	.	20	.	.	.	.	28	1	.	.	19	20	.	.	48
Oct. 11, .	45	.	.	336	.	.	.	.	381	.	1	.	83	84	3	3	471
	76	1	.	372	.	.	.	.	449	1	1	.	115	117	7	3	576
Station II.																	
May 24, .	15	.	2	16	7	.	.	.	40	.	24	2	1	27	1	3	71
June 7, .	17	.	2	25	8	.	.	.	52	1	.	.	16	17	.	5	74
Oct. 11, .	1	7	3	11	.	.	.	.	22	.	5	2	10	17	3	2	44
	33	7	7	52	15	.	.	.	114	1	29	4	27	61	4	10	189
Station III.																	
May 26, .	40	7	.	10	.	.	.	.	57	3	1	.	1	5	.	.	62
June 6, .	8	.	.	1	.	.	.	.	9	6	3	.	1	10	3	.	22
Oct. 12, .	22	5	.	2	.	.	.	.	29	3	.	.	.	3	.	.	32
	70	12	.	13	.	.	.	.	95	12	4	.	2	18	3	.	116
Station IV.																	
May 25, .	69	1	.	32	.	.	.	.	102	.	2	.	39	41	.	.	143
June 14, .	27	1	.	12	.	.	.	.	40	.	.	.	2	2	2	.	44
Oct. 13, .	196	1	.	749	.	.	.	.	946	.	.	.	47	47	2	2	997
	292	3	.	793	.	.	.	.	1088	.	2	.	88	90	4	2	1184
Station V.																	
May 25, .	73	4	1	202	9	.	.	.	289	.	4	1	51	56	.	1	346
June 14, .	3	1	.	13	.	.	.	.	17	.	.	2	16	18	.	1	36
Oct. 13, .	37	5	.	351	.	.	.	.	393	2	1	.	23	26	.	1	420
	113	10	1	566	9	.	.	.	699	2	5	3	90	100	.	3	802
Station VI.																	
May 25, .	17	1	.	20	.	.	.	.	38	.	4	.	4	8	1	.	47
June 14, .	11	.	.	16	.	.	.	.	27	.	4	.	39	43	3	.	73
Nov. 19, .	82	2	.	313	.	.	1	.	398	.	1	.	1	2	4	6	410
	110	3	.	349	.	.	1	.	463	.	9	.	44	53	8	6	530

TABLE A.—Showing Summary of Fish taken by the 'Garland' in Trawling Operations in 1898—*continued.*

Station and Date.	Flat-Fish.									Round-Fish.					Skate.	Other Fish.	Total.
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.			
MORAY FIRTH—*continued.*																	
Station VII.																	
May 27, .	.	1	3	119	40	.	.	.	163	1	3	3	18	25	.	5	193
June 15, .	.	10	1	76	26	.	.	.	113	.	1	.	18	19	1	2	135
Nov. 18, .	.	4	5	174	7	.	.	.	190	.	6	3	5	14	1	5	210
	.	15	9	369	73	.	.	.	466	1	10	6	41	58	2	12	538
Station VIII.																	
May 27, .	2	1	6	162	.	.	.	.	171	1	114	30	28	173	.	9	353
June 15, .	1	5	5	87	60	.	.	.	158	.	4	1	19	24	.	6	188
Nov. 18, .	1	9	30	480	84	.	.	.	604	.	20	30	109	159	.	17	780
	4	15	41	729	144	.	.	.	933	1	138	61	156	356	.	32	1321
Station IX.																	
May 28, .	1	5	3	75	64	.	.	.	148	.	40	5	17	62	1	1	12
June 16, .	3	6	4	77	.	.	.	.	90	.	2	.	21	23	3	2	118
Nov. 18, .	1	4	79	531	94	.	.	.	709	.	5	48	62	115	2	11	837
	5	15	86	683	158	.	.	.	947	.	47	53	100	200	6	14	1167
Station X.																	
May 28, .	.	18	1	93	84	.	.	.	196	5	7	5	14	31	1	47	275
June 16, .	1	9	1	73	53	.	.	.	137	1	6	1	15	23	1	4	165
Nov. 17, .	5	11	11	169	48	.	.	.	244	5	42	16	43	106	4	5	359
	6	38	13	335	185	.	.	.	577	11	55	22	72	160	6	56	799
Station XI.																	
May 19, .	2	2	.	82	1	.	.	.	87	1	87	.	21	109	.	9	205
June 9, .	5	16	.	114	2	.	.	.	137	4	.	2	72	78	.	27	242
	7	18	.	196	3	.	.	.	224	5	87	2	93	187	.	36	447
Station XII.																	
May 18, .	3	11	.	47	.	.	.	.	61	5	1	.	2	8	.	2	71
June 10, .	6	13	.	68	.	.	.	.	87	6	114	5	227	352	.	1	440
	9	24	.	115	.	.	.	.	148	11	115	5	229	360	.	3	511
Station XIII.																	
May 19, .	18	15	.	28	.	.	.	.	61	7	43	.	11	61	1	.	123
June 9, .	2	6	.	20	.	.	1	.	29	1	.	1	24	26	1	1	57
	20	21	.	48	.	.	1	.	90	8	43	1	35	87	2	1	180

TABLE A.—Showing Summary of Fish taken by the 'Garland' in Trawling Operations in 1898—*continued.*

Station and Date.	Flat-Fish.									Round-Fish.							
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.	Skate.	Other Fish.	Total.
Moray Firth—*continued.*																	
Station XIV.																	
May 20, .	7	19	.	40	9	.	.	.	75	4	13	.	17	34	2	4	115
June 9, .	6	14	.	23	8	.	.	2	53	1	8	2	11	22	.	1	76
	13	33	.	63	17	.	.	2	128	5	21	2	28	56	2	5	191
Station XV.																	
May 19, .	5	5	.	131	10	.	.	.	151	.	4	.	13	17	.	2	170
June 10, .	4	15	.	69	3	.	.	.	91	1	25	2	18	46	.	.	137
	9	20	.	200	13	.	.	.	242	1	29	2	31	63	.	2	307
Station XVI.																	
May 18, .	.	.	2	64	78	.	.	.	144	.	32	.	18	50	4	3	201
June 10, .	.	.	.	129	107	.	.	.	236	.	4	2	19	25	4	3	268
	.	.	2	193	185	.	.	.	380	.	36	2	37	75	8	6	469
Aberdeen Bay.																	
Station I.																	
April 27, .	35	.	.	14	.	.	.	.	49	.	.	.	.	.	.	.	49
Station II.																	
May 3, .	17	4	.	54	7	.	.	.	82	4	30	3	13	50	.	2	134
Station III.																	
May 4, .	18	1	.	72	3	1	.	.	95	3	74	10	1	88	.	1	184
Station IV.																	
May 4, .	22	1	.	99	4	.	.	.	126	3	10	4	.	17	.	.	143
Station V.																	
May 5, .	43	1	.	145	.	.	.	.	189	1	.	4	36	41	.	.	230

TABLE A.—Showing Summary of Fish taken by the 'Garland' in Trawling Operations in 1898—*continued.*

Station and Date.	Flat-Fish.									Round-Fish.					Skate.	Other Fish.	Total.
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.			
ABERDEEN BAY—*continued.*																	
Station VI.																	
May 5, .	17	1	.	14	3	.	.	.	35	.	8	20	37	65	1	.	101
Station VII.																	
May 5, .	5	1	.	10	.	.	.	.	16	2	4	17	2	25	2	.	43
FIRTH OF CLYDE.																	
Station I.																	
Aug. 25, .	.	10	.	69	2	.	.	.	81	2	5	2	28	37	37	34	189
Dec. 15, .	.	15	7	8	8	.	.	.	38	12	2	4	1	19	8	71	136
	.	25	7	77	10	.	.	.	119	14	7	6	29	56	45	105	325
Station II.																	
Aug. 24, .	1	.	.	9	4	.	.	.	14	.	.	.	1	1	.	1	16
Dec. 9, .	29	2	8	53	3	1	.	.	96	.	19	4	4	27	2	21	146
	30	2	8	62	7	1	.	.	110	..	19	4	5	28	2	22	162
Station III.																	
Aug. 24, .	2	8	57	.	87	.	.	.	154	.	14	11	7	32	1	83	270
Dec. 8, .	5	6	187	.	63	.	.	.	261	4	4	13	.	21	4	97	383
	7	14	244	.	150	.	.	.	415	4	18	24	7	53	5	180	653
Station IV.																	
Aug. 24, .	.	2	2	1	14	.	.	.	19	.	.	.	9	9	1	4	33
Dec. 8, .	.	2	20	.	5	.	.	.	27	1	10	9	.	20	2	31	80
	.	4	22	1	19	.	.	.	46	1	10	9	9	29	3	35	113
Station V.																	
Aug. 31, .	.	7	.	28	1	.	.	.	36	.	.	.	2	2	3	5	46
Dec. 14, .	.	4	4	9	5	.	.	.	22	.	4	1	2	7	4	3	36
	.	11	4	37	6	.	.	.	58	.	4	1	4	9	7	8	82

TABLE A.—SHOWING SUMMARY OF FISH TAKEN BY THE 'GARLAND' IN TRAWLING OPERATIONS IN 1898—*continued.*

Station and Date.	Flat-Fish.									Round-Fish.							
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total	Skate.	Other Fish.	Total.
FIRTH OF CLYDE—*continued.*																	
Station VI.																	
Aug. 25, .	.	11	.	13	.	.	1	.	25	1	.	.	27	28	24	11	88
Dec. 15, .	.	14	1	30	.	.	.	.	45	1	3	8	17	29	13	10	97
	.	25	1	43	.	.	1	.	70	2	3	8	44	57	37	21	185
Station VII.																	
Sept. 6, .	.	2	5	8	1	.	.	.	16	1	.	.	22	23	7	19	65
Jan. 17, '99,	.	.	4	.	.	.	.	.	4	.	.	2	1	3	.	106	113
	.	2	9	8	1	.	.	.	20	1	.	2	23	26	7	125	178
Station VIII.																	
Sept. 7, .	.	1	15	.	.	.	.	.	16	3	2	1	5	11	2	33	62
Dec. 17, .	.	.	37	1	.	.	.	.	38		9	4	194	208	11	55	312
	.	1	52	1	.	.	.	.	54	4	11	5	199	219	13	88	374
Station IX.																	
Aug. 31, .	.	2	21	.	5	.	.	.	28	2	2	1	408	413	12	29	482
Jan. 17, '99,	1	.	37	13	3	.	.	.	54	.	.	50	31	81	6	50	191
	1	2	58	13	8	.	.	.	82	2	2	51	439	494	18	79	673
Station X.																	
Aug. 25, .	.	4	.	17	.	.	.	.	21	.	.		26	26	8	3	58
Jan. 16, '99,	.	2	64	2	7	.	.	.	75	.	18	130	.	148	7	128	358
	.	6	64	19	7	.	.	.	96	.	18	130	26	174	15	131	416
Station XI.																	
Sept. 8, .	6	1	69	3	65	.	.	.	144	.	.	.	7	7	5	36	192
Jan. 24, '99,	22	7	69	62	82	.	.	1	243	.	1	2	30	33	1	11	288
	28	8	138	65	147	.	.	1	387	.	1	2	37	40	6	47	480
Station XII.																	
Aug. 30, .	4	.	162	1	136	.	.	.	303	2	.	.	1	3	3	15	324
Jan. 20, '99,	1	.	108	.	405	.	.	.	514	1	.	8	1	10	6	48	578
	5	.	270	1	541	.	.	.	817	3	.	8	2	13	9	63	902

TABLE A.—Showing Summary of Fish taken by the 'Garland' in Trawling Operations in 1898—*continued.*

Station and Date.	Flat-Fish.									Round-Fish.					Skate.	Other Fish.	Total.
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	Long Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.			
FIRTH OF CLYDE—*continued.*																	
Station XIII.																	
Aug. 23, .	25	1	19	8	92	.	.	.	145	2	.	1	20	23	2	4	174
Dec. 6, .	.	1	15	1	10	.	.	.	27	6	9	11	4	30	1	9	67
	25	2	34	9	102	.	.	.	172	8	9	12	24	53	3	13	241
Station XIV.																	
Aug. 22, .	7	.	40	8	116	.	.	.	171	2	1	1	17	21	.	5	197
Dec. 6, .	1	1	14	.	16	.	.	.	32	17	2	1	7	27	.	21	80
	8	1	54	8	132	.	.	.	203	19	3	2	24	48	.	26	277
Station XV.																	
Aug. 22, .	1	.	44	.	117	.	.	.	162	.	1	.	1	2	1	15	180
Dec. 6, .	2	.	77	.	46	.	.	.	125	4	2	3	2	11	.	3	139
	3	.	121	.	163	.	.	.	287	4	3	3	3	13	1	18	319
Station XVI.																	
Aug. 23, .	.	.	15	.	.	.	.	.	15	.	.	.	.	.	.	1	16
Dec. 7, .	.	.	12	.	4	.	.	.	16	.	.	.	.	.	.	1	17
	.	.	27	.	4	.	.	.	31	.	.	.	.	.	.	2	33
Station XVII.																	
Aug. 23, .	4	.	67	1	31	.	.	.	103	9	.	.	4	13	.	10	126
Dec. 7, .	.	.	12	.	5	.	1	.	18	.	.	.	.	.	.	5	23
	4	.	79	1	36	.	1	.	121	9	.	.	4	13	.	15	149

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

Station.	Flat-Fish.									Round-Fish.					Skate.	Other Fish.	Total.
	Plaice.	Lemon Soles.	Witch Soles.	Common Dabs.	L. Rough Dabs.	Flounders.	Turbot.	Brill.	Total.	Cod.	Haddocks.	Whitings.	Gurnards.	Total.			
I. *Moray Firth.*																	
I.	25·3	0·3	–	124·0	–	–	–	–	149·7	0·3	0·3	–	38·3	39·0	2·3	1·0	192·0
II.	11·0	2·3	2·3	17·4	5·0	–	–	–	38·0	0·3	9·7	1·3	9·0	20·3	1·3	3·3	63·0
III.	23·3	4·0	–	4·3	–	–	–	–	31·7	4·0	1·3	–	0·7	6·0	1·0	–	38·7
IV.	97·3	1·0	–	264·3	–	–	–	–	362·7	–	0·7	–	29·3	30·0	1·3	0·7	394·7
V.	37·7	3·3	0·3	188·7	3·0	–	–	–	233·0	0·7	1·7	1·0	30·0	33·3	–	1·0	267·3
VI.	36·7	1·0	–	116·3	–	–	0·3	–	154·3	–	3·0	–	14·7	17·7	2·7	2·0	176·7
VII.	–	5·0	3·0	123·0	24·3	–	–	–	155·3	0·3	3·3	2·0	13·7	19·3	0·7	4·0	179·3
VIII.	1·3	5·0	13·7	243·0	48·0	–	–	–	311·0	0·3	46·0	20·3	52·0	118·7	–	10·7	440·3
IX.	1·7	5·0	28·7	227·7	52·7	–	–	–	315·7	–	15·7	17·7	33·3	66·7	2·0	4·7	389·0
X.	2·0	12·7	4·3	111·7	61·7	–	–	–	192·3	3·7	18·3	7·3	24·0	53·3	2·0	18·7	266·3
XI.	3·5	9·0	–	98·0	1·5	–	–	–	112·0	2·5	43·5	1·0	46·5	93·5	–	18·0	223·5
XII.	4·5	12·0	–	57·5	–	–	–	–	74·0	5·5	57·5	2·5	114·5	180·0	–	1·5	255·5
XIII.	10·0	10·5	–	24·0	–	–	0·5	–	45·0	4·0	21·5	0·5	17·5	43·5	1·0	0·5	90·0
XIV.	6·5	16·5	–	31·5	8·5	–	–	1·0	64·0	2·5	10·5	1.0	14·0	28·0	1·0	2·5	95·5
XV.	4·5	10·0	–	100·0	6·5	–	–	–	121·0	0·5	14·5	1·0	15·5	31·5	–	1·0	153·5
XVI.	–	–	1·0	96·5	92·5	–	–	–	190·0	–	18·0	1·0	18·5	37·5	4·0	3·0	234·5
II. *Firth of Clyde.*																	
I.	–	12·5	3·5	38·5	5·0	–	–	–	59·5	7·0	3·5	3·0	14·5	28·0	22·5	52·5	162·5
II.	15·0	1·0	4·0	31·0	3·5	0·5	–	–	55·0	–	9·5	2·0	2·5	14·0	1·0	11·0	81·0
III.	3·5	7·0	122·0	–	75·0	–	–	–	207·5	2·0	9·0	12·0	3·5	26·5	2·5	90·0	326·5
IV.	–	2·0	11·0	0·5	9·5	–	–	–	23·0	0·5	5·0	4·5	4·5	14·5	1·5	17·5	56·5
V.	–	5·5	2·0	18·5	3·0	–	–	–	29·0	–	2·0	0·5	2·0	4·5	3·5	4·0	41·0
VI.	–	12·5	0·5	21·5	–	–	0·5	–	35·0	1·0	1·5	4·0	22·0	28·5	18·5	10·5	92·5
VII.	–	1·0	4·5	4·0	0·5	–	–	–	10·0	0·5	–	1·0	11·5	13·0	3·5	62·5	89·0
VIII.	–	0·5	26·0	0·5	–	–	–	–	27·0	2·0	5·5	2·5	99·5	109·5	6·5	44·0	187·0
IX.	0·5	1·0	29·0	6·5	4·0	–	–	–	41·0	1·0	1·0	25·5	219·5	247·0	9·0	39·5	336·5
X.	–	3·0	32·0	9·5	3·5	–	–	–	48·0	–	9·0	65·0	13·0	87·0	7·5	65·5	208·0
XI.	14·0	4·0	69·0	32·5	73·5	–	–	0·5	193·5	–	0·5	1·0	18·5	20·0	3·0	23·5	240·0
XII.	2·5		135·0	0·5	270·5	–	–	–	408·5	1·5	–	4·0	1·0	6·5	4·5	31·5	451·0

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—I. Moray Firth.

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station I. 1898. May 24. 4-5 p.m. to 6-0 p.m.	Common gurnards,	.	.	.	.	.	2	4	1	2	2	2	.	.	.	.	.	.	.	.	.	13
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	1	4
	Plaice,	.	.	3	2	4	.	.	.	.	.	1	2	4	2	1	.	.	2	.	2	23
	Common dabs,	.	1	4	4	3	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	16
	Lemon sole,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						57
June 7. 8-30 a.m. to 10-15 a.m.	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Common gurnards,	.	.	.	1	1	.	3	2	2	3	4	.	3	.	.	.	.	.	.	.	19
	Plaice,	.	1	.	.	.	1	.	.	.	.	.	1	1	1	.	.	1	1	1	.	8
	Common dabs,	.	5	7	5	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	20
																						48
Oct. 11. 12-14 p.m. to 2 p.m.	Anglers,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	1	3*
	Common gurnards,	.	18	.	5	21	16	17	.	3	.	2	1	.	.	.	.	.	.	.	.	83
	Thornback skate,	.	.	.	.	.	.	.	.	1	.	1	.	.	1	.	.	.	.	.	.	3
	Plaice,	.	.	.	.	.	1	3	5	2	6	8	3	4	7	3	.	.	1	2	.	45
	Common dabs,	.	28	80	108	39	49	20	6	2	1	2	.	.	1	.	.	.	.	.	.	336
	Haddock,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
																						471
Station II. May 24. 12-40 p.m. to 2-40 p.m.	Haddocks,	.	.	.	.	.	3	1	5	1	5	4	2	3	.	.	.	.	.	.	.	24
	Common gurnard,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1†
	Anglers,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	2
	Whitings,	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Butter-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‡
	Thornback skate,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	3	4	3	.	1	1	.	2	.	.	.	.	.	.	1	.	.	.	15
	Witch soles,	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	2
	Long rough dabs,	.	.	2	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Common dabs,	1	3	2	1	2	2	3	2	.	.	.	.	.	.	.	.	.	.	.	.	16
																						71
June 7. 11-20 a.m. to 1-0 p.m.	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1§
	Hake,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Gurnards,	.	.	1	.	3	2	2	3	4	1	.	.	.	.	.	.	.	.	.	.	16
	Angler,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	2‖
	Dragonets,	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Plaice,	.	.	1	.	3	2	4	3	2	1	.	1	.	.	.	.	.	.	.	.	17
	Witch soles,	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	2
	Long rough dabs,	.	2	3	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Common dabs,	.	2	9	6	2	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	25
																						74
Oct. 11. 9-30 a.m. to 11-10 a.m.	Haddocks,	.	.	.	.	.	.	4	1	.	.	.	.	.	.	.	.	.	.	.	.	5
	Whitings,	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	2
	Common gurnards,	.	7	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	Dragonets,	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	1	.	.	.	3
	Plaice,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon soles,	.	.	3	2	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Witch soles,	.	.	.	.	.	.	.	1	.	.	.	.	.	1	1	.	.	.	.	.	3
	Common dabs,	.	.	6	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
																						44

* One 28 inches. † 3 inches. ‡ 1 inch. § 30 inches. ‖ One 54 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—I. Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
Station III.																						
May 26. 10-0 a.m. to 11-45 a.m.	Cod,					1	2															3
	Haddock,																		1			1
	Common gurnard,									1												1
	Plaice,			1	1	1	2		2	10	8	7	3		2	1		1	1			40
	Lemon soles,					1			3	2					1							7
	Common dabs,			4	2	1	3															10
																						62
June 6. 2-20 p.m. to 3.20 p.m.	Cod,					2					1			1			2					6
	Haddocks,																3					3
	Gurnard,								1													1
	Thornback skate,																		1	1	1	3*
	Plaice,								2		1	1	2	1	1							8
	Common dab,							1														1
																						22
Oct. 12. 1-50 p.m. to 2-43 p.m.	Cod,								1								1				1	3†
	Plaice,							1		2	2	4	4	1	5	1	2					22
	Lemon soles,					1	1		1	2												5
	Common dabs,							1	1													2
																						32
Station IV.																						
May 25. 1-5 p.m. to 3-0 p.m.	Haddocks,												1	1								2
	Gurnards,			2		1	15		10	8	1	1	1									39
	Plaice,			18	26	3	3	2			5	2	5		3		1	1				69
	Lemon sole,							1														1
	Common dabs,		8	6	6	8	2	2														32
																						143
June 14. 1-55 p.m. to 3-40 p.m.	Gurnards,				1						1											2
	Thornback skate,													2								2
	Plaice,		1	1	9	7						1		2	1	1	1	1			2	27
	Lemon sole,		1																			1
	Common dabs,		5		3	2	2															12
																						44
Oct. 13. 10-30 a.m. to 12 20 p.m.	Anglers,								1												1	2‡
	Common gurnards,		3	11	13	1	7		10	2												47
	Plaice,					7	6	45	71	8	34			10	6		3		4	1	1	196§
	Lemon sole,											1										1
	Common dabs,	3	93	308	191	86	60	8														749
	Thornback skate,								1								1					2
																						997
Station V.																						
May 25. 9-20 a.m. to 11.5 a.m.	Haddocks,									2	1	1										4
	Whiting,						1															1
	Gurnards,		2	4	17	14		4	1	2	4		3									51
	Dragonet,					1																1
	Plaice,			7	24	22	3		1	6		4	1	1			1		1	1	1	73‖
	Common dabs,	2	23	89	47	22	17			1												¶202
	Witch sole,												1									1
	Lemon soles,				1			1		1		1										4
	Long rough dabs,		5	3	1																	9
																						346

* One 26 inches. † One 33 inches. ‡ One 37 inches. § One 27 inches. ‖ One 30 inches. ¶ One 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—I. Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
June 14. 10-25 a.m. to 12-10 p.m.	Gurnards,			5	5	3			2		1											16
	Angler,																				1	1*
	Whitings,								2													2
	Plaice,				2												1					3
	Lemon sole,											1										1
	Common dabs,		4	4	2	3																13
																						36
Oct. 13. 12-50 p.m. to 3-10 p.m.	Cod,								1				1									2
	Haddock.												1									1
	Angler,					1																1
	Common gurnards,		4	2	1	5	2	2	2	3	2											23
	Plaice,				2		5	5	8	2	2	2	7		2	2						37
	Lemon soles,								1		2		1	1								5
	Common dabs,		48	104	188	10		1														351
																						420
Station VI.																						
May 25. 3-40 p.m. to 5-5 p.m.	Haddocks,								1			2	1									4
	Gurnards,			2		1							1									4
	Thornback skate,																1					1
	Plaice,			4	3	1			2	1			2		1				2	1		17
	Common dabs,		5	8	6	1																20
	Lemon sole,											1										1
																						47
June 14. 8-5 a.m. to 9-45 a.m.	Haddocks,										1	1	1	1								4
	Gurnards,	1		13	14	2	4	2	2			1										39
	Thornback skate,															1		1	1			3
	Plaice,			3								1	1		2		2	1		1		11
	Common dabs,		5	4	3	2	2															16
																						73
Nov. 19. 12-0 noon to 1-30 p.m.	Haddock,														1							1
	Common gurnard,			1																		1
	Red gurnard,				1																	1
	Catfish,																				1	1†
	Turbot,																1					1
	Plaice,				1	7	27	28	1	3	2	6		1		2				2	2	82‡
	Lemon soles,			2																		2
	Common dabs,	124	92	82	4	4	4	2														313§
	Three-bearded rockling,																					3‖
	Solenette,	1																				1
	Thornback skate,			1			1				1	1										4
																						410
Station VII.																						
May 27. 10-0 a.m. to 11-45 a.m.	Cod,							1														1
	Haddocks,			1	2																	3
	Whitings,		2			1																3
	Angler,																	1				1
	Hake,								1						1							2
	Dragonets,			2																		2
	Gurnards,			4	4		3	3	3													¶18
	Witch soles,			1		2																3
	Lemon sole,											1										1
	Common dabs,		10	40	58	11																119
	Long rough dabs,	1	9	20		10																40
																						193

* 49 inches. † 30 inches. ‡ One 30 inches. § One 3 inches. ‖ Two 2 inches, one 3 inches. ¶ One 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—I. Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
June 15.	Haddock,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
8-55 a.m.	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
to	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1*
10-40 a.m.	Com. gurnards,	.	1	5	2	2	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.	18
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Lemon soles,	.	1	3	2	2	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	10
	Witch sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	.	.	16	5	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26
	Common dabs,	.	16	8	39	12	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	76
																						135
Nov. 18.	Haddocks,	.	.	.	.	.	.	2	4	.	.	.	.	.	.	.	.	.	.	.	.	6
1-30 p.m.	Whitings,	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	3
to	Hake,	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
2-20 p.m.	Anglers,	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	2
	Pogge,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common gurnards,	.	.	4	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Cuckoo ray,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon soles,	.	1	.	2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	4
	Witch soles,	.	.	.	.	.	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Long rough dabs,	.	.	4	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Common dabs,	4	66	49	42	9	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	174
																						210
Station VIII.																						
May 27.	Cod,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
1-55 p.m.	Haddocks,	.	.	.	3	22	19	1	25	40	3	.	1	.	.	.	.	.	.	.	.	114
to	Whitings,	.	.	.	1	1	13	9	4	2	.	.	.	.	.	.	.	.	.	.	.	30
3-40 p.m.	Hake,	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	3
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	4†
	Poor-cod,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	2
	Sail fluke,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	.	2	.	.	.	1	2	.	1	.	.	.	.	.	.	.	.	6
	Common dabs,	.	30	67	47	13	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	162
	Gurnards,	1	.	1	4	11	.	4	2	1	4	.	.	.	.	.	.	.	.	.	.	28
																						353
June 15.	Haddocks,	.	.	.	.	1	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	4
2-5 p.m.	Whiting,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Hake,	.	.	.	.	.	.	.	.	1	3	.	.	.	.	.	.	.	.	.	.	4
3-50 p.m.	Com. gurnards,	.	.	7	3	5	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	19
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	Lemon soles,	.	.	2	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	5
	Witch soles,	.	.	.	1	2	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	5
	Long rough dabs,	.	2	14	21	23	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	60
	Common dabs,	1	13	22	31	18	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	87
																						188
Nov. 18.	Haddocks,	.	.	.	.	.	5	4	10	.	.	1	.	.	.	.	.	.	.	.	.	20
10-25 a.m.	Whitings,	.	1	2	1	14	8	4	.	.	.	.	.	.	.	.	.	.	.	.	.	30
to	Hake,	.	.	.	.	.	4	1	.	.	.	.	1	.	.	.	.	.	.	.	.	6
12 noon.	Brassie,	.	2	6	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	Common gurnards,	.	14	48	34	6	2	.	.	3	2	.	.	.	.	.	.	.	.	.	.	109
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	.	18	2	2	4	.	1	.	1	1	1	.	.	.	.	.	.	30
	Lemon soles,	.	2	3	.	2	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	9
	Long rough dabs,	.	6	31	42	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	84
	Common dabs,	10	238	181	42	8	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	480
																						780

* 35 inches. † One 30, one 33 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—I. Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station IX.																						
May 28,	Haddocks,	.	.	.	.	19	.	1	9	.	.	11	.	.	.	.	.	.	.	.	.	40
10-5 a.m.	Whitings,	.	.	.	.	1	1	2	.	.	1	.	.	.	.	.	.	.	.	.	.	5
to	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1*
11-50 a.m.	Starry ray,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Com. gurnards,	.	.	2	1	2	2	4	1	1	.	3	.	.	.	.	.	.	.	.	.	17†
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Lemon soles,	.	.	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Witch soles,	.	.	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	3
	Long rough dabs,	.	11	20	13	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	64
	Common dabs,	1	8	25	30	6	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	75
																						212
June 16.	Haddocks,	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2
11-30 a.m.	Hake,	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2
to	Com. gurnards,	.	.	10	6	.	1	1	.	2	.	.	.	.	.	.	.	.	.	.	.	21‡
1-20 p.m.	Thornback skate,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Starry ray,	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	2
	Plaice,	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	1	.	.	.	.	3
	Lemon soles,	.	1	.	2	.	.	.	.	.	2	.	1	.	.	.	.	.	.	.	.	6
	Witch soles,	.	.	.	.	.	1	.	.	2	.	.	1	.	.	.	.	.	.	.	.	4
	Common dabs,	.	4	36	22	10	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	77§
																						118
Nov. 18.	Haddocks,	.	.	2	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	5
7-5 a.m.	Brassie,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
to	Whitings,	.	.	.	2	24	17	1	3	1	.	.	.	.	.	.	.	.	.	.	.	48
8-40 a.m.	Hake,	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Common gurnards,	.	28	19	8	5	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	62
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	4
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Lemon soles,	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Dragonets,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Pogge,	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	.	.	.	74	.	1	.	.	2	2	.	.	.	.	.	.	.	79
	Long rough dabs,	.	28	39	20	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	94
	Common dabs,	18	114	301	82	13	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	531
	Starry ray,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Station X.																						837
May 28.	Cod,	.	.	2	.	1	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	5
6-35 a.m.	Haddocks,	.	.	.	2	3	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	7
to	Whitings,	.	.	.	.	.	1	1	1	.	2	.	.	.	.	.	.	.	.	.	.	5
8-20 a.m.	Com. gurnards,	.	.	.	.	1	5	1	1	6	.	.	.	.	.	.	.	.	.	.	.	14
	Catfish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	¶1
	Brassie,	14	.	11	13	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**44
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Sail flukes,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	2
	Lemon soles,	.	.	2	1	1	1	.	.	1	2	.	4	4	1	1	.	.	.	.	.	18
	Witch sole,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Long rough dabs,	.	21	20	17	24	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	84
	Common dabs,	.	8	37	18	30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	93
																						275
June 16.	Cod,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
8-5 a.m.	Haddocks,	.	.	.	.	2	.	.	2	.	1	1	.	.	.	.	.	.	.	.	.	6
to	Whiting,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
9-55 a.m.	Com. gurnards,	1	.	1	1	4	3	1	1	2	.	1	.	.	.	.	.	.	.	.	.	15
	Starry ray,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Sail fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Lemon sole,	.	.	.	2	1	.	.	2	1	1	.	1	.	1	.	.	.	.	.	.	9
	Witch soles,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	.	2	16	20	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	53
	Common dabs,	.	15	27	23	6	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	73
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	††3
																						165

* 30 inches. † One 3 inches. ‡ One 3 inches § One 3 inches. ‖ One 28 and one 32 inches.
¶ 28 inches. ** Three 3 inches. †† One 30 and one 42 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—I. Moray Firth—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Nov. 17. 10-45 a.m. to 11-10 a.m.	Cod,	.	.	.	.	1	.	.	1	1	2	.	.	.	.	.	.	.	.	.	.	5
	Haddocks,	.	.	.	.	.	3	20	14	3	1	1	.	.	.	.	.	.	.	.	.	42
	Whitings,	.	.	.	.	.	11	2	.	2	.	.	1	.	.	.	.	.	.	.	.	16
	Brassie,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Hake,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common gurnards,	.	4	12	5	15	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	43*
	Sail fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Witch soles,	.	.	.	1	.	5	4	.	.	.	.	.	1	.	.	.	.	.	.	.	11
	Lemon soles,	.	.	4	.	.	1	1	3	.	2	.	.	.	.	.	.	.	.	.	.	11
	Long rough dabs,	.	15	21	10	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	48
	Common dabs,	.	58	60	33	11	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	169
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	2
	Fuller's ray,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1†
	Starry ray,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Anglers,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	2
	Plaice,	.	.	.	.	.	.	.	.	1	.	2	1	1	.	.	.	.	.	.	.	5
Station XI.																						359
May 19. 5-20 a.m. to 7-15 a.m.	Cod,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Haddocks,	3	37	31	8	2	2	1	.	.	.	.	1	2	.	.	.	.	.	.	.	87
	Com. gurnards,	.	.	1	1	2	2	2	4	8	1	.	.	.	.	.	.	.	.	.	.	21
	Catfish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1‡
	Dragonet,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Pogge	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5§
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	2
	Long rough dabs,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	3	37	31	8	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	82
	Lemon soles,	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	2
	Solenette,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2‖
																						205
June 9. 4-30 p.m. to 6-35 p.m.	Cod,	.	.	.	1	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Hake,	.	.	.	3	3	3	2	3	4	3	.	.	1	.	.	.	.	.	.	.	22
	Whitings,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	¶2
	Com. gurnards,	.	.	10	22	12	14	9	2	2	1	.	.	.	.	.	.	.	.	.	.	72
	Red gurnard,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3
	Dragonet,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	.	.	.	.	.	5
	Lemon soles,	.	.	2	4	.	3	.	1	.	2	2	2	.	.	.	.	.	.	.	.	16
	Long rough dabs,	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Common dabs,	1	21	64	25	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**114
Station XII.																						242
May 18. 4-25 p.m. to 6-25 p.m.	Cod,	.	.	.	1	.	1	.	.	.	1	.	2	.	.	.	.	.	.	.	.	5
	Haddock,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	Com. gurnards,	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Dragonets,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	.	2	.	.	.	.	.	.	3
	Lemon sole,	.	1	.	.	.	.	.	.	.	.	2	4	4	.	.	.	.	.	.	.	11
	Common dabs,	1	22	21	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	47
																						71
June 10. 3-45 a.m. to 5-50 a.m.	Cod,	.	.	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	1	.	6
	Haddocks,	.	.	2	.	26	32	8	8	9	8	8	9	2	1	.	1	.	.	.	.	114
	Whitings,	.	.	.	.	.	1	3	.	.	1	.	.	.	.	.	.	.	.	.	.	5
	Catfish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	††1
	Com. gurnards,	.	.	6	40	37	55	57	23	.	9	.	.	.	.	.	.	.	.	.	.	227
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	.	2	.	1	1	.	1	.	6
	Lemon soles,	.	.	2	1	3	.	1	.	1	1	1	1	2	.	.	.	.	.	.	.	13
	Common dabs,	1	10	25	30	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	68
																						440

* One 3 inches. † 28 inches. ‡ 32 inches. § Four 2 inches, one 3 inches. ‖ 3 inches. ¶ One 3 inches. ** One 3 inches. †† 44 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—I. Moray Firth—*continued.*

Station, Date, and Time Trawl Down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station. XIII.																						
May 19. 2-10 p.m. to 4-5 p.m.	Cod,	.	.	.	.	2	1	.	1	1	2	.	.	.	.	.	.	.	.	.	.	7
	Haddocks,	.	.	.	.	8	7	3	6	3	3	3	5	.	3	.	1	1	.	.	.	43
	Com. gurnards,	.	.	.	.	.	7	1	1	1	1	.	.	.	.	.	.	.	.	.	.	11
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	1	7	6	.	1	1	1	.	.	18
	Lemon soles,	.	.	.	.	1	1	.	.	1	1	2	6	3	.	.	.	.	.	.	.	15
	Common dabs,	.	11	8	6	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	28
																						123
June 9. 11-0 a.m. to 1-0 p.m.	Cod,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whiting,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Com. gurnards,	.	.	1	.	2	6	4	9	2	.	.	.	.	.	.	.	.	.	.	.	24
	Dragonet,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	2
	Turbot,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Lemon soles,	.	.	.	2	.	.	.	.	1	.	.	1	1	1	.	.	.	.	.	.	6
	Common dabs,	2	2	7	6	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
																						57
Station XIV.																						
May 20. 6-30 a.m. to 8-30 a.m.	Cod,	.	.	.	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.	.	1	4*
	Haddocks,	.	.	.	2	1	5	.	2	2	1	.	.	.	.	.	.	.	.	.	.	13
	Com. gurnards,	.	.	.	3	1	8	4	1	.	.	.	.	.	.	.	.	.	.	.	.	17
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3†
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	2
	Plaice,	.	.	.	.	.	.	.	.	1	1	2	1	1	.	1	.	.	.	.	.	7
	Sail fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1
	Lemon soles,	.	.	1	1	1	3	3	1	2	1	1	3	1	1	.	.	.	.	.	.	19
	Long rough dabs,	.	.	3	3	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	Common dabs,	.	24	6	5	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	40
																						115
June 9. 6-55 a.m. to 8-55 a.m.	Cod,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Haddocks,	.	.	.	.	3	1	2	.	1	.	1	.	.	.	.	.	.	.	.	.	8
	Whitings,	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Com. gurnards,	.	.	1	.	.	3	.	4	2	1	.	.	.	.	.	.	.	.	.	.	11
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1‡
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	2
	Plaice,	.	.	.	.	.	.	.	.	.	1	2	2	.	1	.	.	.	.	.	.	6
	Lemon soles,	.	.	.	2	2	.	1	1	.	1	1	2	4	.	.	.	.	.	.	.	14
	Long rough dabs,	.	.	1	5	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Common dabs,	.	1	11	8	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	23
																						76
Station XV.																						
May 19. 9-30 a.m. to 11-30 a.m.	Haddocks,	.	.	.	.	.	1	.	.	1	1	1	.	.	.	.	.	.	.	.	.	4
	Com. gurnards,	.	.	.	1	5	6	1	.	.	.	.	.	.	.	.	.	.	.	.	.	13
	Catfish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1§
	Dragonet,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	2	.	2	.	.	.	.	.	.	5
	Lemon soles,	.	.	.	2	.	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	5
	Long rough dabs,	.	2	2	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	Common dabs,	22	50	51	2	2	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	131
																						170

* One 35 inches   † One 30, one 35, and one 38 inches.   ‡ 30 inches.   § 35 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—I. Moray Firth—*continued.*

Station, Date, and Time Trawl Down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
June 10. 11-30 a.m. to 1-50 p.m.	Cod,				1																	1
	Haddocks,				2	1	3	1	1	8	5	3	1									25
	Whitings,								1	1												2
	Com. gurnards,			1	3	5	2	4	1	2												18
	Plaice,													2	1	1						4
	Lemon soles,			2	1		3	1		3	2		1	2								15
	Long rough dabs,			1	1	1																3
	Common dabs,	1	34	27	7																	69
																						137
Station XVI.																						
May 18. 9-55 a.m. to 11-45 a.m.	Haddocks,		1	7	3	8	3	3	2	3	1		1									32
	Hake,								1													1
	Com. gurnards,		1	7	3	3	3				1											18
	Anglers,																	1			1	2*
	Thornback skate,																		1			1
	Grey skate,																1					1
	Starry ray,								2													2
	Witch soles,							1		1												2
	Long rough dabs,		8	37	30	3																78
	Common dabs,		7	32	15	7	2		1													64
																						201
June 10. 7-0 a.m. to 9-0 a.m.	Catfish,																				1	1†
	Hake,										2											2
	Haddocks,				1	2				1												4
	Whitings,						1	1														2
	Com. gurnards,	1	1	4	1	2	2	2	1	2	3											19
	Grey skate,																	1		1		2
	Starry ray,								2													2
	Long rough dabs,		26	44	36	1																107
	Common dabs,	2	9	59	49	9	1															129
																						268

II. Aberdeen Bay.

Station, Date, and Time Trawl Down.	Kind of Fish.	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
Station I.																						
April 27. 2-45 p.m. to 3-45 p.m.	Plaice,						2	3	2	4	8	7	8							1		35
	Common dabs,		1	3	2	4	2	2														14
																						49
Station II.																						
May 3. 12-30 p.m. to 1-45 p.m.	Plaice,						2	4	3	5			2	1								17
	Common dabs,		7	26	8	4	8	1														54
	Long rough dabs,					2	1	4														7
	Lemon soles,				1		1	2														4
	Cod,								1		1						1			1		4
	Haddocks,			1	15	10			1			1					1	1				30
	Whitings,					1	1	1														3
	Common gurnards,			2	4	2	1	1	1	2												13
	Angler,				1																	1
	Herring,			1																		1‡
																						134

* One 30 inches. † 40 inches. ‡ 6¾ inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—II. Aberdeen Bay—*continued.*

Station, Date, and Time Trawl Down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station III.																						
May 4.	Cod,	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
10-35 a.m.	Haddocks,	.	.	7	27	.	7	8	2	13	2	3	.	1	1	1	.	2	.	.	.	74
to	Whitings,	.	.	.	.	1	6	2	.	1	.	.	.	.	.	.	.	.	.	.	.	10
12-10 p.m.	Common gurnard,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	1	5	3	.	4	3	1	1	.	.	.	.	.	.	18
	Lemon sole,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	3
	Common dabs,	.	10	22	16	9	9	5	1	.	.	.	.	.	.	.	.	.	.	.	.	72
	Halibut,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Flounder,	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
																						184

Station, Date, and Time Trawl Down.	Kind of Fish.	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
Station IV.																						
May 4.	Cod,	.	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3
1-25 p.m.	Haddocks,	.	.	.	3	2	1	1	1	2	.	.	.	.	.	.	.	.	.	.	.	10
to	Whitings,	.	.	.	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
2-50 p.m,	Plaice,	.	.	.	2	2	3	1	4	2	5	3	.	.	.	.	.	.	.	.	.	22
	Lemon sole,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	.	42	18	15	12	6	6	.	.	.	.	.	.	.	.	.	.	.	.	.	99
	Long rough dabs,	.	.	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4
																						143
Station V.																						
May 5.	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*
11-45 a.m.	Whitings,	.	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
to	Common gurnards,	.	.	1	7	9	7	.	5	4	3	.	.	.	.	.	.	.	.	.	.	36
1-30 p.m.	Plaice,	.	.	.	.	4	1	4	5	9	5	6	7	2	.	.	.	.	.	.	.	43
	Lemon sole,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	.	1	47	59	34	2	1	.	1	.	.	.	.	.	.	.	.	.	.	.	145
																						230

Station, Date, and Time Trawl Down.	Kind of Fish.	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
Station VI.																						
May 5.	Haddocks,	.	.	.	.	1	.	.	1	5	.	.	.	1	.	.	.	.	.	.	.	8
2-10 p.m.	Whitings,	.	.	.	.	7	8	1	1	1	2	.	.	.	.	.	.	.	.	.	.	20
to	Common gurnards,	.	.	.	11	1	14	8	1	.	1	1	.	.	.	.	.	.	.	.	.	37
3-30 p.m.	Plaice,	.	.	.	.	.	1	.	2	2	5	4	2	1	.	.	.	.	.	.	.	17
	Lemon sole,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	.	4	4	5	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
	Long rough dabs,	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
																						101

Station, Date, and Time Trawl Down.	Kind of Fish.	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
Station VII.																						
May 5.	Cod,	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
3-55 p.m.	Haddocks,	.	.	.	.	.	.	1	1	.	.	2	.	.	.	.	.	.	.	.	.	4
to	Whitings,	.	.	.	4	6	4	3	.	.	.	.	.	.	.	.	.	.	.	.	.	17
5-35 p.m.	Common gurnards,	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Plaice,	.	.	.	1	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	5
	Lemon sole,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	Common dabs,	.	.	3	2	3	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	Grey skate,	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	2
																						3

* 30 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—II. Aberdeen Bay—*continued.*

Station, Date, and Time Trawl Down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station I.																						
Night Haul.																						
May 5. 9-45 p.m. to 11-20 p.m.	Cod,	.	.	.	1	.	.	2	3	2	.	2	1	.	1	1	.	.	1	.	.	14
	Haddocks,	.	.	34	138	16	3	1	.	7	13	.	3	1	.	.	.	.	.	.	.	216
	Whitings,	.	.	.	.	11	23	2	1	1	.	1	.	.	.	.	.	.	.	.	.	39
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1*
	Common gurnard,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Poor-cod,	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Plaice,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Lemon soles,	.	.	1	.	.	.	1	1	1	.	2	2	.	.	.	.	.	.	.	.	8
	Common dab,	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Sail fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Grey skate,	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	2
	Thornback skate,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						288

III. Firth of Clyde.

Station, Date, and Time Trawl Down.	Kind of Fish.	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
Station I.																						
Aug. 25. 8-10 a.m. to 9-43 a.m.	Cod,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2†
	Haddocks,	.	.	.	.	.	.	.	.	2	2	1	.	.	.	.	.	.	.	.	.	5
	Whitings,	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Brassie,	.	.	1	7	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19
	Hake,	.	.	.	.	.	5	.	1	.	.	.	.	1	1	.	.	.	.	.	.	8
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‡
	Ling,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1§
	Nurse-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1‖
	Thornback skate,	.	.	.	1	.	1	1	.	.	.	.	1	.	1	.	.	.	.	.	.	5
	Grey skate,	.	.	5	14	5	.	6	2	.	.	.	.	.	.	.	.	.	.	.	.	32
	Red gurnards,	.	.	.	.	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Common gurnards,	.	.	3	10	5	6	4	.	.	.	.	.	.	.	.	.	.	.	.	.	28
	Lemon soles,	.	.	.	.	2	.	3	2	2	.	1	.	.	.	.	.	.	.	.	.	10
	Long rough dabs,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Common dabs,	.	23	22	10	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	69
																						189
Dec. 15. 1-40 p.m. to 3-27 p.m.	Cod,	1	3	3	.	2	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	12
	Haddocks,	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	2
	Whitings,	.	.	.	.	.	.	1	1	1	.	.	.	.	1	.	.	.	.	.	.	4
	Brassie,	.	4	15	11	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶46
	Hake,	.	.	.	.	.	.	.	.	3	13	.	.	.	.	1	.	.	.	.	.	17
	Argentines,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**2
	Common gurnard,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††1
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Pogge,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‡‡1
	Black soles,	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	3
	Lemon soles,	.	2	.	5	2	1	1	1	1	1	1	.	.	.	.	.	.	.	.	.	15
	Witch soles,	.	.	.	.	.	.	.	1	2	1	3	.	.	.	.	.	.	.	.	.	7
	Long rough dabs,	.	1	2	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Common dabs,	.	6	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
	Grey skate,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	§§2
	Thornback skate,	1	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	3
	Cuckoo ray,	.	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	3
	Rough-hound,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖‖1
																						136

* 46 inches. † One 28 inches. ‡ 48 inches. § 44 inches. ‖ 28 inches. ¶ Seven 3 inches. ** One 3 inches. †† 3 inches. ‡‡ 3 inches. §§ One 35 inches. ‖‖ 28 inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1898.

A. FISH CAUGHT—III. FIRTH OF CLYDE—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station II.																						
Aug. 24.	Ling,																					1*
3-20 p.m.	Com. gurnard,			1																		1
to	Plaice,											1										1
4.35 p.m.	Long rough dabs,		2	1	1																	4
	Common dabs,		3	5	1																	9
																						16
Dec. 9.	Haddocks,				2					3	6	5	2	1								19
9-12 a.m.	Whitings,					1		1	1	1												4
to	Brassie,	2		1	3																	6
10-35 a.m.	Poor-cod,	1																				1
	Hake,									3	5					1			1			10
	Com. gurnards,			3																		4†
	Argentines,			1																		3‡
	Dory,						1															1
	Turbot,																				1	1
	Plaice,						1	1	2		3	2		1	5	7	2	2	2	1		29
	Witch soles,									1	1	4	1	1								8
	Lemon soles,						1			1												2
	Long rough dabs,		3																			3
	Common dabs,	8	20	6	13	5	1															53
	Thornback skate,						1		1													2
																						146
Station III.																						
Aug. 24.	Whitings,						4	2	4		1											11
12-53 p.m.	Haddocks,							1			1	12										14
to	Brassie,					1																1
2-15 p.m.	Com. gurnards,				2	1		2	1		1											7
	Dragonet,						1															1
	Anglers,													1				1		1	1	4
	Hake,					2	1								3	1	21		40	7	2	77
	Thornback skate,									1												1
	Plaice,												1							1		2
	Lemon soles,				1		3		3					1								8
	Witch soles,					1		4	6	10	1	12	21	1	1							57
	Long rough dabs,		3	10	43	24	7															87
																						270
Dec. 8.	Cod,	3			1																	4
12-25 p.m.	Whitings,								4	3	2	4										13
to	Brassie,	3		4	1		3	1														12
2-0 p.m.	Haddocks,										1	1		1					1			4
	Poor-cod,	8		8																		21§
	Hake,										8					8		14	5	6	12	53
	Angler,																				1	1
	Liparis vulgaris,																					5‖
	Argentines,				1	1																2
	Piked dog-fish,																3					3
	Plaice,														1					2	2	5
	Lemon soles,						1		2		1	2										6
	Witch soles,							15	18	24	48	21	34			27						187
	Grey skate,																	1				1
	Thornback skate,						1							1							1	3
	Long rough dabs,		47	7	2	4	2															¶63
																						383

* 28 inches. † One 3 inches. ‡ Two 2 inches. § Five 3 inches. ‖ 2 inches. ¶ One 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—III. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
Station IV.																						
Aug. 24. 11-18 a.m. to 11-55 a.m.	Hake,							1														1
	Com. gurnards,			2	6	1																9
	Anglers,																			2	1	3
	Thornback skate,													1								1
	Lemon soles,				1						1											2
	Witch soles,							1	1													2
	Long rough dabs,		5	2	4	3																14
	Common dab,				1																	1
																						33
Dec. 8. 10-40 a.m. to 11-20 a.m.	Cod,					1																1
	Haddocks,	1	1	1						1	1	1	1	2	1							10
	Whitings,				6	1					1	1										9
	Brassie,		2																			3*
	Hake,								5	1	12	1										19
	Angler,																1					1
	Witch soles,					1	1	1	2	2	8	1	4									20
	Piked dog-fish,												5		2	1						8
	Thornback skate,		1									1										2
	Long rough dabs,		1	4																		5
	Lemon soles,					2																2
																						80
Station V.																						
Aug. 31. 10-35 a.m. to 11 50 a.m.	Com. gurnards,				1	1																2
	Dragonets,				1																	5†
	Thornback skate,	1								2												3
	Lemon soles,				1		3			2												7
	Long rough dab,			1																		1
	Common dabs,	3	16	6	1	1																28‡
																						46
Dec. 14. 1-53 p.m. to 2-45 p.m.	Haddocks,	3		1																		4
	Whiting,							1														1
	Hake,																1			1		2
	Red gurnard,					1																1
	Com. gurnards,		2																			2
	Lemon soles,		1	1	2																	4
	Witch soles,						1			1	1		1									4
	Long rough dab,			4	1																	5
	Thornback skate,		1				1								1	1						4
	Common dabs,	3	2	3		1																9
																						36
Station VI.																						
Aug. 25. 2-50 p.m. to 4-40 p.m.	Cod,									1												1
	Ling,																			1		1
	Com. gurnards,				11	9	6	1														27
	Anglers,																					1§
	Thornback skate,				2							3	3				1		1			11‖
	Raia maculata,					1																¶2
	Cuckoo rays,			1		2	1			2	1	2										9
	Grey skate,					1																**2
	Black soles,							2														2
	Turbot,															1						1
	Solenette,	1																				1
	Lemon soles,			5		1		4	1													11
	Brassie,				3																	1
	Dory,			1																		1
	Dragonet,				1																	3
	Conger,																					††1
	Common dabs,			3	4	4		2														13
																						88

* One 3 inches. † Three 2, one 3 inches. ‡ One 3 inches. § 30 inches. ‖ One 28 inches. ¶ One 35 inches. ** One 30 inches. †† 51 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—III. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Dec. 15.	Cod,						1															1
11-7 a.m.	Whitings,							2		2		2	2									8
to	Haddocks,							1		1	1											3
1-5 p.m.	Brassie,	1			2	1																4
	Hake,								1		2											3
	Com. gurnards,		2		3	1	1	2	2	2		4										17
	Witch sole,									1												1
	Lemon soles,			4	3	3	1	2		1												14
	Black soles,														1							1
	Common dabs,			8	9	12		1														30
	Thornback skate,								1	3	4		2								1	11
	Cuckoo ray,								1						1							2
	Piked dog-fish,																					1
	Nurse-hound,																					1
Station VII.																						97
Sept. 6.	Cod,																					1*
4-0 p.m.	Hake,					5		7					1									13
to	Brassie,			1																		1
5-50 p.m.	Com. gurnard,				11	9	1		1													22
	Red gurnard,										1											1
	Poor-cod,																					3†
	Piked dog-fish,																					1‡
	Thornback skate.	1		3	1									1						1		7
	Lemon soles,					1		1														2
	Witch soles,							2		2	1											5
	Long rough dab,				1																	1
	Common dabs,		1	3	3	1																8
																						65
Jan. 17.	Haddocks,										2	2										4
1-40 p.m.	Hake,									1												1
to	Whitings,		1	1		11				12		2										27
3-27 p.m.	Brassie,			2		1																3
	Ling,																					1§
	Argentine,				1																	1
	Com. gurnards,		1	1	4																	6
	Black sole,						1															1
	Witch soles,						3		18	13	32	11	10									87
	Plaice,										1	1		1								3
	Common dabs,		6		3	2		1	1													13
	Long rough dabs,	1	1	1	2	2																7
	Thornback skate,					2	1	1	1		1											6
	Fuller's ray,																					1
Night Trawl.																						161
Sept. 23.	Cod,																					2‖
11-47 p.m.	Hake,						1	2							1							4
to	Haddocks,								1	5	3	3										12
1-35 a.m.	Brassie,		2	1																		3
	Conger,																					¶1
	Anglers,																1			1		2
	Thornback skate,	2		1	2								1									6
	Lemon soles,					1	1															2
	Common dabs,	1	32	35	7			1														76
Night Trawl.																						108
Jan. 24.	Haddocks,												1		1							2
6-45 p.m.	Brassie,			1	1	5																7
to	Whitings,			1	2	11	2		2	3	2		2									25
8-30 p.m.	Poor-cod,	2																				**3
	Hake,		1		1					1												3
	Thornback skate,		1		1																	2
	Brill,														1		1					2
	Witch soles,				1				7	7	8	7		11	1							41
	Plaice,									1												1
	Common dab,		1																			1
	Long rough dabs,	1	3	5	14	11																34
																						121

inches. † 3 inches. ‡ 30 inches. § 49 inches. ‖ One 30, one 37 inches. ¶ 44 inches. ** One 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—III. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station VIII.																						
Sept. 7. 12.45 p.m. to 2-15 p.m.	Herring,																					1*
	Haddocks,	2																				2
	Poor-cod,	6																				8†
	Whiting,			1																		1
	Cod,					2																3‡
	Gobius minutus,																					3§
	Com. gurnards,							1		2	2											5
	Three-bearded rockling,			3																		3
	Nurse-hound,																					3‖
	Thornback skate,																1		1			2
	Piked dog-fish,									2	1		1									4
	Argentines,		4		1																	5
	Hake,							1					1									¶3
	Sail flukes,													3								3
	Witch soles,				1		3	4	5	1		1										15
	Lemon sole,	1																				1
																						52
Night Trawl. Sept 23. 8-45 p.m. to 10-30 p.m.	Hake,																	1				1
	Brassie,																					**1
	Poor-cod,																					††1
	Conger,																					‡‡1
	Thornback skate,	2				1	1			3	4	2				1				3		§§19
	Sail fluke,												1									1
	Witch soles,					3	3	5	3	5	3											22
																						46
Dec. 17. 8-16 a.m. to 10-10 a.m.	Cod,																					1
	Haddocks,		2					1		1	1	3	1									9
	Brassie,	3		1																		‖‖5
	Hake,								6	3	2											11
	Argentines,																					¶¶2
	Com. gurnard,		1	7	42	47		46	11	28	6	6										194
	Poor-cod,	2		1																		***4
	Anglers,																					†††1
	Red gurnards,					3		3	4			1	2	2								15
	Piked dog-fish,																					‡‡‡4
	Thornback skate,			1	2					1	2	1							1	1		9
	Cuckoo rays,							1						1								2
	Sail flukes,						1	2		3	1	2		1			1					11
	Witch soles,						2		12	3	11	6	3									37
	Black soles,					1							1									2
	Whitings,					2	2															4
	Common dab,			1																		1
																						312
Night Trawl. 1899. Jan. 17. 5-45 p.m. to 7-40 p.m.	Haddocks,			1	1					1		1										4
	Whitings,				4	43	24		3				2									76
	Hake,								3		10											13
	Anglers,																					§§§2
	Red gurnards,									1	1											2
	Com. gurnards,			4				4														8
	Brassie,				1																	1
	Poor-cod,	3		12																		15
	Thornback skate,	1					1				1							1				4
	Cuckoo ray,											1										1
	Witch soles,						7	13	6	8	10		3									47
																						173

* 3 inches. † Two 3 inches. ‡ One 3 inches. § 2 inches. ‖ 28 inches. ¶ One 35 inches. ** 3 inches. †† 3 inches.
‡‡ 35 inches. §§ Two 28 inches. ‖‖ One 3 inches. ¶¶ 3 inches. *** One 3 inches. ††† 26 inches.
‡‡‡ Two 26, one 28, one 30 inches. §§§ 30 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—III. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station IX.																						
Aug. 31. 1.35 p.m. to 3-28 p.m.	Cod,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2*
	Haddocks,	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	2
	Whiting,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1†
	Hake,	.	.	.	.	2	.	1	.	.	.	4	.	.	.	1	.	.	.	.	.	10‡
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1§
	Com. gurnards,	.	.	.	7	5	24	20	111	95	132	14	.	.	.	.	.	.	.	.	.	408
	Brassie,	.	.	10	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	1	1	1	.	.	.	1	.	.	1	.	.	1	2	.	10‖
	Grey skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Cuckoo ray,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	Sail flukes,	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	2
	Lemon soles,	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	.	1	6	3	3	4	2	2	.	.	.	.	.	.	.	.	.	21
	Long rough dabs,	.	1	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
																						482
1899. Jan. 17. 9-37 a.m. to 11-30 a.m.	Whitings,	.	.	.	31	.	14	2	3	.	.	.	.	.	.	.	.	.	.	.	.	50
	Brassie,	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Poor-cod,	3	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16
	Hake,	.	.	.	.	.	.	.	.	6	5	3	.	.	.	1	.	.	.	.	.	¶16
	Argentines,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**4
	Anglers,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	††1
	Red gurnards,	.	.	.	.	.	.	.	2	.	3	.	1	1	.	.	.	.	.	.	.	7
	Com. gurnards,	.	.	.	.	1	4	2	4	16	4	.	.	.	.	.	.	.	.	.	.	31
	Thornback skate,	.	.	.	.	.	.	.	1	1	1	1	.	1	1	.	.	.	.	.	.	6
	Plaice,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Black sole,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	.	1	6	.	10	2	13	5	.	.	.	.	.	.	.	.	.	37
	Long rough dabs,	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Common dabs,	5	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13
	Zeugopterus, sp.?	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
																						191
Station X.																						
Aug. 25. 11-0 a.m. to 1-10 p.m.	Hake,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Com. gurnards,	.	.	1	11	12	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	26
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Thornback skate,	1	.	.	.	.	1	.	.	1	3	.	.	.	.	.	.	.	.	.	.	6
	Cuckoo ray,	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	2
	Black sole,	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon soles,	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Common dabs,	.	.	7	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
																						58
1899. Jan. 16. 11-50 a.m to 1-30 p.m.	Haddocks,	2	1	.	2	.	.	.	3	3	.	5	1	.	.	.	.	.	.	.	.	‡‡18
	Whitings,	.	4	.	6	63	.	.	43	.	12	.	2	.	.	.	.	.	.	.	.	130
	Brassie,	1	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	4
	Poor-cod,	6	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	Hake,	.	.	.	.	.	.	.	4	48	33	12	.	.	4	2	2	.	.	.	3	§§108
	Thornback skate,	.	.	1	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	.	4
	Fuller's ray,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	.	3
	Argentines,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	‖‖2
	Black soles,	.	.	.	.	.	.	.	.	1	1	.	1	.	1	.	.	.	.	.	.	4
	Lemon soles,	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Witch soles,	.	.	.	.	.	6	13	.	13	13	17	.	2	.	.	.	.	.	.	.	64
	Long rough dabs,	4	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Common dabs,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
																						358

* One 31, one 32 inches. † 35 inches. ‡ One 30, one 35 inches. § 28 inches. ‖ Two 28 inches. ¶ One over 40 inches. ** Three 3 inches. †† 48 inches. ‡‡ 3 inches. §§ Two over 25 inches. ‖‖ One 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—III. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Station XI.																						
Sept. 8. 12-42 p.m. to 2-20 p.m.	Hake,	.	.	.	.	7	11	4	1	.	.	5	.	4	1	1	.	.	.	1	.	35
	Com. gurnards,	.	.	.	3	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	5*
	Piked dog-fish,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Witch soles,	.	.	.	1	8	7	18	.	23	.	6	5	1	.	.	.	.	.	.	.	69
	Lemon sole,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	1	.	1	2	1	1	.	.	.	.	.	.	.	6
	Common dabs,	.	.	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	3
	Long rough dabs,	.	3	36	19	3	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	65
																						192
1899. Jan. 24. 8-33 a.m. to 10-55 a.m.	Haddock,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Whitings,	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	7
	Com. gurnards,	.	.	1	.	14	13	1	.	1	.	.	.	.	.	.	.	.	.	.	.	30
	Streaked gurnards,	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2
	Dragonet,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1†
	Plaice,	.	.	1	1	.	2	.	1	5	3	1	2	2	.	3	1	.	.	.	.	22
	Brill,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1
	Witch soles,	.	.	.	.	2	5	17	14	1	18	10	2	.	.	.	.	.	.	.	.	69
	Lemon soles,	.	.	1	2	1	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	7
	Black sole,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	8	32	.	22	17	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	82‡
	Common dabs,	19	18	13	8	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	62
																						288
Station XII.																						
Aug. 30. 12-20 p.m. to 2-10 p.m.	Cod,	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	2
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	9§
	Poor-cod	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2‖
	Conger,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	¶1
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**1
	Com. gurnard,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Pristiurus melanostomus,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	Thornback skate,	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Grey skate,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	4
	Sail fluke,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
	Witch soles,	.	.	.	.	.	2	8	17	47	57	26	3	.	2	.	.	.	.	.	.	162
	Long rough dabs,	1	.	28	77	28	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	††136
	Common dab,	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
																						324
Night Trawl. Sept. 8. 8-0 p.m. to 9.57 p.m.	Cod,	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	‡‡5
	Hake,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	1	.	.	4
	Angler,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	Thornback skate,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	§§2
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	2
	Witch soles,	.	.	.	.	.	4	15	20	19	32	.	11	.	.	.	.	.	.	.	.	101
	Long rough dabs,	.	.	14	9	14	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	53
																						168

* One 26, one 28, and one 35 inches. † 26 inches. ‡ One 3 inches. § One 26, three 28, one 30, one 39, one 40, and one 44 inches. ‖ One 3 inches. ¶ 45 inches. ** 30 inches. †† One 3 inches. ‡‡ One 30, two 36, and one 38 inches. §§ One 28 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—III. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches. 4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	Total.
1899.	Cod,																					1*
Jan 20.	Whitings,				1	7																8
10-24 a.m.	Brassie,	1																				1
to	Poor-cod,	3																				8†
12-10 p.m.	Hake,			1		3					15				3		2	3		2		33‡
	Argentines,	1			1																	2
	Red gurnard,							1														1
	Com. gurnard,				1																	1
	Angler,																					1§
	Rockling, sp.						1															1
	Thornback skate,	1											1							1		5‖
	Fuller's ray,																1					1
	Plaice,						1															1
	Witch soles,	13			4		8		16	20		19		28								108
	Long rough dabs,		37	67	97	144	56	4														405
	Black sole,								1													1
Night																						578
Trawl.																						
Jan. 23.	Cod,																					¶1
6-0 p.m.	Whitings,	8			1	18																27
to	Brassie,			1																		1
7.55 p.m.	Hake,									4	3	1				3						11
	Anglers,																					**2
	Thornback skate,	1																			1	2
	Witch soles,						6	6	11	8	19	32		1								83
	Lemon sole,						1															1
	Long rough dabs,	2	82	29	49	96	47	2														307
Station XIII.																						435
Aug. 22.	Cod,						1	1														2
8-37 a.m.	Whiting,							1														1
to	Herring,																					††1
9-30 a.m.	Hake,						1															1
	Com. gurnards,				9		7	2	1	1												20
	Liparis vulgaris																					‡‡2
	Thornback skate,												1							1		2
	Plaice,									3	2	13	3	2	1	1						25
	Lemon sole,								1													1
	Witch soles,							1	1		9	8										19
	Long rough dabs,		9	14	24	24	21															92
	Common dabs,				2	6																8
																						174
Dec. 6.	Cod,									1			1	1	1			1	1			6
8 30 a.m.	Haddocks,			4								1	2	1		1						9
to	Whitings,				1			1		5	1	1	1									§§11
9-30 a.m.	Brassie,				1			1														‖‖3
	Hake,								3							1	1					5
	Com. gurnards,					1	2	1														4
	Argentine,					1																1
	Lemon soles,															1						1
	Witch soles,							1	7	2	2	3										15
	Common dab,		1																			1
	Long rough dabs,			1	3	5		1														10
	Thornback skate,																			1		1
Station XIV.																						67
Aug. 22.	Cod,							1			1											2
9-50 a.m.	Saithe,															1	2					3
to	Haddock,														1							1
11-0 a.m.	Hake,						1										1					2
	Whiting,							1														1
	Com. gurnards,			2		6	7	2														17
	Plaice,										1	5			1							7
	Witch soles,								2	10	11	15	2									40
	Common dabs,			2		6																8
	Long rough dabs,		4	22	60	29	1															116
																						197

* 38 inches. † Five 3 inches. ‡ Three 26, one 28 inches. § 35 inches. ‖ One between 2 and 3 inches, and one 26 inches. ¶ 38 inches. ** 28 inches. †† 3 inches. ‡‡ $2\frac{1}{2}$ inches. §§ One 3 inches. ‖‖ One 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT—III. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	21 +	23 +	25 +	
Dec. 6. 9·50 a.m. to 10-50 a.m.	Cod,										3	1	2	1	1	3	4	1			1	17
	Haddocks,													1				1				2
	Whiting,					1																1
	Brassie,	5			2	5	5															18*
	Hake,										1			1								2
	Com. gurnards,				2	1		2	1	1												7
	Piked dog-fish,																					1†
	Plaice,													1								1
	Witch soles,									8	4	1	1									14
	Lemon soles,												1									1
	Long rough dabs,			1		8	7															16
																						80
Station XV. Aug. 22. 11-40 a.m. to 12-40 p.m.	Saithe,							1	1	4	2											8
	Haddock,											1										1
	Hake,																1					1
	Com. gurnard,					1																1
	Herring,																					2‡
	Liparis vulgaris.																					3§
	Piked dog-fish,																		1			1
	Grey skate,									1												1
	Plaice,											1										1
	Witch soles,							2	15	6	11	8	2									44
	Long rough dabs,		3	43	33	24	13	1														117
																						180
Dec. 6. 11-50 a.m. to 12-50 p.m.	Cod,												2	1				1				4
	Haddocks,													2								2
	Whitings,	1	2																			3
	Brassie,				2																	2
	Com. gurnards,			2																		2
	Conger,																			1		1
	Plaice,										1		1									2
	Witch soles,							4	5	6	28	28	6									77
	Long rough dabs,			3	21	20	2															46
																						139
Station XVI. Aug. 23. 11-37 a.m. to 1-50 p.m.	Piked dog-fish,																				1	1
	Witch soles,						9	3	2	1												15
																						16
Dec. 7. 11-15 a.m. to 1-20 p.m.	Brassie,			1																		1
	Witch soles,						3	4	3	1	1											12
	Long rough dabs,				2	1	1															4
																						17
Station XVII. Aug. 23. 8-55 a.m. to 9-55 a.m.	Cod,						1			1	1	3		1	2							9
	Saithe,							1	2	3	2		1									9
	Conger,																					1‖
	Com. gurnards,					1	1	1	1													4
	Plaice,										1		1	2								4
	Witch soles,					3	1	11		32	2	16	2									67
	Long rough dabs,	1	5	5	5	10	5															31
	Common dabs,					1																1
																						126
Dec. 7. 8-30 a.m. to 10-0 a.m.	Brassie,	1		1																		2
	Poor-cod,																					¶1
	Conger,																					**1
	Gobius minutus,																					††1
	Turbot,																		1			1
	Witch soles,		1		2	1			1	1		4		1								‡‡12
	Long rough dabs,		2	1																		§§5
																						23

* One 3 inches. † 28 inches. ‡ 2½ inches. § 1½ inches. ‖ 28 inches. ¶ 3 inches. ** 38 inches. †† 2 inches.
‡‡ One 3 inches. §§ Two 3 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT (*Shrimp Trawl*)—IV. Moray Firth.

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		2 +	3 +	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	25 +	
Moray Firth. Shrimp Hauls.																						
Station V. June 14. 30 minutes	Com. gurnards,	.	2		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Plaice,	.	.		.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	2
	Solenette,	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Common dabs,	9	22	4	8	5	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	53
																						59
Oct. 13. 30 minutes	Whiting,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Com. gurnards,	.	.	.	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Plaice,	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	3
	Common dabs,	.	.	22	32	16	3	3	.	.	.	1	.	.	.	.	.	.	.	.	.	77
	Solenette,	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
Station VII.																						91
May 17. 30 minutes	Whitings,	.	.	.	.	6	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	7
	Hake,	.	.	.	.	6	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	8
	Com. gurnards,	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	2
	Dragonet,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon soles,	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Common dabs,	.	3	.	2	8	4	2	1	.	.	.	.	.	.	.	.	.	.	.	.	20
	Long rough dabs,	.	1	1	7	8	5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	24
																						64
June 15. 30 minutes	Com. gurnards,	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	3
	Lemon sole,	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	.	.	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Common dabs,	5	29	3	1	5	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	47
																						55
Nov. 18. 2-45 p.m. to 3-15 p.m.	Hake,	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Poor-cod,	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Gobius minutus,	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3*a*
	Dragonets,	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Pogge,	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Lemon sole,	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs,	.	.	.	.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	4
	Common dabs,	6	.	2	1	1	4	.	1	.	.	.	.	.	.	.	.	.	.	.	.	15
Station IX.																						31
May 28. 30 minutes	Whitings,	.	.	.	.	2	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	4
	Gurnards,	.	6	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
	Lemon soles,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Witch soles,	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Long rough dabs,	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Common dabs,	37	35	4	8	5	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	93
																						110
June 16. 30 minutes	Com. gurnards,	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Lemon sole,	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Long rough dabs	.	.	.	3	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Common dabs	26	29	3	6	8	3	1	2	.	.	.	.	.	.	.	.	.	.	.	.	78
																						87
Nov. 18 30 minutes	Whiting,	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	Com. gurnards,	.	4	8	2	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17
	Dragonets,	.	1	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
	Pogge,	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Anglers,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Plaice,	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1
	Lemon soles,	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Solenette,	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	Long rough dabs	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
	Common dabs	38	.	41	73	14	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	181
																						218

a Two at 1 inch.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1898.

A. FISH CAUGHT (*Shrimp Trawl*)—IV. MORAY FIRTH—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		2 +	3 +	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	25 +	
Station XI.																						
May 19. 30 minutes	Dragonet,				2	1																3
	Pogge,			3																		3
	Solenettes,		2	4																		6
	Lemon sole,							1														1
	Common dabs,		5	10	30	15	4															64
																						77
June 9. 30 minutes	Haddocks,							1			1	2	1									5
	Whitings,					1	1															2
	Lemon soles,						1						1		1							3
	Common dabs,					1	1															2
																						12
Station XIII.																						
May 18. 30 minutes	Lemon sole,			1																		1
	Common dabs,			3	6	2	1															12
	Pogge,		1	1																		2
																						15
June 9. 30 minutes	Cod,						1				1											2
	Haddock,																1					1
	Whiting,											1										1
	Brassie,			2	2	6	8	4														22
	Ling,																					1*a*
	Lemon sole,								1													1
	Common dabs,					4		1														5
																						33
Station XVI.																						
May 18. 30 minutes	Dragonets,		2	5	1																	8
	Lumpsucker,	2																				2
	Pogge,			1																		1
	Long rough dabs.					1																1
	Common dabs,	4	4	14	8	8	2															40
																						52
June 10. 30 minutes	*Argentine*,						1															1
	Haddocks,						1	1					1									3
	Whitings,				1	8	4		4			1										18
	Brassie,						1															1
	Poor cod,					1																1
	Com. gurnards					1		1				1										3
	Dragonet,				1																	1
	Lemon sole,			1																		1
	Long rough dabs,		14	7	12	13	3															49
	Common dabs,				2	3	1	2														8
																						86

a. 28 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT (*Shrimp Trawl*)—V. Firth of Clyde.
(1) Ordinary Trawling Stations.

Station, Date, and Time Trawl Down.	Kind of Fish.	2 +	+	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	25 +	Total.
Firth of Clyde. Shrimp Hauls. **Station VIII.**																						
Sept. 7. 30 minutes	Cod,		2																			2
	Haddocks,		4	3																		7
	Whitings,					8																8
	Poor-cod,		87	100																		187
	Com. gurnard,								1													1
	Three-bearded rockling,					2	2															4
	Dragonets,		20	37																		57
	Herring,	1																				1
	Gobius minutus,		6																			6
	Thornback skate										1	2										4
	Sail fluke,										1											1
	Solenette,				2																	2
	Long rough dabs,	15																				15*a*
																						295
Dec. 17. 30 minutes	Brassie,	6	36	11																		53
	Poor-cod,	2	14	11	2																	29
	Whiting,						1	1														2
	Argentines,	3	1																			4
	Dragonets,		7	7																		14
	Gobius minutus,	4																				4
	Sail fluke,	1						1														2
	Witch soles,							2		1	1											4
	Com. gurnard,							1														1
																						113
Station IX.																						
Aug. 31. 30 minutes	Cod,	2																				2
	Haddocks,		1	1																		2
	Hake,		1		1																	1
	Argentines,	2				2	1															5
	Whitings,			1	11	3																15
	Poor-cod,			100																		218*b*
	Com. gurnards,						2	2				1										5
	Three-bearded rockling,						1															1
	Sail fluke,				1		1															2
	Thornback skate,													1								2*c*
	Cuckoo ray,															1						1
	Gobius minutus,		1																			1
																						255
1899. Jan. 17. 30 minutes	Hake,										1	4										5
	Whitings,				4		3	28	9		1		1									46
	Brassie,	5	29	69	49	5																156
	Poor-cod,	8	50	64	194	4																320
	Argentines,		10	7	10	5	2															34
	Com. gurnards,						4		16	2		1	2									25
	Dragonets,		11	6	1	1		1														20
	Three-bearded rockling,						1															1
	Thornback skate,		1											1	1							3
	Gobius sp?		2																			2
	Plaice,																1					1
	Witch soles,								1	2	1		5									9
	Common dab,					1																1
	Long rough dabs,		1	3	1																	5
																						628

a $2\frac{1}{2}$ inches. *b* One hundred and eighteen about $2\frac{1}{2}$ inches. *c* One 30 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT *(Shrimp Trawl)*—V. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total
		2 +	3 +	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	25 +	
Station X.																						
Aug. 25. 30 minutes	Haddock,														1							1
	Com. gurnards,						3	1														4
	Dragonets,		5																			5
	Cuckoo ray,						1															1
	Lemon soles,				2	1																3
	Common dabs,					3	5															8
																						22
1899. Jan. 16. 30 minutes	Brassie,	6	6	15	13																	40
	Poor cod,	1	28	143	72	29	1															271
	Hake,											3	4	3			1			1		13
	Argentines,	1	3			1																5
	Liparis vulgaris,		1																			1
	Liparis montagui	2	3																			5
	Haddock,					1																1
	Whitings,							9	1	3	1											14
	Gobius sp. ?	1																				1
	Dragonet,		1																			1
	Thorn-back skate,														1	1						1
	Witch soles,									2	1	1	3			2						9
	Long rough dabs,	1		1	1																	4*a*
																						366
Station XII.																						
Aug. 30. 30 minutes	Cod,		5	4																		9
	Haddocks,		2	1																		3
	Whitings,			6	2																	8
	Poor-cod,			500	1000																	2316*b*
	Three - bearded rocklings,				2	1																3
	Herring,		1																			2*c*
	Witch sole,														1							1
	Long rough dabs,		8	13	9	7	5															42
																						2384
1899. Jan. 20. 30 minutes	Brassie,		7	5																		12
	Poor-cod,		13	17																		30
	Argentines,	2																				2
	Gobius sp. ?																					2*d*
	Ling,																					1*e*
	Three - bearded rockling,					1																1
	Witch soles,			1					9	1												11
	Long rough dabs,			9	20		14		1													44
																						103

a One at 1 inch. *b* Eight hundred and sixteen at $3\frac{1}{2}$ inches. *c* One at $2\frac{1}{2}$ inches. *d* 1 inch. *e* 35 inches.

TABLE C.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1898.

A. FISH CAUGHT (*Shrimp Trawl*)—V. FIRTH OF CLYDE—*continued*.
(2) CROSS SECTION—SANDA TO BENNAN HEAD.

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		2 +	3 +	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	25 +	
Station II.																						
Sept. 1. 4-20 p.m. to 4-55 p.m.	Cod,	1	2	1																		4
	Brassie,				5	28	27	20														80
	Whiting,										1											1
	Com. gurnards,							16	18	34		15	8	1								92
	Thornback skate,																					1
	Raia maculata,													2					1			3
	Lemon soles,		9	4	12		1															30*a*
	Zeugopterus punctatus,		1																			1
																						212
1899. Jan. 19, 30 minutes	Cod,			1																		1
	Brassie,		58	30	10	1																99
	Poor-cod,		5	8	14																	27
	Herring,	1																				1
	Red gurnard,									1												1
	Com. gurnards,						1	2	3	4	2											12
	Dragonet,	1																				1
	Liparis vulgaris,	1																				1
	Lemon sole,																					1
	Long rough dab,	1																				1
																						145
Station III.																						
Sept. 1. 3-17 p.m. to 3-50 p.m.	Haddock,		1	1	3				1													6
	Brassie,					2																2
	Whiting,				17	36		1	3	1												58
	Hake,								1													1
	Poor-cod,	800		168																		968
	Cod,		2																			2
	Argentines,	3		3	2	1																9
	Gobius sp. ?	2																				2
	Com. gurnards,					1	3		1				3									8
	Dragonets,	40			42																	82
	Nurse-hound,																					1*b*
	Sail fluke,														1							1
	Lemon sole,				1																	1
	Long rough dabs,	3			5																	8
	Solenettes,		2				1															3
																						1152
1899. Jan. 19. 30 minutes	Whitings,							1	1			1										3
	Poor-cod,		1	1	1																	3
	Brassie,	1	18	17																		36
	Com. gurnard,					6	8	5	2		1											22
	Dragonets,		2																			2
	Lemon sole,		1																			1
	Common dab,					1																1
																						68
Station IV.																						
Sept. 7. 10 45 a.m. to 11-20 a.m.	Whitings,		3	19	9					1												32
	Com. gurnard,						1															1
	Herring,	1	2																			3
	Argentines,	1	1																			2
	Dragonets,			30			10															40
	Poor-cod,	3	93	200																		293
	Gobius minutus,		3																			3
	Gobius sp. ?		7																			1
	Thornback skate,																					7
	Sail fluke,															1						1
	Witch soles,					2	1	1	1		6											11
	Lemon sole,				1																	1
	Long rough dabs,	12		1	6	3	2	2														26
																						421

a Four at $2\frac{1}{2}$ inches. *b* 28 inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT (*Shrimp Trawl*)—V. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		2 +	3 +	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	25 +	
1899. Jan. 17. 30 minutes	Whitings,						2		3	1												6
	Brassie,		6		16	1																23
	Poor-cod,		51		73																	124
	Argentine,	4		3																		7
	Dragonets,			3																		3
	Conger eel,															1						1
	Three-bearded rocklings,						2															2
	Gobius sp. ?		4																			4
	Plaice,		1																			1
	Long rough dabs			3			1															4
	Arnoglossus laterna,			3																		3
																						178
Station V. Sept. 7. 30 minutes	Hake,							1	2					1								4
	Brassie,				10	10	1		1													22
	Cod,		1																			1
	Whitings,				3		2															5
	Com. gurnards,					8	10			1		1										20
	Poor-cod,			320																		528*a*
	Argentines,	1																				1
	Angler,																1					1
	Ling,										1											1
	Dragonets,		30	7																		37
	Gobius sp.,		1																			1
	Herring,		1																			1
	Sail fluke,			3																		3
	Lemon soles,			1	1																	2
	Common dabs,				5	8	1															14
																						641
1899. Jan. 17. 30 minutes	Brassie,		18	6		1																25
	Poor-cod,		4																			4
	Com. gurnard,										1											1
	Dragonets,		3	3																		6
	Witch soles,												1									1
	Long rough dabs,				2																	2
	Common dabs,			1			1															1
																						40
	(3) Corsewall to Mull of Cantyre.																					
Station VI. Sept. 1. 12-35 p.m. to 1-15 p.m.	Cod,		11	2																		13
	Haddock,			1																		1
	Poor-cod,	2	28	15																		45
	Liparis vulgaris,	6																				10*b*
	Pogge,																					2*c*
																						71
1899. Jan. 24. 30 minutes	Brassie,		2	6	3																	11
	Poor-cod,		9	24	11																	44
	Hake,												1									1
																						56
Station VII. Sept. 1. 10-15 a.m. to 10-45 a.m.	Cod,	8																				15*d*
	Brassie,					1	1		1	1												4
	Poor-cod,	2	5	21	15																	43
	Com. gurnard,	1																				1*e*
	Liparis vulgaris,	1																				1
																						64

a Two hundred and eight about $2\frac{1}{2}$ inches. *b* Four at 1 inch. *c* $3\frac{1}{2}$ inches. *d* Seven at $3\frac{1}{2}$ inches. *e* $2\frac{1}{2}$ inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT (*Shrimp Trawl*)—V. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches. 2 +	3 +	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	25 +	Total.
1899. Jan. 24. 30 minutes	Brassie,		12	6	14		1															33
	Poor-cod,		5	19																		24
	Com. gurnard,	1																				1
	Three-bearded rockling,				2																	2
	Liparis vulgaris,	21																				21
	Liparis montagui																					6*a*
	Rockling sp.?		3																			3
	Cuckoo ray,												1									1
	Zeugopterus sp.?		1																			1
																						92
	(4) Pladda to Turnberry Point.																					
Station VIII. Sept. 6. 11-5 a.m. to 11-35 a.m.	Cod,	15		16																		31
	Poor-cod,		40	42																		82
	Three-bearded rockling,				4	1	2															7
	Angler																				2	2*b*
	Dragonet,				1																	1
	Lumpenus lampetriformis,							1														1
	Gobius minutus,	2	11																			13
	Lemon sole,		1																			1
	Witch soles,								1				1									2
	Sail fluke,																				1	1
	Long rough dabs,		1	4		2	1															8
	Zeugopterus punctatus,	1																				1
	Sprats,		2																			3*c*
																						153
1899. Jan. 25. 30 minutes	Whitings,							2														2
	Brassie,			6			1															7
	Poor-cod,		3	62	15																	182
	Conger,																					2
	Argentine,						1															1
	Herring,			1																		1
	Three-bearded rockling,				2																	2
	Witch soles,							1					1		2	1						5
	Long rough dabs,						1															1
	Zeugopterus sp.?		1																			1
																						204
Station IX. Sept. 6. 12-10 p.m. to 12-45 p.m.	Hake,															1						1
	Whitings,		1	2	11	2																16
	Poor-cod,	1	7																			8
	Com. gurnards,						1		1	1	1											4
	Three-bearded rockling,						1															1
	Witch soles,			1		1	1		7	5	6		5									26
	Long rough dabs,	1	17	14	7	1	1															41
	Thornback skate,																				1	1
	Grey skate,																					1
																						99

a $1\frac{1}{2}$ inches. *b* 30 and 40 inches. *c* One at $2\frac{1}{2}$ inches.

TABLE C.—Record of Observations made on Board the 'Garland' during 1898.

A. FISH CAUGHT (*Shrimp Trawl*)—V. Firth of Clyde—*continued.*

Station, Date, and Time Trawl down.	Kind of Fish.	Size in Inches.																				Total.
		2 +	3 +	4 +	5 +	6 +	7 +	8 +	9 +	10 +	11 +	12 +	13 +	14 +	15 +	16 +	17 +	18 +	19 +	20 +	25 +	
1899. Jan. 25. 30 minutes	Whiting,						1															1
	Brassie,		18	5																		23
	Poor-cod,		7	27								1										34
	Hake,											1										1
	Com. gurnards,							1		1												2
	Argentine,		1																			1
	Dragonet,		1																			1
	Gobius minutus,	4																				4
	Gobius sp.,		4																			4
	Three-bearded rockling,						1															1
	Witch soles,						1	2	2													5
	Long rough dabs,	1	7	9		8	9	1														35
	Common dabs,					1																1
Station X.																						112
Sept. 6. 1-10 p.m. to 4-45 p.m.	Cod,		2																			2
	Haddocks,		3																			3
	Whitings,			2	1	3																6
	Brassie,					1																1
	Hake,								1	1			1									3
	Poor-cod,			54																		254*a*
	Gurnards,					4	1	2		4	3	1										15
	Argentines,		2																			2
	Dragonets,	1	23		21																	45
	Gobius minutus,	3																				3
	Liparis vulgaris,	2																				2
	Liparis montagui				1																	1
	Thornback skate,												1									1
																						338
1899. Jan. 25. 30 minutes	Hake,												1									1
	Brassie,	3	16	13																		32
	Poor cod,			1																		1
	Dragonet,			1																		1
	Com. gurnards,						2															2
	Witch soles,							1					2									3
	Common dabs,			1		1			1													3
	Long rough dabs,	3		1		1																5
	Zeugopterus sp. ?		1																			1
																						49

a Two hundred about $2\frac{1}{2}$ inches.

TABLE B.—Record of Observations made on Board the 'Garland' during 1898.

B. PHYSICAL OBSERVATIONS—I. Moray Firth.

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Temperature. Water. Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station I.												
1898. May 24.												
3.55 p.m.	W.	49·28	49·6	49·2	7	E.	2	Haze & Fog	E. swell.	1 h. ebb.	29·95	6
6.5 p.m.	E.	49·10	49·0	48·9	$8\frac{1}{4}$	E.	3	,,	,,	3h.10m.eb.	,,	$6\frac{1}{2}$
June 7.												
8.25 a.m.	E.	55·4	50·6	49·8	8	W.	3	Cloudy.	Moderate.	1 h. ebb.	29·88	8
10.30 a.m.	W.	58·10	51·5	49·5	$5\frac{1}{2}$	N.N.W.	1	Clear.	Slight.	3 ,,	29·90	Bot'm
Oct. 11.												
12.8 p.m.	W.	53·42	54·1	54·0	$7\frac{1}{2}$	N.E.	1	Cloudy.	Smooth.	$3\frac{1}{4}$ h. ebb.	30·1	6
2.10 p.m.	E.	53·60	54·0	54·0	$8\frac{1}{2}$	N.E.	1	,,	,,	$5\frac{1}{4}$,,	30·11	$5\frac{1}{2}$
Station II.												
May 24.												
12.35 p.m.	W.	51·44	50·8	46·9	$12\frac{1}{2}$	E.	1	Hazy.	E. swell.	$4\frac{1}{2}$ h. fl.	29·95	7
2.45 p.m.	E.	51·62	50·9	48·1	12	E.	1	,,	,,	$\frac{1}{4}$ h. ebb.	,,	5
June 7.												
11.15 a.m.	E.	59·00	50·9	47·0	$18\frac{1}{2}$	N.E.	Light	Clear.	Slight S.E. swell.	$3\frac{3}{4}$ h. ebb.	29·90	7
1.10 p.m.	W.	60·44	50·2	47·6	14	N.N.E.	,,	,,	,,	$5\frac{3}{4}$,,	29·92	4
Oct. 10.												
9.25 a.m.	W.	51.62	54·0	53·8	13	N.W.	1	Overcast.	Smooth.	$\frac{1}{2}$ h. ebb.	30·09	5
11.15 a.m.	E.	54·68	54 0	53·9	13	N.E.	1	Fine.	,,	$2\frac{1}{4}$,,	30·10	$6\frac{1}{2}$
Station III.												
May 26.												
9.45 a.m.	E.	50·90	50·9	49·9	$8\frac{3}{4}$	N.	4	Cloudy.	Choppy.	$\frac{1}{2}$ h. fl.	29·85	$2\frac{1}{2}$
11.55 a.m.	W.	50·00	51·1	51·0	7	N.	2	,,	,,	$2\frac{1}{2}$h. 5m. fl.	29·84	3
June 6.												
2.10 p.m.	W.	56·48	50·3	49·5	12	E.S.E.	4	Cloudy.	Moderate.	1 h, ebb.	29·70	3
3.23 p.m.	E.	58·10	50·2	49·0	$13\frac{1}{2}$	E.	Sq'lly	,,	Choppy.	$2\frac{1}{4}$,,	,,	$3\frac{1}{2}$
Oct. 12.												
1.45 p.m.	W.	53·42	54·0	54·2	8	E.N.E	1	Cloudy.	Smooth.	4 h. ebb.	30·05	5
2.48 p.m.	E.	54·68	54·0	54·4	9	E.N.E.	1	Overcast.	,,	5 ,,	30·03	$4\frac{1}{2}$
Station IV.												
May 25.												
1.0 p.m.	E.	48·38	48·9	48·8	12	N.E.	3	Cloudy, with passing sh'w'rs	N.E. Swell.	$4\frac{1}{2}$ h. fl.	29·88	5
3.5 p.m.	W.	49·64	50·3	49·1	9	E.N.E.	4	,,	,,	$\frac{1}{2}$,,	,,	$5\frac{1}{2}$
June 14.												
1.50 p.m.	E.	58·82	53·3	49·3	11	E.	1	Clear.	Slight E. swell.	$5\frac{1}{4}$ h. ebb.	30·32	9
3.45 p.m.	W.	56·48	54·9	51·0	$8\frac{1}{2}$	E.	2	,,	,,	$1\frac{3}{4}$ h. fl.	30·28	Bot'm
Oct. 13.												
10.35 a.m.	S.	52·70	53·5	54·1	$10\frac{1}{4}$	E.S.E.	3	Fine.	E. swell.	High water	29·99	7
12.25 p.m.	N.	52·88	53·8	54·2	$12\frac{1}{2}$	E.S.E.	3	Overcast,	Moderate.	2 h. ebb.	,,	$8\frac{1}{2}$

TABLE B.—Record of Observations made on Board the 'Garland' during 1898.

B. PHYSICAL OBSERVATIONS.—I. Moray Firth—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Baro-meter.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Sur-face.	Bot-tom.	Depth in faths.	Direc-tion.	Force.					
Station V.												
1898. May 25. 9.10 a.m.	E.	47·66	48·3	48·0	19½	N.E.	4	Cloudy, with passing showers.	N.E. swell.	½ h. fl.	29·88	5
11.10 a.m.	W.	48·56	50·1	48·1	12	N.E.	3	,,	,,	2½ ,,	,,	6
June 14. 10.20 a.m.	S.W.	56·30	53·8	49·5	12½	S.	Light.	Clear.	Slight E. swell.	2 h. ebb.	30·32	10
12.20 a.m.	N.E.	56·12	53·6	48·0	21	S.E.	1	,,	,,	4 ,,	,,	8
Oct. 13. 12.45 p.m.	N.E.	52·52	53·5	54·0	15	E.S.E.	3	Cloudy.	Moderate.	2h.20m.eb.	29·99	8
2.30 p.m.	S.W.	53·60	53·4	54·2	13	S.E.	3	,,	Moderate E. swell.	4½ h. ebb.	29·97	8½
Station VI.												
May 25. 3.55 p.m.	W.	49·64	50·3	50·0	6	E.N.E.	4	Cloudy.	N.E. swell.	1 h. ebb.	29·88	5
5.10 p.m.	E.	48·20	49·1	47·2	16½	N.	5	,,	,,	2h.10m.eb.	29·86	6
June 14. 8.0 a.m.	W.	50·36	52·9	50·8	6	S.	Light.	Cloudy.	Slight.	5¾ h. fl.	30·34	6
9.55 a.m.	E.	56·30	52·5	48·1	16½	S.	,,	,,	Slight E. swell.	1½ h. ebb.	30·32	10¼
Nov. 19. 10.10 a.m.	S.	50·54	49·4	50·4	7	S.S.W.	2	Fine, haze.	Smooth.	40 m. fl.	30·20	3½
11.55 a.m.	E.	51·80	49·5	50·6	16	S.W.	2	Fine.	,,	1½ h. fl.	30·21	6
Station VII.												
May 27. 9.50 a.m.	W.	47·84	47·8	46·0 47·5	25¼ 12½	N.N.W.	2	Cloudy.	N.E. swell.	5¾ h. ebb.	29·91	7½
11.55 a.m.	E.	50·0	47·7	46·0 46·0	33 16½	N.	2	Rain.	,,	1¾ h. fl.	29·92	7¾
June 15. 8.50 a.m.	W.	54·86	54·0	47·2 48·8	25½ 12¾	Calm.	..	Hazy.	Slight E. swell.	5½ h. fl.	30·26	9
10.52 a.m.	E.	56·84	53·7	47·0 47·8	33 16½	Calm.	..	,,	E. swell.	1¾ h. e	,,	12½
Nov. 18. 1.25 p.m.	E.	51·26	49·7	51·0	30	S.W.	5	Fine.	Moderate.	4½ h. fl.	30·14	6
2.40 p.m.	W.	53·42	49·8	50·9	27	S.W.	4	,,	,,	5½ ,,	,,	5
Station VIII.												
May 27. 1.40 p.m.	N.	48·20	47·8	46·0	34	N.N.W.	1	Cloudy.	N.E. swell.	3½ h. fl.	29·92	6½
3.55 p.m.	S.	48·38	48·0	46·0 46·3	36½ 18¼	W.	1	Rain.	,,	4¾ ,,	,,	5
June 15. 1.40 p.m.	N.	56·84	53·5	47·0 48·0	33 16½	S.E.	Light.	Hazy.	E. swell.	4¾ h. ebb.	30·26	12½
4.0 p.m.	S.	57·02	52·9	47·0 47·9	30½ 15¼	S.S.E	2	Cloudy.	,,	½ h. fl.	,,	13
Nov. 18. 10.20 a.m.	N.	50·18	51·0	51·0	32	S.S.W.	3	Fine.	Moderate.	1h. 10m. fl.	30·19	9
0.15 p.m.	S.	53·60	51·0	51·0	35	S.W.	3	,,	,,	3¼ ,,	30·16	9

TABLE B.—Record of Observations made on Board the 'Garland' during 1898.

B. PHYSICAL OBSERVATIONS—I. Moray Firth—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station IX.												
1898. May 28. 1.00 a.m.	S.	49·64	47·8	46·0	36	W.N.W.	5	Cloudy.	Moderate.	5 h. ebb.	30·01	7
				47·3	18							
12.0 a.m.	N.	51·08	48·0	46·0	$30\frac{1}{2}$	N.N.W	3	,,	,,	1 h. fl.	30·02	7
June 16. 11.10 a.m.	S.	59·18	53·2	47·5	$37\frac{1}{4}$	S.	Light.	Slight haze.	Slight.	..	30·26	12
				47·9	$18\frac{1}{2}$							
1.30 p.m.	N.	60·44	54·8	47·3	31	E.S.E.	1	Clear.	Slight E. swell.	..	,,	13
				48·0	$15\frac{1}{2}$							
Nov. 18. 7.0 a.m.	S.	53·60	50·9	50·8	33	S.S.E.	2	Cloudy.	Slight.	4 h. ebb.	30·30	$8\frac{1}{2}$
8.55 a.m.	N.	51·44	51·0	51·0	28	S.S.W.	3	Fine.	Moderate.	Near low water.	30·20	$9\frac{1}{2}$
Station X.												
May 28. 6.25 a.m.	N.W.	48·74	48·4	46·0	42	N.N.W.	2	Cloudy, passing showers.	N.E. swell.	$1\frac{1}{2}$ h. ebb.	29·96	10
8.25 a.m.	S.E.	50·00	48·8	46·0	19	,,	3	Cloudy.	,,	$3\frac{1}{2}$,,	30·01	7
				48·7	$9\frac{1}{2}$							
June 16. 8.0 a.m.	S.W.	51·44	52·4	47·8	24	E.N.E.	Light.	Overcast.	Slight.	4 h. fl.	30·26	10
				48·9	12							
10.0 a.m.	N.E.	58·46	53·3	47·1	36	Calm.	..	Slight haze.	,,	$5\frac{3}{4}$,,	,,	11
				48·0	18							
Nov. 17. 10.40 a.m.	S.E.	52·52	49·8	50·2	19	W.	2	Fine.	,,	$2\frac{1}{4}$ h. fl.	30·10	8
2.20 p.m.	N.W.	52·34	50·9	51·0	37	W.S.W.	2	Cloudy.	,,	5 ,,	30·14	7
Station XI.												
May 19. 5.10 a.m.	E.	44·96	47·2	46·1	23	S.E.	2	Clear.	,	$\frac{1}{2}$ h. fl.	30·31	7
7.30 a.m.	W.			46·0	$11\frac{1}{2}$							
7.30 a.m.	W.	48·92	47·3	46·0	$28\frac{1}{2}$	S.S.E.	2	,,	,,	$2\frac{3}{4}$,,	,,	7
				46·1	$14\frac{1}{4}$							
June 9. 4.25 p.m.	E.	55·04	50·0	48·9	23	N.E.	1	Hazy.	,	1 h. ebb.	30·25	6
6.55 p.m.	W.	56·66	51·0	47·8	$32\frac{1}{2}$	,,	2	,,	,,			
				48·0	$16\frac{1}{4}$					3h.20m.eb.	30·28	$13\frac{1}{2}$
Station XII.												
May 18. 4.20 p.m.	S.	55·22	48·8	46·1	$22\frac{1}{2}$	S.S.E.	1	Clear.	,,	Near low water.	30·32	9
6.30 p.m.	N.	55·04	48·5	46·2	25	S.E.	1	,,	,,	$2\frac{1}{2}$h.10m.fl.	,,	6
June 10. 3.40 a.m.	N.	49·46	49·5	48·4	$23\frac{1}{2}$	N.E.	1	Hazy.	,,	$5\frac{3}{4}$ h. fl.	30·30	6
				48·6	$11\frac{3}{4}$							
6.0 a.m.	S.	50·72	50·2	48·3	$25\frac{1}{4}$	,,	1	,,	,,	$2\frac{1}{2}$ h. ebb.	,,	$6\frac{1}{4}$
				48·4	$12\frac{1}{2}$							
Station XIII.												
May 19. 1.55 p.m.	S.	49·82	47·9	46·1	27	S.E.	2	Clear.	,,	$3\frac{3}{4}$ h. ebb.	30·31	7
				46·4	13							
4.10 p.m.	N.	50·90	47·9	46·1	30	,,	2	,,	,,	$5\frac{3}{4}$h.5m.eb.	,,	8
June 9. 10.55 a.m.	N.	51·80	48·7	48·2	28	NE byE.	1	Fog.	,,	2 h. fl.	30.25	6
1.15 p.m.	S.	52·70	49·6	48·0	30	E.	2	,,	,,	4 ,,	30·27	6
				48·2	15							

TABLE B.—Record of Observations made on Board the 'Garland' during 1898.

B. PHYSICAL OBSERVATIONS.—I. Moray Firth—*continued.*

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station XIV. 1898. May 20. 6.27 a.m.	N.	48·92	47·4	46·3 46·7	29 18	E.	2	Slight haze.	S E. swell.	1 h. fl.	30·25	8
8.30 a.m.	S.	49·64	48·0	46·0 45·9	40½ 20¼	E.N.E.	2	Clear.	,,	3 ,,	,,	10
June 9. 6.35 a.m.	N.	54·50	48·4	48·1 48·2	30 15	N.E.	1	Haze.	Slight.	3½ h. ebb.	30·22	7½
9.10 a.m.	S.	56·84	50·0	48·0 48·0	42½ 21¼	E.S.E.	Light.	Hazy.	,,	Near low water.	30·27	8
Station XV. May 19. 9.20 a.m. 11.0	N.	49·64	47·7	46·0 45·9	34 17	S.S.E.	3	Clear.	,,	4½ h. fl.	30·31	9
11.30 a.m.	S.	50·54	47·6	46·0 46·0	27 13½	,,	3	,,	,,	1½ h. ebb.	,,	7
June 10. 11.35 a.m.	S.	50·00	50·1	48·5 48·5	26 13	N.E.	2	Fog.	,,	..	30·30	8½
2.0 p.m.	N.	50·90	50·5	47·6	37½	E.N.E.	2	Hazy.	,,	..	30·31	10½
Station XVI. May 18. 9.45 a.m.	S.	49·28	47·2	45·9 46·1	41½ 21½	W. by N.	1	Clear.	,,	5½ h. fl.	30·29	10
11.55 a.m.	N.	51·44	47·5	46·0 46·3	38 19	Light air.	..	,,	Calm to slight.	1h.25m.eb.	30·32	9
June 10. 6.55 a.m.	N.	51·44	50·	47·9 48·0	36½	N.E.	1	Hazy.	Slight.	..	30·30	7
9.10 a.m.	S.	51·44	50·7	47·3 47·5	40½ 20¼	E.N.E.	1	,,	,,	..	,,	7

II. Aberdeen Bay.

Station, Date, and Hour.	End of Station.	Air. Dry Bulb.	Water. Surface.	Water. Bottom.	Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station I. 1898. April 27. 2.42 p.m.	N.E.	48·38	44·9	44·2	10½	S.E.	4	Hazy.	S.E. swell.	3¾ h. fl.	29·84	5
3.53 p.m.	S.W.	45·32	45·0	44·3	9½	,,	4	,,	,,	Nr. 4 h. fl.	,,	3
Station II. May 3. 12.20 p.m.	W.	51·44	47·1	44·3	7	S.S.W.	3	Hazy.	,,	1½ h. ebb.	29·44	2½
2.5 p.m.	E.	49·64	46·0	43·9	21	S.	5	Slight haze.	,,	3½ h. ebb.	29·42	3
Station III. May 4. 10.26 a.m.	E.	49·82	44·0	46·0	20	S.	3	Hazy.	S.S.E. swl.	4¾ h. fl.	29·46	1½
12.10 p.m.	W.	48·56	45·0	44·0	7½	S.	1	Haze, with showers.	,,	½ h. ebb.	,,	2

TABLE B.—Record of Observations made on Board the 'Garland' during 1898.

B. PHYSICAL OBSERVATIONS.—II. Aberdeen Bay—*continued.*

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Temperature. Water. Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station IV.												
1898. May 4.												
1.20 p.m.	W.	48·92	46·4	44·5	8¼	S.	2	Haze.	S.S.E. swell.	1½ h. ebb.	29·46	2
3.3 p.m.	E.	49·46	46·0	44·5	10½	S.	2	Hazy.	,,	3½ ,,	29·47	2¾
Station V.												
May 5.												
11.38 a.m.	N.E.	51·98	44·9	45·0	10	W.N.W.	5	Cloudy.	Moderate.	5¼ h. fl.	29·60	2
1.30 p.m.	S.W.	50·90	44·5	44·7	12	N.W.	3	Rain.	S.E. swell.	1½ h. ebb.	,,	3
Station VI.												
May 5.												
2.8 p.m.	S.W.	48·02	44·7	44·5	17	S.S.W.	3	Showery.	,,	2½ h. ebb.	29·61	4
3.40 p.m.	N.E.	50·18	44·8	44·7	14	N.W.	3	,,	,,	4¼ ,,	29·62	4
Station VII.												
May 5.												
3.52 p.m.	S.W.	50·36	44·8	44·5	20	N.W.	3	,,	,,	4h.22m.eb.	29·62	4
5.40 p.m.	N.E.	53·06	44·6	44·3	32	N.N.W.	5	Cloudy.	,,	Near high water.	29·66	5
Station I.												
Night trawl. May 5.												
9.30 p.m.	N.W.	48·56	46·3	44·0 45.2	42½ 21¼	N.	1	,,	Slight swell.	3½ h. fl.	29·72	..
11.37 p.m.	S.E.	48·56	46·5	44·0 44·0	52 26	N.W.	2	,,	Slight N.E. swell.	5½h.7m.fl.	29·74	..

III. Firth of Clyde.

Station, Date, and Hour.	End of Station.	Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station I.												
1898. August 25.												
8.3 a.m.	N.	57·56	58·1	54·8 55·9	24 12	S.	2	Cloudy.	Slight.	3¾ h. ebb.	30·18	9
9.55 a.m.	S.	60·08	58·1	55·7	..	S.	2	Fine.	,,	5½ ,,	30·17	9
Dec. 15.												
1.35 p.m.	S.	48·56	49·0	50·6	18	N.W.	3	Cloudy.	,,	1h. 5m. eb.	30·15	3
3.40 p.m.	N.	48·20	50·0	49·8	19	,,	1	,,	Smooth.	3h.10m.eb.	30·16	4
Station II.												
August 24.												
3.15 p.m.	Inner End.	59·54	58·1	55·9 58·6	19 9	N.W.	2	,,	,,	5¼ h. fl.	30·19	9
4.45 p.m.	Outer End.	59·90	58·2	53·9 58·0	20 10	N.N.W.	1	,,	,,	¾ h ebb.	30·29	9½
Dec. 9.												
9.5 a.m.	W.	48·20	50·1	50·0	17	W.	7	Overcast, with heavy snow & hail.	S.W. swell.	1½ h. ebb.	29·44	3½
10.51 a.m.	S.E.	47·12	50·1	50·4	25	W.	7	Squally, with heavy hail showers.	Choppy. S.W. swell.	3½ ,,	29·44	5

TABLE B.—Record of Observations made on Board the 'Garland' during 1898.

B. PHYSICAL OBSERVATIONS—III. Firth of Clyde—*continued.*

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Water. Surface.	Water. Bottom.	Water. Depth in faths.	Wind. Direction.	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station III.												
1898. August 24. 12.45 p.m.	N.	60·44	57·2	55·0 55·5	26 13	N.W.	2	Cloudy.	Slight.	2¾ h. fl.	30·18	8
2.35 p.m.	S.	60·80	57·8	53·7 55·8	29 14½	,,	2	,,	,,	4½ ,,	30·19	8
Dec. 8. 12.15 p.m.	N.	42·98	50·1	51·0 50·6	20 10	S.	3	Overcast.	,,	5½ h. ebb.	29·94	5
2.20 p.m.	S.W.	44·24	50·0	50·9 50·8	37 18½	,,	4	,,	Moderate.	1½ h. fl.	29·93	5
Station IV.												
August 24. 10.10 a.m.	N.	59·72	58·2	54·0 55·8	27 13½	N.W.	2	Cloudy.	Slight.	1¼ h. fl.	30·18	7
12.2 p.m.	S.	60·80	58·2	53·4 56·0	29 14½	,,	2	,,	,,	3¾ ,,	30·19	7
Dec. 8. 10.30 a.m.	N.	41·00	50·1	50·7 50·2	27 13½	S'therly.	1	Clear.	Smooth.	3¾ h. ebb.	29·94	5
11.35 a.m.	S.	42·80	50·1	50·5 50·4	29½ 14¾	S.	3	Overcast.	Choppy.	4¾ ,,	29·95	5
Station V.												
August 31. 10.30 a.m.	N.	56·84	55·9	56·5	19	N.W.	4	Clear.	Smooth.	5 h. fl.	30·04	5
12.0 a.m.	W.	58·64	56·9	55 0	20	,,	4	Cloudy.	Slight.	½ h. ebb.	30·03	5
Dec. 14. 1.45 p.m.	N.	48·20	49·8	49·7	18	W.N.W.	8	Cloudy, with rain squalls.	Rough.	2 h. ebb.	29·90	4
2.56 p.m.	S.	47·84	50·0	49·9	22	,,	8	Cloudy, squally.	Choppy.	3¼ ,,	29·90	3½
Station VI.												
August 25. 2.40 p.m.	W.	58·10	56·9	57·0	29	S.	5	Overcast.	Rough.	..	30·10	8
4.57 p.m.	N.E.	58·64	56·8	57·0	21	,,	6	,,	,,	..	30·8	7½
Dec. 15. 10.0 a.m.	S.	47·84	50·5	51·0 50·9	27 13½	N.W.	5	Squally.	Moderate.	4½ h. fl.	30·13	4
1.15 p.m.	N.	48·38	50·9	51·0 50·8	20 10	,,	3	Cloudy.	Slight.	¾ h. ebb.	30·14	3½
Station VII.												
Sept. 6. 3.55 p.m.	N.E.	68·00	58·6	56·4	18	S.	3	Fine, but hazy.	Moderate	5 h. ebb.	29·98	7½
6.5 p.m.	S.W.	61·88	57·3	58·0	24	,,	3	,,	,,	..	29·97	5
Night trawl Sept. 23. 11.40 p.m.	S.E.	53·60	56·2	56·0	21	S.E.	1	Fine.	Slight S.E. swell.	1 h. fl.	30·20	..
Sept. 24. 1.43 a.m.	N.W.	52·88	56·8	55·5	22	,,	2	,,	,,	Nr. 3 h. fl.	30·20	..

TABLE B.—RECORD OF OBSERVATIONS MADE ON BOARD THE 'GARLAND' DURING 1898.

B. PHYSICAL OBSERVATIONS—III. FIRTH OF CLYDE—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
1899.												
Jan. 17. 1.35 p.m.	S.W.	39·38	47·0	48·0 47·0	22 11	W.S.W.	2	Snow showers.	Moderate S.W. swell.	3 h. fl.	29·89	4
3.42 p.m.	N.E.	39·92	47·6	47·2 46·8	20 10	S.E.	1	Overcast.	Slight S.W. swell.	5¼ ,,	29·86	4
Night trawl. Jan. 24. 6.40 p.m.	S.W.	37·76	46·0	47·4 46·0	21 10½	S.S.E.	4	Clear moonlight.	Choppy.	2h. 10m. fl.	30·40	..
8.45 p.m.	..	40·41	46·0	47·1	19½	S.E.	4	,,	,,	4¼ h. fl.	30·43	..
Station VIII.												
1898. Sept. 7. 12.35 p.m.	W.	61·16	56·9	56·3 56·9	33 16½	S.S.W.	3	Hazy.	Moderate.	2¾ h. fl.	29·96	6½
2.30 p.m.	E.	63·14	57·5	54·8	30	,,	2	Fine, thick haze at times.	,,	4¾ ,,	29·95	7
Night trawl. Sept. 23. 8.35 p.m.	E.	57·56	57·0	55·2 56·2	27 13½	S.	1	Fine.	Slight S.W. swell.	3¾ h. ebb.	30·23	..
10.40 p.m.	W.	53·96	56·4	57·0	33½	S.E.	1	,,	,,	Near l.w.	30·21	..
Dec. 17. 8.12 a.m.	W.	47·84	49·9	51·4 51·2	32 16	W.	3	Overcast.	Westerly swell.	l. w.	30·11	5
10.25 a.m.	E.	47·12	49·7	51·0 50·4	28 14	W.S.W.	2	,,	,,	2¼ h. fl.	30·13	5¼
Night trawl. 1899. Jan. 17. 5.40 p.m.	N.E.	40·64	47·0	48·2 46·8	29 14½	S.S.E.	3	,,	Slight.	1h. 10m. eb.	29·84	..
8.0 p.m.	S.W.	41·00	47·0	48·1 47·2	34½ 17¼	S.	5	Dull, with rain.	Moderate.	3½ h. ebb.	29·87	..
Station IX.												
1898. August 31. 1.30 p.m.	N.E	56·30	56·1	54·0 55·9	28 14	N.W.	5	Cloudy.	,,	2 h. ebb.	30·10	7
3.37 p.m.	S.W.	58·64	56·2	55·2	28	W.N.W.	4	Fine.	,,	4h. 7m. eb.	30·15	7
1899. Jan. 17. 9.30 a.m.	N.E.	38·12	46·8	48·0 46·7	26 13	N.W.	3	Fine, pass'ng snow sh'wrs.	Slight.	4¾ h. ebb.	29·87	5
11.40 a.m.	S.W.	39·56	46·9	48·2 46·8	27½ 13¼	W.	3	Showery, snow.	,,	1¼ h. fl.	29·90	4
Station X.												
1898. August 25. 10.55 p.m.	N.E	59·00	58·0	56·6 57·5	26 13	S	3	Fine.	Choppy.	½ h. fl.	30·16	10½
1.20 p.m.	S.W.	58·64	56·9	56·3 56·5	26 13	,,	4	,,	S.W. swell.	3¾ ,,	30·15	8
1899. Jan. 16. 11.40 a.m.	S.W.	45·14	47·5	47·8 47·3	26 13	W.S.W.	6	Cloudy.	Choppy.	2½ ,,	29·03	3½
1.45 p.m.	N.E.	44·78	47·2	47·6 47·2	27 13½	N W.	6	,,	Rough.	4½ ,,	29·02	3½

TABLE B.—Record of Observations made on Board the 'Garland' during 1898.

B. PHYSICAL OBSERVATIONS—III. Firth of Clyde—*continued.*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Station XI.												
1898. Sept. 8. 12.35 p.m.	N.E.	62·60	60·0	55·7 57·0	23 11½	S.W.	2	Cloudy.	Choppy.	2 h. fl.	29·94	7
2.30 p.m.	N.W.	62·06	59·4	53·1	32	,,	1	,,	,,	4 ,,	29·94	7
1899. Jan. 24. 8.25 a.m.	N.E.	32·72	45·3	47·1 46·0	20 10	S.E.	2	Hazy.	Smooth.	4 h. fl.	30·30	3
10.9 a.m.	S.W.	36·68	45·0	47·2 46·8	34 17	,,	1	Fine, Slight haze.	,,	5¾ ,,	30·35	3
Station XII.												
1898. August 30. 12.10 p.m.	W.	58·10	57·0	50·5 52·7	43½ 22	W.N.W.	5	Overcast.	Rough.	1½ h. ebb.	29·68	6½
2.25 p.m.	E.	56·48	56·1	50·9½ 53·1	40 20	W.S.W.	5	Heavy rain.	Moderate.	3¾ ,,	29·64	6
Night trawl Sept. 8. 8.0 p.m.	N.E.	60·98	59·9	52·4 56·6	37 18½	Calm.	..	Overcast.	Smooth.	3 h. ebb.	29·94	..
10.23 p.m.	S.W.	59·00	59·5	51·3	45	N.N.W.	1	Fine rain, overcast.	,,	5½ ,,	29·90	..
1899. Jan. 20. 10.15 a.m.	W.	46·04	46·7 46·5	47·0	41½ 20¾	S.W.	5	Heavy S.W. swell.	Moderate.	4 h. ebb.	29·46	5
12.25 p.m.	E.	46·04	46·7	46·5 46·5	34½ 17¼	,,	5	Overcast.	Moderate; strong S.W. swell.	Top of l.w.	29·43	5
Night trawl 1899. Jan. 23. 5.55 p.m.	W.	40·28	46·7	46·3 46 1	41½ 20¾	N.N.W.	4	Clear.	Moderate.	2 h. fl.	30·12	..
8.30 p.m.	E.	39·02	45·5	47·0 46·4	45 22½	N.N.E.	2	Clear starlight.	Slight.	4½ ,,	30 18	..
Station XIII.												
1898. August 22. 8.25 p.m.	S.W.	60·08	56·0	51·80 51·44	25 12½	S'ly.	..	Fine, with haze at times	Calm.	5½ h. ebb	29·92	5½
9.43 a.m.	N.E.	21·8	57·0	51·1 53·0	31 15½	,,	1	Hazy.	Slight.	¾ h. fl.	29·88	4½
Dec. 6. 8.25 a.m.	S.W.	50·00	50·4	51·4 50·5	27 13½	S.S.W.	6	Overcast.	Slight.	3½ h. ebb.	29·56	4
2.55 p.m.	N.E.	45·32	50·1	51·3 50·4	30 15	S.W.	7	Heavy rain.	Moderate.	3h. 25m. fl.	29·41	3
Station XIV.												
Sept. 22. 6.43 a.m.	S.W.	21·8	57·0	51·1 53·0	31 15½	S'ly.	1	Hazy.	Slight.	¾ h. fl.	29·88	4½
11.10 a.m.	N.E.	21·8	56·8	51·4 54·7	24½ 12¼	,,	2	Fine.	,,	2¼ ,,	29·85	5½
Dec. 6. 11.10 a.m.	N.E.	51·08	50·0	51·2 49·0	26½ 13¼	S.S.W.	7	Cloudy; heavy showers.	Choppy.	Low water.	29·54	3½

TABLE B.—Record of Observations made on Board the 'Garland' during 1898.

B. PHYSICAL OBSERVATIONS—III. Clyde (Upper Loch Fyne).

Station, Date, and Hour.	End of Station.	Temperature. Air. Dry Bulb.	Temperature. Water. Surface.	Temperature. Water. Bottom.	Depth in faths.	Wind. Direction	Wind. Force.	Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
Station XV.												
1898. August 22. 11.35 a.m.	S.W.	21·9	56·0	49·7 52·0	32½ 16¼	S.	2	Fine.	Slight; choppy.	2¾ h. fl.	29·84	6
12.50 p.m.	N.E.	22·4	56·2	48·6 51·1	40 20	S.	2	,,	Slight.	4 ,,	29·82	5
Dec. 6. 11.45 a.m.	S.W.	51.44	49·9	50·5 50·0	33½ 16¾	S.S.W.	7	Cloudy; heavy showers.	Choppy.	½ h. fl.	29·52	3½
1.10 p.m.	N.E.	51·08	49·5	50·1	32	S.W.	7	Cloudy; heavy passing showers.	Moderate.	2h. 10m. fl.	29·51	3½
Station XVI.												
August 23. 11.25 a.m.	N.E.	61·16	56·2	47·0 49·8	60 30	W.N.W.	2	Fine.	Smooth.	2¼ h. fl.	29·96	5
2.5 p.m.	S.W.	63·14	55·6	47·2 49·8	65 32½	,,	2	,,	Slight.	5 ,,	30·01	4½
Dec. 7. 11.0 a.m.	E.	43·70	47·8	48·5 50·4	62 31	W.S.W.	7	Cloudy; passing hail and snow show'rs	Choppy.	5½ h. ebb.	29·44	3
1.35 p.m.	W.	44·60	48·8	48·1 50·7	69 34½	S.W.	7	Heavy rain.	,,	·2h. 5m. fl.	29·42	3
Station XVII.												
August 23. 8.30 a.m.	N.E.	57·56	57·1	52·0	15	S.	1	Fine.	Smooth.	5½ h. ebb.	29·93	4½
10.5 a.m.	S.W.	58·28	55·8	47·1 51·6	35 17½	W.S.W.	1	,,	,,	1 h. fl.	29·96	5½
Dec. 7. 8.25 a.m.	E.	41·00	45·5	49·8 50·8	16 35	S.W.	7	Overcast, with passing showers.	Choppy.	3 h. ebb.	29·44	1
10.20 a.m.	W.	40·82	47·0	49·7	17½	,,	7	Heavy hail and snow showers.	,,	5 ,,	29·44	2

TABLE B.—Record of Observations made on Board the 'Garland' during 1898.

B. PHYSICAL OBSERVATIONS.—IV. Firth of Clyde *(Shrimp Trawl).*

Station, Date, and Hour.	End of Station.	Temperature.				Wind.		Weather.	Sea.	Tide.	Barometer.	Transparency. Fathoms.
		Air.	Water.									
		Dry Bulb.	Surface.	Bottom.	Depth in faths.	Direction.	Force.					
Sanda to Bennan Head.												
Station II. 1898. Sept. 1. 5.5 p.m.	N.	51·20	55·9	56·2 56·0	33 16	S.W.	2	Overcast.	Moderate.	Low water.	30·20	5¼
1899. Jan, 19. 10.0 a.m.	N.W.	44·96	47·1	48·1 47 2	29 14½	W.	6	Cloudy.	Rough.	5 h. ebb.	29·30	4
Station III. 1898. Sept 1. 3.12 p.m.	S.E.	58·46	56·0	55·5	32	S.W.	2	Overcast.	Moderate.	4 h. ebb.	30·23	5
1899. Jan. 19. 11.35 a.m.	,,	45·32	47·2	48·0 47·7	32 16	W.	6	Cloudy.	Rough.	½ h. fl.	29·35	5
Jan. 17. 4.50 p.m.		40·46	47·0	48·0 47·4	26½ 13¼	S.S.E.	3	Overcast.	Slight.	20m. ebb.	29·85	4½
Station V. 1898. Sept. 7. 10.20 a.m.	N.W.	61·52	57·5	56·7	28½	S.	1	,,	,,	¾ h. fl.	29·98	7
Corsewall to Mull of Cantyre.												
Station VI. Sept. 1. 1.30 p.m.	S.E.	57·56	56·2	56·0 56·0	64 32	W.S.W.	1	Overcast.	S.W. swell.	2½ h. ebb.	30·23	5
1899. Jan. 24. 4.5 p.m.	N.	38·30	48·0	48·0 48·0	66 33	S.S.E.	3	Fine, Slight haze.	Choppy.	5½ h. ebb.	30·38	3
Station VII. 1898. Sept. 1. 10.55 a.m.	S.W.	56·48	56·0	56·1 56·0	62 31	W.S.W.	2	Cloudy.	Moderate.	5¾ h. fl.	30.23	6½
1899. Jan. 24. 2.25 p.m.	S.	44·24	47·9	47·9 48·0	64½ 32¼	S.	2	Fine. Slight haze.	Slight.	4 h. ebb.	30·38	3½
Pladda to Turnberry Point.												
Station VIII. 1898. Sept. 6. 10.55 a.m.	N.W.	66·92	58·4	51·5 54·0	49 24½	S.	1	Fine, haze.	Choppy.	2 h. fl.	30·07	7
1899. Jan. 25. 10.10 a.m.	N.	38·30	46·0	46·7 45·8	41 20½	,,	6	Fine, Slight haze.	Rough.	Top of h.w.	30·52	4
Station IX. 1898. Sept. 6. 0.5 p.m.	N.W.	68·00	58·0	52·8 55·9	32 16	,,	3	Fine, haze.	Moderate.	3 h. fl.	30·05	7
1899. Jan. 25. 12.21 p.m.	N.E.	32·50	46·2	46·8 45·9	34 17	,,	6	Fine, Slight haze.	Rough.	1½ h. ebb.	30·53	3½
Station X. 1898. Sept. 6. 2.0 p.m.	S.E.	68·04	58·5	54·5 57·0	25 12	,	2	Fine.	Moderate.	5 h. fl	30.04	7
1899. Jan. 25. 2.10 p.m.	S.W.	32·58	46·0	47·0	25	,,	6	Haze.	Rough.	3½ h. ebb.	30·52	3

TABLE D.—SHOWING THE QUANTITIES OF FISH CAUGHT BY LINE IN 1898 WITHIN THE MORAY FIRTH (INSIDE A LINE BETWEEN DUNCANSBY HEAD AND RATTRAY POINT), AND THE NUMBER OF SHOTS OF THE BOATS BY WHICH THE FISH WERE CAUGHT.

WICK DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.
Jan.	452	290	2,536	3·417	238	0·320	.	.	2,017	2·583	306	0·412	2	0·002	1	0·001	55	0·074	.	.	3	0·004	175	0·235	459	0·618	143	0·192	5,947	8·122
Feb.	619	170	2,597	3·291	425	0·538	.	.	1,110	1·406	138	0·175	5	0·006	5	0·006	75	0·095	.	.	20	0·025	118	0·149	544	0·689	56	0·071	5,093	6·455
March	383	237	3,621	5·84	438	0·706	.	.	638	1·029	197	0·317	.	.	3	0·004	179	0·288	.	.	32	0·051	81	0·13	648	1·045	46	0·074	5,883	9·488
April	115	169	995	3·5	251	0·883	.	.	394	1·387	54	0·095	.	.	3	0·01	68	0·239	.	.	4	0·014	22	0·607	444	1·563	19	0·066	2,254	7·936
May	188	165	1,532	4·34	6	0·017	.	.	1,357	3·844	10	0·028	.		.	.	2	0·005	.	.	18	0·051	4	0·011	6	0·017	10	0·028	2,925	8·286
June	120	222	2,203	6·441	10	0·029	.	.	2,774	8·11	195	0·57	.	.	.	.	8	0·023	.	.	35	0·012	7	0·022	10	0·029	10	0·029	5,252	15·356
July	100	216	611	1·933	.	.	.	.	467	1·477	113	0·357	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12	0·038	1,207	3·819
Aug.	12	79	648	7·12	.	.	.	.	320	3·517	65	0·714	.	.	.		.	.	.	.	16	0·175	.	.	.	.	41	0·45	1,090	11·978
Sept.	.	258	172	0·66	.	.	.	.	61	0·237	60	0·232	.	.	.	.	1	0·003	.	.	44	0·17	.	.	7	0·027	15	0·058	460	1·781
Oct.	.	248	154	0·622	.	.	.	.	50	0·217	40	0·161	.	.	.	.	1	0·004	.	.	46	0·185	.	.	.	.	20	0·08	311	1·254
Nov.	.	372	225	0·604	.	.	.	.	69	0·185	90	0·241	.	.	.	.	.	.	.	.	17	0·045	.	.	.	.	58	0·155	459	1·233
Dec.	.	420	339	0·807	5	0·011	.	.	35	0·083	54	0·128	.	.	.	.	.	.	1	·002	41	0·097	1	0·002	6	0·014	20	0·047	502	1·195
Totals,	1,989	2,846	15,633	3·233	1,373	0·283	.	.	9,292	1·921	1,322	0·273	7	0·001	12	0·002	389	0·080	1	0·0002	276	0·057	408	0·084	2,124	0·439	450	0·093	31,383	6·490

TABLE D.—*continued.*—LYBSTER DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.
Jan.	.	128	351	2·741	.	.	.	.	41	0·32	120	0·937	.	.	.	.	.	.	.	.	1	0·007	8	0·062	.	.	19	0·148	540	4·218
Feb.	34	90	215	1·733	.	.		.	14	0·112	56	0·451	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	0·048	291	2·346
March	77	122	404	2·03	8	0·04	.	.	39	0·195	142	0·713	.	.	.	.	5	0·025	.	.	.	.	.	.	.	.	51	0·256	649	3·261
April	16	89	201	1·914	.	.	.	.	52	0·495	31	0·295	.	.	.	.	3	0·028	.	.	.	.	.	.	.	.	14	0·133	301	2·866
May	.	116	165	1·422	.	.	.	.	44	0·379	51	0·439	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	260	2·241
June	.	151	220	1·456	.	.	.	.	78	0·516	55	0·364	.	.	.	.	.	.	.	.	6	0·039	.	.	.	.	37	0·245	396	2·622
July	13	50	172	2·73	.	.	.	.	142	2·253	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22	0·349	336	5·33
Aug.	8	56	109	1·703	.	.	.	.	33	0·515	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	0·125	150	2·5
Sept.	.	64	109	1·703	.	.	.	.	23	0·359	48	0·75	.	.	.	.	.	.	.	.	.	.	18	0·281	.	.	29	0·453	227	3·39
Oct.	.	99	140	1·414	.	.	.	.	31	0·313	170	1·717	.	.	.	.	.	.	.	.	.	.	21	0 212	.	.	21	0·212	383	3·86
Nov.	.	121	206	1·702	.	.	.	.	.	.	156	1·297	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	0·165	382	3·157
Dec.	.	125	277	2·216	.	.	.	.	.	.	215	1·72	.	.	.	.	.	.	.	.	.	.	.	.	.	.	31	0·248	523	4·184
Totals,	148	1,211	2,569	1·890	8	0·005	.	.	497	0·367	1,044	0·768	.	.	.	.	8	0·005	.	.	7	0·005	47	0·034	.	.	258	0·190	4,438	3·265

TABLE D.—*continued.*—HELMSDALE DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	121	290	1,483	3·608	5	0·012	.	.	75	0·158	525	1·277	9	0·021	1	0·003	4	0·009	.	.	146	0·355	47	0·111	29	0·07	.	.	2,323	5·652
Feb.	141	142	817	2·886	10	0·035	.	.	7	0·024	134	0·473	.	.	.	.	3	0·01	.	.	362	1·279	3	0·01	8	0·028	115	0·406	1,460	5·159
March	130	283	1,487	3·6	10	0·024	.	.	28	0·067	177	0·428	.	.	.	.	5	0·012	.	.	162	0·392	6	0·014	13	0·031	.	.	1,888	4·571
April	34	143	655	3·7	.	.	.	.	38	0·214	150	0·847	8	0·045	.	.	3	0·016	.	.	121	0·683	.	.	10	0·056	60	0·339	1,045	5·903
May	.	209	263	1·257	.	.	.	.	36	0·172	189	0·904	6	0·028	.	.	.	.	.	.	8	0·038	.	.	.	.	83	0·397	585	2·799
June	.	235	251	1·068	.	.	.	.	95	0·404	220	0·936	5	0·021	.	.	2	0·008	.	.	25	0·106	.	.	4	0·017	108	0·459	710	3·021
July	.	82	92	1·121	.	.	.	.	31	0·378	90	1·097	.	.	.	.	.	.	.	.	8	0·097	.	.	.	.	.	.	221	2·573
Aug.	.	61	60	0·983	.	.	.	.	.	.	114	1·868	.	.	.	.	.	.	.	.	10	0·163	.	.	.	.	.	.	184	3·016
Sept.	.	340	147	0·432	.	.	.	.	36	0·105	511	1·503	7	0·02	.	.	.	.	.	.	18	0·052	.	.	.	.	.	.	719	2·114
Oct.	.	345	284	0·829	.	.	.	.	43	0·124	761	2·205	19	0·055	.	.	.	.	.	.	25	0·072	34	0·098	10	0·028	.	.	1,176	3·408
Nov.	3	513	408	0·79	.	.	.	.	48	0·093	1,078	2·081	26	0·05	.	.	.	.	.	.	2	0·003	25	0·048	9	0·017	.	.	1,596	3·096
Dec.	19	328	557	1·605	.	.	.	.	29	0·083	586	·688	10	0·028	.	.	1	0·002	.	.	.	.	14	0·04	9	0·026	30	0·086	1,236	3·561
Totals,	448	2,971	6,504	1·902	25	0·007	.	.	466	0·136	4,535	1·326	90	0·026	1	0·0002	18	0·005	.	.	887	0·259	129	0·037	92	0·026	396	0·115	13,143	3·844

TABLE D.—*continued*.—Cromarty District.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	.	618	516	0·833	.	.	.	.	.	.	769	1·244	.	.	.	.	.	.	.	.	8	0·012	67	0·108	3	0·004	100	0·161	1,463	2·367
Feb.	.	512	389	0·759	.	.	.	.	.	.	507	0·99	.	.	.	.	.	.	.	.	94	0·183	.	.	.	.	93	0·181	1,083	2·115
March	2	552	516	0·931	.	.	.	.	.	.	519	0·936	.	.	.	.	.	.	.	.	156	0·281	.	.	.	.	104	0·187	1,295	2·337
April	.	592	478	0·807	.	.	.	.	.	.	483	0·815	.	.	.	.	.	.	.	.	61	0·103	.	.	2	0·003	114	0·192	1,138	1·905
May	.	366	265	0·724	.	.	.	.	3	0·008	341	0·931	.	.	.	.	.	.	.	.	112	0·306	.	.	11	0·030	14	0·038	746	2·038
June	.	505	328	0·649	.	.	.	.	.	.	495	0·98	6	0·011	.	.	.	.	.	.	15	0·029	.	.	3	0·005	90	0·178	937	1·855
July	.	204	98	0·48	.	.	.	.	.	.	371	1·818	15	0·073	.	.	.	.	.	.	4	0·019	.	.	.	.	87	0·426	575	2·818
Aug.	.	196	78	0·397	.	.	.	.	.	.	347	1·77	2	0·01	.	.	.	.	.	.	22	0·112	.	.	4	0·02	100	0·51	553	2·821
Sept.	.	550	117	0·212	.	.	.	.	.	.	797	1·449	.	.	.		.	.	.	.	66	0·12	.	.	2	0·003	99	0·18	1,081	1·965
Oct.	.	575	214	0·372	.	.	.	.	.	.	620	1·078	.	.	.	.	.	.	.	.	32	0·055	.	.	.	.	124	0·215	990	1·721
Nov.	.	668	329	0·492	.	.	.	.	4	0·005	703	1·052	.	.	.	.	.	.	.	.	15	0·002	.	.	.	.	102	0·152	1,153	1·726
Dec.	.	677	473	0·698	.	.	.	.	128	0·189	675	0·99	4	0·005	.	.	.	.	.	.	17	0·025	.	.	.	.	117	0·172	1,414	2·088
Totals,	2	6,015	3,801	0·631	.	.	.	.	135	0·022	6,627	1·101	27	0·004	.	.	.	.	.	.	602	0·100	67	0·011	25	0·004	1,144	0·19	12,428	2·065

TABLE D.—*continued.*—FINDHORN DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	340	1,082	1,102	0·775	21	0·014	.	.	99	0·069	2,527	1·77	4	0·002	.	.	8	0·005	.	.	2	0·001	8	0·005	37	0·026	5	0·003	3,813	2·681
Feb.	276	576	1,477	1·733	9	0·01	.	.	33	0·038	972	1·14	.	.	.	.	9	0·01	.	.	124	0·145	4	0·004	22	0·025	4	0·004	2,654	3·115
March	433	1,205	2,403	1·467	15	0·009	.	.	22	0·013	2,874	1·76	.	.	.	.	8	0·004	.	.	514	0·313	3	0·001	36	0·021	6	0·003	5,881	3·584
April	275	942	934	0·767	10	0·008	.	.	42	0·034	1,377	1·131	.	.	.	.	1	0·0008	.	.	257	0·211	.	.	36	0·029	4	0·003	2,661	2·186
May	53	636	186	0·269	3	0·004	.	.	248	0·359	653	0·947	18	0·026	.	.	.	.	.	.	112	0·162	.	.	.	.	7	0·01	1,227	1·78
June	38	719	143	0·188	10	0·013	.	.	293	0·387	923	1·219	23	0·03	.	.	.	.	.	.	35	0·046	.	.	.	.	15	0·019	1,442	1·904
July	981	422	19	0·013	.	.	.	.	39	0·027	530	0·377	89	0·063	.	.	.	.	.	.	4	0·002	.	.	3	0·002	23	0·015	707	0·503
Aug.	938	499	13	0·009	.	.	.	.	5	0·003	685	0·476	43	0·029	.	.	.	.	.	.	16	0·001	.	.	3	0·002	22	0·015	787	0·547
Sept.	269	832	53	0·048	.	.	.	.	.	.	1,739	1·578	29	0·026	.	.	.	.	.	.	19	0·017	.	.	.	.	16	0·014	1,856	1·685
Oct.	129	1,084	197	0·158	.	.	.	.	7	0·005	2,193	1·764	25	0·02	.	.	.	.	.	.	176	0·141	.	.	.	.	18	0·014	2,616	2·104
Nov.	174	1,434	588	0·365	.	.	.	.	13	0·008	2,793	1·736	7	0·004	.	.	.	.	.	.	105	0·065	.	.	.	.	11	0·006	3,517	2·187
Dec.	242	1,146	1,056	0·76	.	.	.	.	18	0·012	2,506	1·805	.	.	.	.	1	0·0007	.	.	.	.	.	.	8	0·005	11	0·007	3,609	2·608
Totals,	4,148	10,577	8,171	0·548	68	0·004	.	.	819	0·055	19,772	1·342	238	0·016	.	.	27	0·001	.	.	1,364	0·092	15	0·001	145	0·009	142	0·009	30,770	2·088

TABLE D.—*continued.*—BUCKIE DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age.	Cwt.	Aver-age
Jan.	514	979	2,249	1·50	284	0·190	.	.	750	0·502	4,490	3·007	.	.	.	.	60	0·04	.	.	3	0·0002	18	0·012	314	0·21	290	0·194	8,458	5·665
Feb.	337	404	2,456	3·315	70	0·094	.	.	111	0·149	2,416	3·26	.	.	.	.	50	0·067	.	.	.	.	3	0·004	69	0·093	260	0·35	5,435	7·334
March	552	414	4,191	4·338	85	0·087	.	.	97	0·1004	4,768	4·935	.	.	.	.	57	0·059	.	.	.	.	17	0·017	160	0·165	195	0·201	9,570	9·906
April	236	371	981	1·616	53	0·087	.	.	59	0·097	743	1·223	.	.	.	.	46	0·075	.	.	8	0·011	8	0·011	15	0·024	65	0·107	1,978	3·258
May	.	748	397	0·53	.	.	.	.	31	0·041	945	1·263	.	.	.	.	.	.	.	.	.	.	.	.	.	.	72	0·096	1,445	1·931
June	.	930	310	0·33	.	.	.	.	12	0·012	1,160	1·247	.	.	.	.	1	0·001	.	.	.	.	.	.	.	.	70	0·075	1,553	1·669
July	.	156	79	0·506	.	.	.	.	.	.	166	1·064	.	.	.	.	4	0·025	.	.	.	.	18	0·115	6	0·038	.	.	273	1·75
Aug.	.	101	.	.	.	.	.	.	.	.	189	1·871	.	.	.	.	.	.	.	.	.	.	6	0·059	.	.	.	.	195	1·93
Sept.	33	687	252	0·35	.	.	.	.	.	.	1,910	2·652	.	.	.	.	.	.	.	.	33	0·045	.	.	.	.	115	0·159	2,310	3·208
Oct.	85	952	510	0·491	.	.	.	.	.	.	1,938	1·863	.	.	.	.	.	.	.	.	12	0·011	.	.	.	.	120	0·115	2,580	2·487
Nov.	99	1,141	539	0·433	.	.	.	.	4	0·003	2,885	2·326	.	.	.	.	.	.	.	.	2	0·001	3	0·002	52	0·041	150	0·12	3,635	2·931
Dec.	102	844	1,064	1·124	.	.	.	.	13	0·013	2,551	2·695	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	3,670	3·879
Totals,	1,958	7,727	13,028	1·343	492	0·05	.	.	1,077	0·111	24,161	2·494	.	.	.	.	218	0·022	.	.	58	0·005	73	0·007	616	0·063	1,337	0·137	41,102	4·243

TABLE D.—*continued.*—BANFF DISTRICT.

Months.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.		Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Jan.	288	1,008	1,247	0·96	192	0·148	24	0·018	57	0·044	1,710	1·319	126	0·097	.	.	13	0·01	.	.	17	0·013	58	0·044	80	0·061	118	0·091	3,642	2·518
Feb.	208	865	614	0·572	106	0·098	.	.	45	0·042	2,610	2·432	123	0·114	.	.	14	0·013	.	.	28	0·026	11	0·01	43	0·04	99	0·092	3,693	3·441
March	602	935	934	0·607	73	0·047	.	.	68	0·044	6,844	4·387	207	0·134	.	.	5	0·003	.	.	27	0·017	7	0·004	39	0·025	154	0·100	8,358	5·437
April	192	820	337	0·333	68	0·067	5	0·005	68	0·067	2,009	1·975	92	0·090	.	.	10	0·009	.	.	9	0·008	.	.	22	0·021	89	0·087	2,709	2·676
May	5	311	154	0·487	43	0·136	.	.	608	1·924	334	1·056	54	0·170	.	.	17	0·053	.	.	10	0·031	7	0·022	30	0·095	30	0·095	1,287	4·072
June	1	280	106	0·377	22	0·782	.	.	851	3·028	418	1·486	45	0·16	.	.	7	0·024	.	.	10	0·035	.	.	8	0·028	35	0·124	1,502	5·345
July	.	270	55	0·203	2	0·007	14	0·051	561	2·077	429	1·588	58	0·215	.	.	.	.	.	.	16	0·059	.	.	20	0·074	8	0·029	1,163	4·307
Aug.	.	298	74	0·248	9	0·03	.	.	183	0·614	394	1·325	74	0·248	.	.	.	.	.	.	12	0·04	.	.	6	0·02	42	0·14	794	2·664
Sept.	18	1,258	139	0·151	.	.	.	.	72	0·056	1,919	1·496	110	0·086	.	.	.	.	.	.	34	0·026	.	.	.	.	63	0·049	2,337	1·831
Oct.	97	1,799	951	0·501	46	0·024	.	.	63	0·033	3,340	1·761	124	0·065	.	.	.	.	.	.	41	0·021	.	.	8	0·004	81	0·042	4,654	2·454
Nov.	201	1,748	893	0·46	16	0·008	.	.	13	0·006	2,868	1·473	133	0·068	.	.	.	.	.	.	15	0·007	.	.	4	0·002	74	0·037	4,016	2·06
Dec	96	914	998	0·998	24	0·023	.	.	6	0·005	762	0·754	27	0·026	.	.	4	0·003	.	.	12	0·011	4	0·003	11	0·010	54	0·053	1,902	1·883
Totals,	1,708	10,506	6,502	0·532	601	0·049	43	0·003	2,595	0·212	23,637	1·935	1,173	0·096	.	.	70	0·005	.	.	231	0·018	87	0·007	271	0·022	847	0·069	36,057	2·133

TABLE E.—TOTAL QUANTITIES OF FISH CAUGHT BY LINE IN 1898 WITHIN THE MORAY FIRTH (INSIDE A LINE BETWEEN DUNCANSBY HEAD AND RATTRAY POINT), AND THE NUMBER OF SHOTS OF THE BOATS BY WHICH THE FISH WERE CAUGHT.

Districts.	Number of Shots.		Cod.		Ling.		Torsk (Tusk).		Saithe (Coalfish).		Haddock.	
	Large Boats.	Small Boats.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Wick, .	1,918	2,846	15,633	3·233	1,373	0·283	.	.	9,292	1·921	1,322	0·273
Lybster,	148	1,211	2,569	1·890	8	0·005	.	.	497	0·367	1,044	0·768
Helmsdale,	448	2,971	6,504	1·902	25	0·007	.	.	466	0·136	4,535	1·326
Cromarty,	2	6,015	3,801	0·631	.	.	.	.	135	0·022	6,627	1·101
Findhorn,	4,148	10,577	8,171	0·548	68	0·004	.	.	819	0·055	19,772	1·342
Buckie,	1,958	7,727	13,028	1·343	492	0·05	.	.	1,077	0·111	24,161	2·494
Banff, .	1,708	10,506	6,502	0·532	601	0·049	43	0·003	2,595	0·212	23,637	1·935
Totals,	10,330	41,853	56,208	1·077	2,567	0·049	43	0·0008	1,4881	0·285	81,098	1·554

Districts.	Whiting.		Turbot.		Halibut.		Sole (Lemon Sole).		Flounder, Plaice, Brill.		Eel.		Skate.		Other kinds of White Fish.		Total of Line-caught Fish.	
	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.	Cwt.	Average.
Wick, .	7	0·001	12	0·002	389	0·080	1	0·0002	276	0·057	408	0·084	2,124	0·439	450	0·093	31,383	6·490
Lybster,	.	.	.	.	8	0·005	.	.	7	0·005	47	0·034	.	.	258	0·190	4,438	3·265
Helmsdale,	90	0·026	1	0·0002	18	0·005	.	.	887	0·259	129	0·037	92	0·026	396	0·115	13,143	3·844
Cromarty,	27	0·004	.	.	.	.	.	.	602	0·100	67	0·011	25	0·004	1,144	0·19	12,428	2·065
Findhorn,	238	0·016	.	.	27	0·001	.	.	1,364	0·092	15	0·001	145	0·009	142	0·009	30,770	2·088
Buckie,	.	.	.	.	218	0·022	.	.	58	0·005	73	0·007	616	0·063	1,337	0·137	41,102	4·243
Banff, .	1,173	0·096	.	.	70	0·005	.	.	231	0·018	87	0·007	271	0·022	847	0·069	36,057	2·133
Totals,	1,535	0·029	13	.	730	0·013	1	.	3,425	0·065	826	0·015	3,273	0·062	4,574	0·087	169,321	3·244

II. ON THE PELAGIC FISH-EGGS AND LARVÆ OF LOCH FYNE.

By H. Chas. Williamson, M.A., B.Sc. (Plates II-VI.)

Towards the end of the year 1897 I was instructed to determine, as far as possible, the approximate number of pelagic eggs and larvæ in Loch Fyne. The name Loch Fyne is used to designate that portion of the Clyde area extending from Ardlamont Point to Cairndow, and it is conveniently divided by Otter Spit into Lower and Upper Loch Fyne. Mill* refers Lower Loch Fyne to the Arran basin, and Upper Loch Fyne, cut off, as it is, from the lower portion by the shallow barrier at Otter, he considers a distinct area.

"Loch Fyne† runs, on the whole, north-eastward for 26 miles, following "the slight curves of its axis. For the first 20 miles the breadth varies "between $\frac{3}{4}$ and $1\frac{1}{2}$ mile, then tapering to the head. The total water area "is $28\frac{1}{2}$ square miles; the average depth is $22\frac{1}{2}$ fathoms, and the depth "along the axis averages $40\frac{1}{2}$ fathoms at low tide. The outline of Loch "Fyne suggests its division into two distinct parts, which are found to "correspond with the conditions of depth also. From Otter Spit to "Minard Narrows is a distance of $7\frac{1}{2}$ miles, and this section has been "termed the Gortans Basin. The depth in the Narrows at Otter is only "15 fathoms, at Minard 17 fathoms; but between them the Gortans "Basin sinks to a maximum depth of 35 fathoms, with a depth exceeding "30 fathoms for 3 miles. Speaking generally, Gortans Basin is a shallow "and relatively wide hollow shut off by bars from the deep Lower Loch "Fyne on the seaward side, and from the upper basin on the landward "side. The upper basin, though narrower, is much deeper. The depth "increases gently from Minard for 3 miles, until off Furnace it begins to "increase abruptly, reaching a maximum of 75 fathoms off Strachur, and "only beginning to shallow off Strone Point, Inveraray. The depth in "the centre of the upper basin is over 60 fathoms for nearly 6 miles. "The form of the land bordering Loch Fyne has greatly restricted its "drainage area; and the only streams of any importance enter near the "head of the loch. The tidal current, according to the Admiralty "publications, enters Loch Fyne at Otter at the rate of $3\frac{1}{2}$ knots, passes "through the Gortans Basin at 2 knots, increasing to $2\frac{1}{2}$ at Minard "Narrows, but then slackening until, off Dunderawe, near the head of "the loch, it is reduced to 1 knot."

Method of Research.

In order to carry out the purpose of the research, it was decided to fix upon certain stations where examinations of the water of the area might be made once each month. Accordingly the stations (numbered I.–V. respectively in Plate II.) were selected.

Station I., situated in Lower Loch Fyne, and on the line from Battle Island (at the mouth of West Loch Tarbert) to Buidhe Island on the eastern shore, was taken as a suitable position for obtaining a sample of the pelagic life of Lower Loch Fyne. The remaining four stations—viz.,

* Mill—"Clyde Sea Area," *Trans. Roy. Soc., Edin.* Vol. xxxvi. (1892).

† Mill—"Report on Physical Observations, bearing on Circulation of Water in Loch Fyne" (April and September 1896), 15*th Report of the Fishery Board*, Part III. p. 262.

No. II., immediately above Otter Spit; No. III., about one mile above Minard Narrows; No. IV., crossing the loch at Inveraray; and No. V., opposite Cairndow at the head of the loch, were judged to be fairly representative of the Upper Loch. The distances between the stations are—Between I. and II., 10 miles; II. and III., 8 miles; III. and IV., 9 miles; and between IV. and V., 4 miles. In the selection of the stations, Captain Campbell, late of the *Garland*, kindly assisted me.

It was not always possible for me, with the appliances at my disposal, to examine the water of the loch from the surface to the bottom, since it was necessary on most occasions to employ fishing boats and a small local steamer; the stratum of water examined on each station was 15 fathoms deep. While on Station V. bottom may be found at 15 fathoms, in the middle of the other stations very much greater depths are found.

In order to ascertain the numbers of eggs present on any one station, a number of nets were fastened along a rope at such intervals as to cause them when towed *horizontally* to fish at certain depths. These depths were—Surface, 1 fathom, 2 fathoms, 4 fathoms, 6 fathoms, 10 fathoms, 15 fathoms. In order to offer as small a resistance as possible to the passage of the water through the cloth of the net a fairly open canvas, which has been much used on the *Garland*, was found suitable. The meshes of this cloth when wet with sea-water have openings measuring on an average ·45 × ·45mm.; the thread of the cloth is ·4mm. in thickness. The mouth of each net had a diameter of 2 feet. In addition to the horizontal tow, a *vertical* haul was made on each station. The net used for this purpose had a mouth of 3 feet diameter; it was let down to a depth of 15 fathoms, and then drawn vertically to the surface. By having the cod-end weighted, the net was prevented from fishing as it descended. In this way the forms floating in a vertical column of water were captured. The material of which this net was made was silk grit gauze. When wet with sea-water the meshes were ·55 × ·45 mm.; the threads were of two sizes—one ·33mm. thick; the other, at right angles to the former, ·27mm. thick. The nets thus had small enough meshes to retain all pelagic fish eggs and the greater proportion of the Copepoda and Zoëæ, but allowed all Diatoms and most of the Invertebrate larvæ to escape. Each visit to a station was timed to take place exactly 28 days after the preceding examination. While in the case of certain stations this was successfully accomplished, on some occasions a few days over the allotted interval elapsed before an opportunity of carrying out the work presented itself. Bad weather was the disturbing factor.

In addition to the tow-net work, physical observations were made each month on all the stations. The temperature and specific gravity of the water were taken at the surface, 7½ fathoms, and 15 fathoms. For the temperature observations, the reversing thermometers used on board the *Garland* were employed; in connection with the specific gravity determinations Mill's self-locking water-bottle and the Kiel Hydrometers were made use of. During May, when I was unable to have the *Garland's* self-locking bottle, an attempt was made to get water from 7½ and 15 fathoms with a zinc bottle, the cork of which was intended to be drawn when the bottle sank to the desired depth. This bottle was, however, unworkable. An improvement was made by replacing the cork with a ground brass valve, which was found to be comparatively easily drawn at a depth of 15 fathoms. Leakage occurred; but it was very slight. The improved bottle was used in June. In January and August the work was carried on by means of the *Garland*; during the intervening months fishing boats were employed for Stations I. and II., and a small local paddle-boat was hired for Stations III., IV., and V.

The temperature of the air was noted, as also were the direction and force of the wind, the state of tide, and weather.

Preservation of Tow-Net Collections.

Each collection was preserved in formalin. Commercial formalin was reduced with sea-water (39 parts sea-water to 1 part formalin) until the mixture contained 1 per cent. of formic aldehyde. This fluid preserved the eggs very satisfactorily, there being no immediate shrinkage. After 12 months' immersion in the fluid the shrinkage was about 3·5 per cent. The eggs moreover remained very translucent. Fish larvæ, however, were not preserved well, unless separated from the rest of the tow-net collection. The liquid was changed once or twice, and a large quantity of fluid (proportionally) given the material to be preserved.

Method of Treatment of Results.

The results will be discussed in the following order:—

1. An enumeration of the species the eggs of which were found in Loch Fyne.
2. A discussion of the times of occurrence and relative abundance of the eggs of different species.
3. The stages of development of the eggs.
4. A comparison between the different stations as to the abundance of pelagic ova and Copepoda.
5. The estimated numbers of the eggs of different species in Upper Loch Fyne.
6. The discussion as to the depth at which pelagic eggs and copepods float.
7. On the drift of eggs, &c.
8. List of young fishes captured in the tow-nets.

The Identification of the Ova.

While the identification of some of the ova, either in the fresh or preserved condition, is doubtful, there are certain species which, by the possession of oil globules, markings on the zona, etc., are very readily diagnosed. The egg of the plaice is by its large size separated sharply from all other pelagic eggs. An accurate determination of the numbers of the eggs of every species of the Gadoids is so far not possible. The variation in the size of the eggs of a species introduces a difficulty which, until a determination of the percentage number that vary on either side of the average size is made, prevents an accurate separation of each species. It is always possible by means of size to diagnose the majority of the eggs of a species. Thus, for example, in the case of the eggs of cod and haddock, in the preserved condition, the average size of the former is 1·32—1·34mm. diameter, while of the latter 1·41 is the average size. In a mixture of cod and haddock eggs, then, the method which has been followed has been to separate the two by the size 1·39mm. Eggs of greater diameter—viz., from 1·39—1·5mm. diameter—have been regarded as those of haddock; while those eggs measuring 1·3—1·39mm. have been diagnosed as those of cod. It is among the eggs of the cod and haddock that the greatest difficulty exists in this respect, but from a very careful tabulation, and by the construction of a curve, of the sizes of the eggs of these species collected in March —2277 in number—the great majority can be separated. For the other Gadoids present the average size for each is as follows:—Whiting, 1·2mm.; saithe, 1·13mm.; bib, 1·07mm.; poor-cod, ·93mm.; pollack, 1·11mm.

The numbers of eggs allocated to these species in the Tables are therefore to be regarded as determined on these bases, and more than approximate accuracy is not claimed for them. The identification of the eggs of the other species (with two exceptions) mentioned in the Tables is arrived at with certainty by means of characteristic features other than size. The eggs of the other two referred to, dab and flounder, were separated easily by size, the average diameter of the former being ·8mm.; of the latter, ·88mm.

Tables I. and II. give the numbers of the eggs of each species obtained in the horizontal nets on each station, the limitations with regard to accuracy, cited above, being borne in mind. Table III. gives the same for the vertical nets.

In Tables IV.–XI. the number of eggs captured in each net is given; the horizontal row is marked by the depth (in fathoms) at which the net was fishing. The volume of Copepoda, etc., taken in each net along with the eggs is also given (*vide* p. 113).

Certain of the physical observations made at each station are given in the margin. With regard to notes referring to the wind, the word "force" is represented by the letter "f." The temperature of the air is given always in degrees centigrade. The temperature and salinity of the water are recorded in Table XVI.

In the Tables there are a few blanks; these are due to the loss of the contents of certain nets.

TABLE I.

Number of Eggs of each Species Captured on the Different Stations.

Month.	January.		February.					March.					April.				
Station.	I.	II.	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.
Rockling,	2	4	6	104	28	14	48	123	566	83	41	37	183	398	35	21	17
Dragonet,	..	..	..	1	3	..	2	24	76	26	1	3	81	55	11	6	1
Haddock,	..	..	..	3	4	8	12	9	298	105	47	137	1	64	10	13	22
Saithe,	..	..	..	72	37	1	36	21	423	331	29	68	66	219	50	27	58
Whiting,	..	..	..	3	..	..	..	3	19	15	15	104	73	361	307	124	960
Cod,	..	..	..	..	..	..	2	..	477	325	125	754	163	887	433	289	1332
Bib,	..	..	..	..	..	1	..	45	913	730	34	755	162	286	16	5	29
Plaice,	..	..	..	..	..	..	..	10	119	32	1	29	54	181	17	2	51
Dab,	..	..	..	..	..	..	..	1	139	74	25	252	104	177	56	20	195
Flounder,	..	..	..	..	..	..	..	52	528	199	68	227	683	614	135	103	228
Gurnnard,		..	..	..	..	..	..	..	2	1	1	1	13	14	3	..	..
Turbot,	..	..	..	..	..	..	..	1	..	..	..	13	3	7	3	..	1
Pollack,	..	..	..	..	..	..	..	..	27	..	..	..	8	..	..	..	..
Long Rough Dab,	..	..	..	.	..	..	..	..	1	..	..	..	12	3	27	5	64
Solenette,	.	..	..	..	..	..	..	1	..	..	..	..	..	..	..	1	..
Witch,	..	..	.	..	..	..	..	..	..	..	..	.	8	..	..	..	..
Ling,	..	..	..	..	..	..	..	4	..	..	..	..	..	..	..	..	..
Poor-cod,	..	..	..	..	..	..	..	..	..	..	..	..	..	..	47	47	24
Hake (?),	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..
Mackerel,	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..
Species G	..	..	..	..	..	..	..	..	...	..	..	..	5	..	..	..	..

TABLE II.

Number of Eggs of each Species Captured on the Different Stations.

Month.	May.					June.					July.					August.				
Station.	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.
Rockling,	298	61	36	6	26	12	34	153	24	48	34	19	20	29	10	7	1	1	3	2
Dragonet,	57	32	22	6	40	18	55	187	4	23	24	29	16	4	13	12	17	6	..	7
Haddock,	1	5	4	..	77	1	..	29	4	8	..	..	..	..	..	..	..	..	..	..
Saithe,	38	17	18	9	84	1	9	63	8	408	..	1	..	..	..	..	..	1	..	2
Whiting,	70	102	181	115	426	3	17	133	74	451	6	24	1	7	..	2	..	2	..	5
Cod,	56	59	96	135	982	7	32	114	25	164	4	12	3	2	7	..	..	..	..	5
Bib,	29	22	5	5	9	..	2	28	2	23	3	2	1	..	3	..	..	..	..	..
Plaice,	..	2	9	1	17	1	..	2	..	1	..	..	..	..	..	..	..	..	..	..
Dab,	41	34	44	21	148	23	27	191	22	45	176	27	62	65	6	..	8	10	2	..
Flounder,	251	74	152	55	122	28	16	42	14	31	1	..	..	1	1	3	..	..	..	..
Gurnard,	6	18	6	2	26	1	18	34	2	35	..	8	1	..	2	..	..	..	..	..
Turbot,	21	5	15	..	1	2	1	9	2	159	..	2	2	12	24	..	..	1	..	4
Pollack,	..	..	..	..	4	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
Long Rough Dab,	..	2	7	3	14	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..
Solenette,	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Witch,	..	..	..	..	18	15	27	50	121	946	20	26	9	15	41	2	..	..	..	38
Ling,	..	..	..	..	5	..	1	2	..	2	..	..	..	..	1	..	..	..	..	..
Poor-cod,	81	21	51	23	234	62	54	324	36	92	3	2	2	..	1	..	..	..	..	..
Hake (?)	..	..	..	..	..	..	..	4	..	20	..	2	..	..	5	..	..	..	..	1
Mackerel,	..	..	..	..	..	..	3	9	9	28	2	2	1	128	73	..	..	..	..	..
Species G.,	..	..	..	..	..	1	..	1	..	1	..	3	1	155	112	..	..	..	..	..
Phrynorhombus unimaculatus (?)	..	18	8	7	7	..	16	96	1	8	6	1	..	5	4	1	..	..	..	..
Weever,	..	..	..	..	2	..	..	1	2	..	..	2	..	..	..	..	..	..	..	..
Topknot,	..	..	..	..	2	1	..	1	..	5	..	..	..	..	..	..	..	..	..	..
Lemon Sole,	..	..	..	..	..	..	38	87	27	39	50	60	..	53	7	3	..	2	4	2
Arnoglossus laterna (?)	..	..	..	..	..	61	124	188	5	6	114	73	10	7	..	3	3	6	..	..
Brill,	..	..	..	..	..	..	..	6	2	..	..	..	..	..	2	..	..	..	..	..
Ctenolabrus rupestris (?)	..	..	..	..	..	..	..	11	..	9	..	..	..	..	31	..	..	..	..	..

TABLE III.—NUMBER OF EGGS OF EACH SPECIES TAKEN IN THE VERTICAL NETS.

MONTH.	JAN.	FEB.		MARCH.				APRIL.					MAY.					JUNE.					JULY.					AUG.
STATION.	II.	III.	V.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.	II.
Rockling,	1	...	1	4	...	2	...	...	8	5	1	...	3	1	1	10	1	...	2	...	1	3	...	1	1	...	2	...
Dragonet,	1	...	..	1	...	...	...	...	4	1	...	...	...	2	2	1	1	...	1	4	...	...	1	2	1	...	...	1
Haddock,	...	...	...	...	...	2	1	...	...	...	...	...	1	...	...	1	6	...	...	2	...	...	...	...	...	...	...	...
Saithe,	...	3	1	1	...	...	...	2	1	7	...	...	4	1	...	...	...	...	1	...	...	43	...	...	...	...	...	...
Whiting,	...	...	...	...	...	...	1	3	3	25	3	9	1	4	4	1	4	1	1	2	1	24	...	...	...	1	4	...
Cod,	...	...	...	4	1	1	6	...	7	42	3	24	2	1	...	6	18	...	...	1	1	10	...	1	...	...	...	...
Bib,	...	...	...	3	1	1	14	1	4	2	1	3	1	...	...	...	1	...	...	...	...	7	...	...	...	...	...	...
Plaice,	...	...	...	1	1	...	1	...	2	3	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
Dab,	...	...	...	3	...	2	3	1	6	7	...	7	1	4	1	3	2	...	1	1	...	4	1	1	3	1	...	1
Flounder,	...	...	...	1	...	...	4	...	14	21	3	6	8	...	..	...	...	...	1	...	1	1	...	...	...	...	...	...
Gurnard,	...	...	...	...	...	...	...	2	...	1	...	...	...	2	...	...	...	...	...	1	...	1	...	...	...	...	...	...
Turbot,	...	...	...	...	...	...	...	...	1	...	...	...	1	2	...	...	...	...	...	...	...	...	...	...	...	...	3	...
Long R'gh Dab	...	...	...	...	...	...	...	...	...	7	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Witch,	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	7	...	1	...	...	2	...
Ling,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
Poor-cod,	...	...	...	...	...	...	...	...	4	6	2	...	4	1	...	...	...	3	3	5	...	5	...	...	...	...	...	...
Mackerel,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	1	...	2	3	...
Species G.,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	...
Lemon Sole,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	4	1	...	...	...	...	...
Arnoglossus laterna (?)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	5	1	1	...	...	1	...	...	...	...

TABLE IV.—January.

JANUARY.	Nets. Depth in Fathoms.	Pelagic Eggs of Fish. Number of Eggs in each Net.	Pelagic Eggs of Fish. Number Eggs for each Station.	Copepoda, *Zoëæ*, etc. Volume of Copepoda, etc., in each Net.	Copepoda, *Zoëæ*, etc. Volume of Copepoda, etc., for each Station.
Station I.					
17th: 10.5 a.m.	0			**15** c.c.	
Tow: $1\frac{2}{5}$ mile	1				
Wind: W.S.W., squally	2			**4** c.c.	
Weather: cloudy	4		2	**6** c.c.	55 c.c.
Sea: slight	6			**8·5** c.c.	
Tide: 5 hrs. ebb	10			**12·5** c.c.	
Temperature—air: 10·5°	15			**9** c.c.	
Vertical net				**6·5** c.c.	
Station II.					
20th: 11.10 a.m.	0			**6** c.c.	
Tow: $\frac{4}{5}$ mile	1			**6·5** c.c.	
Wind: N., light	2			**9** c.c.	
Weather: overcast	4		5	**8** c.c.	48 c.c.
Sea: smooth	6			**3** c.c.	
Tide: 1 hr. ebb	10			**6** c.c.	
Temperature—air: 6·7°	15			**9·5** c.c.	
Vertical net				220 Copepods, 1 *Zoëa*	
Station III.					
20th: 8.35 a.m.	0			148 Copepods: 69 *Cumacea*, 24 *Zoëæ*	
Tow: 1 mile	1			**1·5** c.c.	
Wind: S., light	2			**1·5** c.c.	
Weather: slight haze	4		0	**9** c.c.	35 c.c.
Sea: smooth	6			**4** c.c.	
Tide: $4\frac{1}{2}$ hrs. flood	10			**5** c.c.	
Temperature—air: 5·3°	15			**13·5** c.c.	
Vertical net				82 Copepods, 2 *Zoëæ*	
Station IV.					
19th: 1.45 p.m.	0			**19** c.c.	
Tow: $1\frac{1}{10}$ mile	1			**12·5** c.c.	
Wind: W.S.W., squally	2			**9** c.c.	
Weather: rain, hazy	4		0	**28·5** c.c., y. mainly.	106 c.c.
Sea: moderate	6			**15·5** c.c.	
Tide: $4\frac{1}{2}$ hrs. ebb	10			**8·5** c.c.	
Temperature—air: 11°	15			**13** c.c.	
Vertical net				360 Copepods.	
Station V.					
19th: 9.15 a.m.	0			2 Copepods, 81 small Isopods, 5 Amphipods.	
Tow: $\frac{1}{2}$ mile	1			4 Young Amphipods, 1 young Schizopod.	
Wind: S.W., squally	2			135 Copepods, 17 *Zoëæ*.	About 16 c.c.
Weather: fog, rain	4		0		
Sea: slight	6			170 Copepods, 127 *Zoëæ*.	
Tide: near high water	10			**7** c.c.	
Temperature—air: 11.5°	15			**7** c.c.	
Vertical net				16 Copepods, 26 *Zoëæ*.	

Sum of Eggs obtained on the Five Stations.	Horizontal Nets—**7** eggs of **2** species, Vertical Nets—**2** eggs of **2** species.	Total Volume of Copepoda, etc. for the Five Stations.	Horizontal Nets—**260** c.c. Vertical Nets—**8·5** c.c.

Note.—In Tables IV.-XI. the vertical columns labelled "Number of Eggs for each Station" and "Volume of Copepoda for each Station" contain the total contents of the *Horizontal Nets* alone.

TABLE V.—FEBRUARY.

FEBRUARY.	Nets. Depth in Fathoms.	Pelagic Eggs of Fishes. Number of Eggs in each Net.	Pelagic Eggs of Fishes. Number of Eggs for each Station.	Copepoda, *Zoëæ*, etc. Volume of Copepoda, etc., in each Net.	Copepoda, *Zoëæ*, etc. Volume of Copepoda, etc., for each Station.
Station I.					
14th: 3.45 p.m.	0	0			
Tow: ¾ mile	1	2		**2** c.c.	
Wind: W., f. 4	2	1		**7·5** c.c.	
Weather: cloudy	4	0	6	**7** c.c.	42·5 c.c.
Sea: smooth	5	2		**12·5** c.c.	
Tide: 4½ hrs. flood	10	1		**6** c.c.	
Temperature—air: 8·7°	15	0		**7·5** c.c.	
Vertical net		0		**3** c.c.	
Station II.					
17th: 11.30 a.m.	0	35		148 Copepods (16 *Euchætæ*), 10 *Zoëæ*.	
Tow: ⅘ mile	1	20		**5** c.c.	
Wind: N.W., f. 3	2	17		**4·5** c.c.	
Weather: cloudy	4	47	183	**7·5** c.c.	27·5 c.c.
Sea: smooth	6	11		**3** c.c.	
Tide: 3 hrs. ebb	10	26		**4·5** c.c.	
Temperature—air: 6·2°	15	27		**2·5** c.c.	
Vertical net		3		114 Copepods (5 *Euchætæ*) 5 *Zoëæ*.	
Station III.					
18th: 1 p.m.	0	2		**2·5** c.c	
Tow: 1 mile	1	9		**7** c.c.	
Wind: N.N.E., f. 4	2	6		**7** c.c.	
Weather: cloudy	4	1	72	243 Copepods, mainly y.	103·5 c.c.
Sea: smooth	6	18		**60** c.c.	
Tide: 2¾ hrs. ebb	10	12		**17** c.c.	
Temperature—air: 4·7°	15	24		**9** c.c.	
Vertical net		0		**1·5** c.c.	
Station IV.					
19th: 8.20 a.m.	0	17		**21** c.c.	
Tow: $1\frac{1}{10}$ mile	1	2		**17** c.c.	
Wind: S.W., f. 4	2	3		**30** c.c.	
Weather: rain	4	2	24	**16** c.c.	169 c.c.
Sea: choppy	6	0		**28** c.c.	
Tide: 3 hrs. ebb	10	0		**27** c.c.	
Temperature—air: 4°	15	0		**30** c.c.	
Vertical net		0		**55** c.c.	
Station V.					
19th: 4.25 p.m.	0	7		**57** c.c.	
Tow: ¼ mile	1	23		**61** c.c.	
Wind: S.W., f. 3	2	16		**43·5** c.c.	
Weather: rain	4	4	100	**10·5** c.c.	249 c.c.
Sea: slight	6	10		**22·5** c.c.	
Tide: 5 hrs. ebb	10	15		**25** c.c.	
Temperature—air: 5·6°	15	25		**29·5** c.c.	
Vertical net		2		**3·5** c.c.	

Sum of Eggs obtained on the Five Stations.	Horizontal Nets—**385** eggs of **7** species. Vertical Nets—**5** eggs of **2** species.	Total Volume of Copepoda, etc., for the Five Stations.	Horizontal Nets—**591** c.c. Vertical Nets—**14** c.c.

TABLE VI.—March.

MARCH.	Nets. Depth in Fathoms.	Pelagic Eggs of Fishes. Number of Eggs in each Net.	Number of Eggs for each Station.	Copepoda, *Zoëæ*, etc. Volume of Copepoda in each Net.	Volume of Copepoda, etc., for each Station.
Station I.					
14th: 3.15 p.m.	0	80		**7** c.c.	
Tow: ¾ mile	1	30		**9** c.c., l.q. E.*	
Wind: N.W., f. 3	2	46		**13·5** c.c.	
Weather: cloudy	4	75	290	**43·5** c.c., l.q. E.	114·5 c.c.
Sea: slight	6	37		**28·5** c.c., l.q. E.	
Tide: 5 hrs. flood	10	14		**10** c.c., E.	
Temperature—air: 5·8°	15	8		**3** c.c., E.	
Vertical net		0		**2** c.c., E.	
Station II.					
16th: 9.30 a.m.	0	852		**3** c.c., almost entirely E.	
Tow: ¾ mile	1	748		**4** c.c., ,, ,,	
Wind: W., f. 5	2	544		**2** c.c., E.	
Weather: overcast, rain	4	549	3,598	**5** c.c.	22·5 c.c.
Sea: choppy	6	448		½ c.c.	
Tide: ½ ebb	10	268		**4·5** c.c., E.	
Temperature—air: 7·5°	15	189		**3·5** c.c., almost entirely E.	
Vertical net		18		**1** c.c.	
Station III.					
17th: 1.30 p.m.	0	628		**12** c.c.	
Tow: ¾ mile	1	276		**12·5** c.c.	
Wind: S.W., f. gale	2			**7·5** c.c.	
Weather: rain	4	358	1,921	**17** c.c,	8 c.c.
Sea: choppy	6	362		**17** c.c.	
Tide: about low water	10	209		**12** c.c.	
Temperature—air: 10·4°	15	88		**10** c.c.	
Vertical net		3		**1·5** c.c.	
Station IV.					
18th: 3.15 p.m.	0	39		**16·5** c.c., very few E.	
Tow: ¾ mile	1	43		**22** c.c., l.q. E.	
Wind: W., f. gale	2	38		**12** c.c., E.	
Weather: rain	4	77	373	**14·5** c.c., l.q. E.	118 c.c.
Sea: moderate	6	72		**21** c.c., l.q. E.	
Tide: low water	10	46		**12** c.c., E.	
Temperature—air: 9·5°	15	58		**20** c.c., E.	
Vertical net		8		**3** c.c., E.	
Station V.					
19th: 12.15 p.m.	0	6		120 Copepods	
Tow: ½ mile	1	187		**6** c.c., E.	
Wind: N.W., f. squally	2				
Weather: cloudy	4	759	2,380	**24** c.c., E.	117 c.c.
Sea: smooth	6	658		**35** c.c., E.	
Tide: 2 hrs. 20 min. ebb	10	612		**31** c.c.	
Temperature—air: 10°	15	158		**21** c.c.	
Vertical net		30		**4** c.c.	

Sum of Eggs obtained on the Five Stations.	Horiz. Nets—**8562** eggs of **15** species. Vertical Nets—**59** eggs of **10** species.	Total Volume of Copepoda, etc., for the Five Stations.	Horizontal Nets—**460** c.c. Vertical Nets—**11·5** c.c.

* For the meaning of the letters used in this column, see p. 113.

TABLE VII.—April.

APRIL.	Nets. Depth in Fathoms.	Pelagic Eggs of Fishes. Number of Eggs in each Net.	Pelagic Eggs of Fishes. Number of Eggs for each Station.	Copepoda, *Zoëæ*, etc. Volume of Copepoda, etc., in each Net.	Copepoda, *Zoëæ*, etc. Volume of Copepoda, etc., for each Station.
Station I.					
11th: 3.40 p.m.	0	770		**18** c.c., 1 y., 1 a.	
Tow: ¼ mile	1	241		**6·5** c.c., 4 y., 1 a.	
Wind: W., f. 3	2	223		**54** c.c., 1 y., 1 a.	
Weather: cloudy	4		1,625		438·5 c.c.
Sea: smooth	6	266		**205** c.c., 3 y., 1 a.	
Tide: ½ hr. ebb.	10	80		**86** c.c., ,,	
Temperature—air: 10·8°	15	45		**69** c.c., ,,	
Vertical net		9		**14·5** c.c., 1 y., 1 a.	
Station II.					
14th: 8.40 a.m.	0	748		**3·5** c.c., 4 y., 1 a.	
Tow: ¼ mile	1	1,026		**13** c.c., ,,	
Wind: S.W., f. 3.	2	482		**174** c.c., ,,	
Weather: cloudy	4	339	3,297	**173** c.c., ,,	542 c.c.
Sea: smooth	6	392		**120** c.c., ,,	
Tide: ½ ebb	10	189		**35** c.c., ,,	
Temperature—air: 7·8°	15	123		**23·5** c.c. ,,	
Vertical net		54		**20** c.c., 2 y., 1 a.	
Station III.					
19th: 1.20 p.m.	0	49		**192** c.c., 1 y., 1 a.	
Tow: ¼ mile	1	138		**700** c.c., 2 y., 1 a.	
Wind: S., f. 4	2	183		**190** c.c., ,,	
Weather: cloudy	4	320	1,150	**237** c.c., ,,	1,621 c.c.
Sea: slight	6	282		**180** c.c., ,,	
Tide: 2 hrs. ebb	10	111		**85** c.c., 1 y., 1 a.	
Temperature—air: 9°	15	67		**37** c.c., ,,	
Vertical net		127		**62** c.c., ,,	
Station IV.					
18th: 9.10 a.m.	0	1		**2** c.c., 1 y., 1 a.,	
Tow: ¼ mile	1	21		**71** c.c., ,,	
Wind: S.S.E., f. 5	2	149		**245** c.c., ,,	
Weather: cloudy	4	208	663	**505** c.c., ,,	1,375 c.c.
Sea: slight	6	130		**337** c.c., 1 y., 2 a.	
Tide: 4¾ hrs. flood	10	95		**135** c.c., ,,	
Temperature—air: 10·75°	15	59		**80** c.c., ,,	
Vertical net		16		**26·5** c.c., 1 y., 1 a.	
Station V.					
16th: 12.40 p.m.	0	0		**14·5** c.c., 3 y., 1 *Evadne*	
Tow: ¼ mile	1	395		**17** c.c., *Evadne*	
Wind: S.W., f. 3	2	648		**67** c.c., 4 y., 1 a.	
Weather: showery	4	1,150	2,982	**175** c.c., ,,	424 c.c.
Sea: choppy	6	189		**33** c.c., 3 y., 1 a.	
Tide: 4 hrs. ebb	10	455		**70** c.c., ,,	
Temperature—air: 10·6°	15	145		**47·5** c.c., 2 y., 1 a.	
Vertical net		52		**13·5** c.c., 1 y., 1 a.	

Sum of Eggs obtained on the Five Stations.	Horiz. Nets—**9717** eggs of **21** species. Vertical Nets—**25** eggs of **13** species.	Total Volume of Copepoda, etc., for the Five Stations.	Horizontal Nets—**4400** c.c. Vertical Nets—**136** c.c.

TABLE VIII.—May.

MAY.	Net. Depth in Fathoms.	Pelagic Eggs of Fishes. Number of Eggs in each Net.	Number of Eggs for each Station.	Copepoda, *Zoëæ*, etc. Volume of Copepoda, etc., in each Net.	Volume of Copepoda, etc., for each Station.
Station I.					
9th: 3.55 p.m.	0	229		170 Copepods, 1 y., 1 a.	
Tow: ¾ mile	1	242		**121** c.c., 1 y., 1 a.	
Wind: N.N.W., f. 4	2	152		**380** c.c., 1 y., 1 a.	
Weather: cloudy	4	150	949	**925** c.c., 4 y., 1 a.	2734·5 c.c.
Sea: slight	6	136		**1216** c.c., 4 y., 1 a.	
Tide: 1½ hr. ebb	10				
Temperature—air: 12·2°	15	40		**92·5** c.c., 2 y., 1 a.	
Vertical net		28		**80** c.c., 2 y., 1 a.	
Station II.					
11th: 9.30 a.m.	0	95		**9** c.c., 1 y., 1 a.	
Tow: ¼ mile	1	59		**100** c.c., 1 y., 2 a.	
Wind: N., squally	2	66		**290** c.c., 1 y., 2 a.	
Weather: cloudy	4	83	473	**149** c.c., 1 y., 1 a.	870·5 c.c
Sea: slight	6	105		**225** c.c., 1 y., 1 a.	
Tide: low water	10	22		**53·5** c.c., 1 y., 1 a.	
Temperature—air: 5.9°	15	43		**44** c.c., 1 y., 1 a.	
Vertical net		18		**3·5** c.c., 1 y., 2 a.	
Station III.					
12th: 1.15 p.m.	0	97		201 Copepods, 1 y., 3a.	
Tow: ¼ mile	1	101		**216** c.c., 1 y., 3 a.	
Wind: N.W., f. 4.	2	63		**210** c.c., 1 y., 3 a.	
Weather: showery	4	104	654	**432** c.c., 1 y., 3 a.	1439 c.c.
Sea: slight	6	101		**390** c.c., 1 y., 3 a.	
Tide: 2 hrs. flood	10	105		**130** c.c., 1 y., 3 a.	
Temperature—air: 10°	15	83		**60** c.c. 1 y., 3 a.	
Vertical net		8		**18** c.c., a.	
Station IV.					
13th: 12.30 p.m.	0	50		50 Copepoda, 1 y., 1 a.	
Tow: ¼ mile	1	66		**25** c.c., a.	
Wind: N.W., f. 2	2	71		**93** c.c., a.	370 c.c.
Weather: cloudy	4	117	388	**143** c.c., 1 y., 3a.	
Sea: smooth	6	70		**67** c.c., 1 y., 3 a., E.	
Tide: 1 hr. flood	10	6		**26** c.c., a., E.	
Temperature—air: 10°	15	8		**16** c.c., a., E.	
Vertical net		22		**8·5** c.c., a.	
Station V.					
14th: 8 a.m.	0	118		999 Copepods, y.	
Tow: ¼ mile	1	713		**126** c.c., 2 y., 1 a.	
Wind: calm	2	593		**207** c.c., 2 y., 1 a.	
Weather: cloudy	4	627	2246	**185** c.c., 2 y., 1 a.	730·5 c.c.
Sea: smooth	6	135		**150** c.c., 2 y., 1 a.	
Tide: 1 hr. ebb	10	35		**48** c.c., 3 c., 1 Z.	
Temperature—air: 7·2°	15	25		**13** c.c., 1 c., 2 Z.	
Vertical net		35		**14** c.c., a., mainly.	

Sum of Eggs obtained on the Five Stations.	Horizontal Nets—**4710** eggs of **23** species. Vertical Nets—**111** eggs of **15** species.	Total Volume of Copepoda, etc., for the Five Stations.	Horizontal Nets—**6314** c.c. Vertical—**124** c.c.

TABLE IX.—June.

June.	Nets. Depth in Fathoms.	Pelagic Eggs of Fishes. Number of Eggs in each Net.	Number of Eggs for each Station.	Copepoda, *Zoëæ*, etc. Volume of Copepoda, etc., in each Net.	Volume of Copepoda, etc., for each Station.
Station I.					
6th : 1.45 p.m.	0	31		**76** c.c., a.	
Tow : ¼ mile	1	56		**435** c.c., 1 y., 1 a.	
Wind : S.E., f. 5	2	56		**325** c.c., a.	
Weather : rain	4	42	237	**305** c.c., a.	1786 c.c.
Sea : moderate	6	40		**365** c.c., a.	
Tide : high water	10	5		**165** c.c., a.	
Temperature—air : 11·1°	15	7		**115** c.c., a.	
Vertical net		6		**47** c.c. a.	
Station II.					
8th : 9.15 a.m.	0	72		**8** c.c., a.	
Tow : ¼ mile	1	78		**27** c.c., a.	
Wind : S., f. 2	2	55		**31·5** c.c., a.	
Weather : cloudy	4	78	475	**61** c.c., a.	265·5 c.c.
Sea : smooth	6	90		**70** c.c.. a.	
Tide : ½ hr. flood	10	50		**41** c.c., a.	
Temperature—air : 13·8°	15	52		**27** cc., a.	
Vertical net		16		**10** c.c., a.	
Station III.					
9th : 1.10 p.m.	0	171		149 Copepods, a.	
Tow : ¼ mile	1	428		**12** c.c., a.	
Wind : S.W., f. 2	2	241		**23** c.c., a.	
Weather : cloudy	4	344	1,767	**45** c.c.. 1 y., 3 a.	497 c.c.
Sea : smooth	6	333		**114** c.c., 4 y., 1 a	
Tide : 3 hrs. flood	10	134		**71** c.c., 4 y., 1 a.	
Temperature—air : 22°	15	116		**91** c.c., 3 y., 1 a.	
Vertical net		17		**40** c.c., 1 y., 1 a.	
Station IV.					
10th : 8.35 a.m.	0	53		92 Copepods, a.	
Tow : ¼ mile	1	98		**2·75** c.c., a.	
Wind : S.W., f. 1	2	106		**8** c.c., a.	
Weather : hazy	4	79	384	**61** c.c., a.	307 c.c.
Sea : smooth	6	41		**196** c.c., a.	
Tide : 4 hrs. ebb	10	4		**22** c.c., a.	
Temperature—air 11·1°	15	3		**17** c.c., a.	
Vertical net		6		**11·5** c.c., a.	
Station V.					
10th : 6.15 p.m.	0	61		**3** c.c., 1 a., 3 Z.	
Tow : ¼ mile	1	763		**8** c.c., 1 a., 2 Z.	
Wind : E., f. 3	2	889		**11** c.c., 1 a., 2 Z.	
Weather : cloudy	4	577	2,549	**66** c.c., 1 y., 1 a., 1 Z.	188 c.c.
Sea : smooth	6	155		**72** c.c., 3 y., 1 a., 2 Z.	
Tide : 1½ hr. ebb	10	66		**13** c.c., 1 a., 1 Z.	
Temperature—air : 18·5°	15	38		**15** c.c., 1y., 1 a., 1 Z.	
Vertical net		111		**11** c.c., 1 y., 2 a., 3 Z.	

Sum of Eggs obtained on the Five Stations.	Horizontal Nets—**5409** eggs of **30** species. Vertical Nets—**156** eggs of **14** species.	Total Volume of Copepoda, etc., for the Five Stations.	Horizontal Nets—**3043** c.c. Vertical Nets—**119** c.c.

TABLE X.—July.

JULY	Nets. Depth in Fathoms.	Pelagic Eggs of Fishes. Number of Eggs in each Net.	Pelagic Eggs of Fishes. Number of Eggs for each Station.	Copepoda, *Zoëæ*, etc. Volume of Copepoda, etc., in each Net.	Copepoda, *Zoëæ*, etc. Volume of Copepoda, etc., for each Station.
Station I.					
5th : 9.35 a.m.	0	124		**1** c.c., a., E.	
Tow : ¼ mile	1	90		**20·5** c.c., mainly a.	
Wind : W. by S., f. 2	2	55		**12** c.c., mainly a.	
Weather : overcast	4	56	444	**15** c.c., mainly a.	81·5 c.c.
Sea : smooth	6	86		**14·5** c.c., mainly a.	
Tide : ½ flood	10	17		**12·5** c.c., mainly a.	
Temperature—air : 12°	15	16		**6** c.c., 1 y., 1 a.	
Vertical net		3		**2·5** c.c., a., E.	
Station II.					
6th : 8.45 a.m,	0	78		**36** c.c., a.	
Tow : ¼ mile	1	64		**21** c.c., 1 y., 2 a.	
Wind : W., f. 1	2	42		**1·5** c.c., 2 a., 3 Z.	
Weather : cloudy	4	43	304	**1·5** c.c., 1 y,, 1 a.	97 c.c.
Sea : smooth	6	48		**9** c.c., 1 y., 2 a.	
Tide : 1 hr. flood	10	15		**10** c.c., 1 y., 1 a.	
Temperature—air : 14°	15	14		**18** c.c., 1 y., 1 a.	
Vertical net		8		**1** c.c , 6 a., 1 Z.	
Station III.					
8th : 5.5 p.m.	0	67		Abt. ·**7** c.c.	
Tow : ¼ mile	1	9		Abt. ·**5** c.c.	
Wind : N.W., f. 3	2	7		2 Copepods, 102 *Zoëæ*.	
Weather : cloudy	4	10	129	Abt. ·**5** c.c., mainly Z.	6·5 c.c.
Sea : smooth	6	20		Abt. ·**5** c.c., Z.	
Tide : 1½ hr. ebb	10	9		**1** c.c., 1 a., 1 Z.	
Temperature—air : 18·5°	15	7		**3** c.c., 1 y., 1 a., 2 Z.	
Vertical net		5		29 Copepods, 7 *Zoëæ*.	
Station IV.					
7th : 8.45 a.m.	0	183		**2·5** c.c., y.	
Tow : ¼ mile	1	191		**16** c.c., 1 y., 1 a., 2 E.	
Wind : S. W., f. 3	2	63		**10** c.c., 1 y., 1 a., 2 E.	
Weather : rain	4	18	483	**79** c.c., y., E.	676·5 c.c.
Sea : smooth	6	24		**300** c.c., y., E.	
Tide : ¼ hr. flood	10	3		**150** c.c., y., E.	
Temperature—air : 13·5°	15	1		**119** c.c., 3 y., 1 a.	
Vertical net		45		**10** c.c., a., Z.	
Station V.					
7th : 4.25 p.m.	0	0		**1** c.c., *Evadne*	
Tow : ¼ mile	1	54		**9** c.c., y.	
Wind : N.W., f. 5	2	12		**4·5** c.c., y.	
Weather : cloudy	4	126	342	**121** c.c., y., Z.	662 c.c.
Sea : slight	6	100		**149** c.c., y., Z.	
Tide : 1¾ hr. ebb	10	34		**41** c.c., y., Z.	
Temperature—air : 17·5°	15	16		**251** c.c., y., Z.	
Vertical net		20		**18·5** c.c., y., Z.	

Sum of Eggs obtained on the Five Stations.	Horizontal Nets—**1703** eggs of **22**. species. Vertical Nets—**40** eggs of **11** species.	Total Volume of Copepoda, etc., for the Five Stations.	Horizontal Nets—**1524** c.c. Vertical Nets—**32** c.c.

TABLE XI.—August.

AUGUST.	NETS. Depth in Fathoms.	PELAGIC EGGS OF FISHES. Number of Eggs in each Net.	PELAGIC EGGS OF FISHES. Number of Eggs for each Station.	COPEPODA, *Zoëæ*, etc. Volume of Copepoda, etc., in each Net.	COPEPODA, *Zoëæ*, etc. Volume of Copepoda, etc., for each Station.
Station I.					
8th : 11.10 a.m.	0	5		3 Copepods, 3 *Zoëæ*, 9 *Evadne.*	
Tow : ¼ mile	1	6		13 Copepods (y.), 2 *Zoëæ*, 7 *Evadne.*	
Wind : N.W., f. 1	2	0		5 *Medusæ*, 2 *Zoëæ*, E.	
Weather : cloudy	4	8	33	14 *Medusæ*, *Caligus*, (sp.).	About ·2 c.c. + 420 *Medusæ.*
Sea : smooth	6	4		34 *Medusæ*, 16 *Zoëæ*, 2 Copepods.	
Tide : 1 hr. flood	10	1		141 *Medusæ*, 10 *Zoëæ*, E.	
Temperature—air : 13°	15	9		226 *Medusæ*. 20 Copepods, E.	
Vertical net		0		11 *Medusæ.*	
Station II.				8 *Medusæ*, 3 *Zoëæ.*	
9th : 3.50 p.m.	0	7		15 *Medusæ*, *Caligus* (sp.).	
Tow : ¼ mile	1	6		33 *Medusæ*, 1 Copepod.	
Wind : W., f., 1	2	3		107 *Medusæ*, 1 Copepod, 1 *Zoëa.*	
Weather : fine	4	7	29	79 *Medusæ*, 2 Copepods.	About ·5 c.c. + 526 *Medusæ.*
Sea : smooth	6	3		105 *Medusæ*, 3 Copepods, 17 *Zoëæ.*	
Tide : ¾ hr. flood	10	1		179 *Medusæ*, 41 Copepods (1 y., 1 a.), 46 *Zoëæ.*	
Temperature—air : 15·9°	15	2			
Vertical net		2		18 *Medusæ*, 3 Copepods, 4 *Zoëæ.*	
Station III.				4 Copepods (y.).	
9th : 2.20 p.m.	0	10		Ascidian larva.	
Tow : ¼ mile	1	1		8 *Medusæ*, *Caligus*, (sp.).	
Wind : W., f. 1	2	2		13 *Medusæ*, 2 Copepods (y.), 1 *Zoëa.*	
Weather : fine	4	2	29	23 *Medusæ*, 7 Copepods, 4 *Zoëæ.*	About **1**·8 c.c. + 54 *Medusæ.*
Sea : smooth	6	5		10 *Medusæ*, 32 Copepods, (1 y., 1 a.), 38 *Zoëæ.*	
Tide : ½ flood	10	5		**1·6** c.c., 2 y., 1 a., 1 Z., M.	
Temperature—air : 16·4°	15	4		1 *Medusa*, 1 Copepod.	
Vertical net		0			
Station IV.					
9th : 11.5 a.m.	0	1		4 Copepods.	
Tow : ¼ mile	1	5		1 Copepod (y.), 1 *Zoëa*, E.	
Wind : N.W., f. 1	2	2		2 Copepods, 2 *Zoëæ*, E.	
Weather : fine	4	0	9	Abt. **·4** c.c., 4 Copepods, 1 *Zoëa*, E.	About 2·3 c.c.
Sea : smooth	6	0		Abt. **·4** c.c., mainly E., (c., Z., M.).	
Tide : ¼ flood	10	1		Abt. **·4** c.c.. mainly E., (c., Z., M.).	
Temperature—air : 15·4°	15	0		Abt. **1** c.c.. 2 y., 1 Z., 1 E.	
Vertical net		0		1 Copepod, 1 *Medusa*, 8 E.	
Station V.					
9th : 7.35 a.m.	0	0		Abt. **·5** c.c., mainly y., 5 *Zoëæ.*	
Tow : ¼ mile	1	17		Abt. **1** c.c., 2 y., 1 a.	
Wind : calm	2	1		140 Copepods (3 y., 1 a)., 6 *Zoëæ.*	
Weather : fine	4	11	66	**3** c,c., 1 y., 2 a., Z.	About 14·5 c.c.
Sea : smooth	6	10		**3·5** c.c., 2 y., 1 a., 1 Z., M.	
Tide : ½ ebb	10	25		**3** c.c., 1 y., 1 Z., a.	
Temperature—air : 11·5°	15	2		**3·5** c.c., 1 y., 1 Z., a.	
Vertical net		0		39 Copepods, 22 *Zoëæ.*	
Sum of Eggs obtained on the Five Stations.	Horizontal Nets—**166** eggs of **13** species. Vertical Nets—**2** eggs of **2** species.			Total Volume of Copepoda, etc., for the Five Stations.	Horizontal Nets—**19·6** c.c. Vertical Nets—Abt. **·3** c.c.

List of Species, Eggs of which were found.

Bib, *Gadus luscus*, Will.
Brill, *Bothus rhombus*, L. (*Rhombus lævis*).
Cod, *G. callarias*, L. (*Gadus morrhua*).
Dab, *Pleuronectes limanda*, L.
Dragonet, *Callionymus lyra*, L.
Flounder, *Pleuronectes flesus*, L.
Gurnard, Grey, *Trigla gurnardus*, L.
Gurnard, Red, *T. cuculus*, L.
Haddock, *Gadus æglefinus*, L.
Hake, *Merluccius vulgaris*, L.
Lemon Sole, *Pleuronectes microcephalus*, Don.
Ling, *Molua molva*, L. (*Molva vulgaris*).
Long Rough Dab, *Drepanopsetta platessoides*, Fab.
Mackerel, *Scomber scombrus*, L.
Plaice, *Pleuronectes platessa*, L.
Pollack, *Gadus pollachius*, L.
Poor-Cod, *Gadus minutus*, L.
Five-bearded Rockling, *Onos mustela* L. (*Motella mustela*).
Three-bearded Rockling, *O. tricirratus*, Brünn (*M. tricirrata*).
Saithe, *Gadus virens*, L.
Solenette, *Solea lutea*, Risso.
Topknot, *Zeugopterus punctatus*, Bl.
Turbot, *Bothus maximus*, Will. (*Rhombus maximus*).
Weever, *Trachinus vipera*, Cuv.
Whiting, *Gadus merlangus*, L.
Witch, *Pleuronectes cynoglossus*, L.
Phrynorhombus unimaculatus, Risso.
Arnoglossus laterna, Gthr.
Ctenolabrus rupestris, (Sp. F).
Species C.
,, D.
,, E.
,, G.

Notes on the above List.

Hake (*Merluccius vulgaris*, L.). The egg which has been provisionally regarded as that of the hake has a diameter of 1·31–1·36mm., with an oil globule measuring ·25–·35mm. Holt* gives the size of this egg as 1·35 × 1·08mm.; oil globule, ·3mm. According to Raffaele,† the egg of the species measures ·94–1·03mm. (O.G. ‡ ·27mm.). Mr. H. M. Kyle has informed me that ripe eggs taken from a hake at Banyuls measured less than 1mm. in diameter, while other eggs measuring 1·07mm. (O.G. ·23–·27mm.), captured in the Mediterranean, produced larvæ agreeing exactly with Raffaele's description of the hake embryo. The disparity between the sizes given by Holt and Raffaele is too great to be accounted for merely by the variation found among the eggs of every species.

Mackerel (*Scomber scombrus*, L.). The size of the egg of this fish is given by Cunningham § as 1·22mm. in diam., O.G. ·32–·33mm. In the Loch Fyne collections, ova measuring 1·2–1·25mm. diam., O.G. ·3–37mm., were obtained. The eggs of the mackerel have not, so far, been described from Scotch waters, but numbers of ripe mackerel are caught each year in Loch Fyne, and it is extremely probable that the diagnosis of the latter egg as mackerel is correct.

Pollack (*Gadus pollachius*, L.). Holt ‖ gives 1·13mm. as the size of this egg. This agrees closely with the dimensions given by M'Intosh¶, viz., 1·14mm. A number of eggs measuring 1·11mm. were captured in Loch Fyne, and as this size is a little smaller than the average size of the saithe, they were regarded as Pollack. In the case of preserved eggs, a

* "On the Eggs and Larvæ of Teleosteans." *Trans. Roy. Dublin Socy.*, vol. iv. (ser. ii.), 1891.

† "Le uova gallegianti e le larve dei Teleostei nel Golfo di Napoli," *Mittheil. Zool. Stat. Neapel*, Bd. viii., p. 37, 1888.

‡ Oil globule.

§ *Journal Mar. Biol. Assoc.*, N.S., vol. i., p. 31.

‖ *Op. cit.*

¶ M'Intosh and Masterman, "British Marine Food Fishes," p 271 1897 large amount of dependence on size is necessary, since such a diagnostic feature as the pigment of the embryo is obliterated to a large extent. Holt * believes an egg measuring 1·4–1·5mm., captured at Plymouth, to be the egg of a large Pollack.

Müller's Topknot (*Zeugopterus punctatus*, Bl.). The size of the egg of this species is given by M'Intosh and Prince † as 1·05mm. in diam., O.G. ·2mm. An egg measuring 1·1mm., O.G. ·2mm., I have regarded as belonging to this species.

Species A (*Phrynorhombus unimaculatus* ?). An egg measuring ·9–·95mm. in diam., O.G. ·17–·19mm., occurred frequently in the tow-nets in May, and from time to time in June, July, and August. Holt § measured the ripe eggs of this form, and found them to be ·92–·93mm. in diameter. Cunningham ‡ records that eggs were obtained by Brook in Loch Fyne in June from a female *P. unimaculatus.* They measured in diam. ·96mm., and had a small yellowish oil globule. The eggs of *Rhombus norvegicus* are not very different from those of *P. unimaculatus*, but so far the former species has not been recorded from Loch Fyne. Holt* discusses the relationship between the eggs of the three Topknots.

Species B (*Arnoglossus laterna*, Gthr.). Egg measuring ·65–·7mm., O.G. ·15. Holt ‖ obtained ripe ova of this species. He found them to measure ·675–·690mm. in diam. (O.G. ·14–·15mm.) in one case, in June, and ·75–·76mm. (O.G. ·12–·13mm.) in another case, in July. Ehrenbaum ¶ had previously described an egg taken in the tow-net as belonging to this species. The egg obtained in Loch Fyne was very common in June and July, and occurred also in August. It was obtained quite close to the surface in greatest numbers, but also occurred down to a depth of 10 to 15 fathoms.

Species C, D, E. These eggs measured respectively—C, 1·2 and 1·25mm., O.G. ·2mm.; D, 1·17mm., O.G. ·15mm.; E, ·9mm., O.G. ·27mm. Four eggs of C were found—two in April and two in May. One each of D and E were noticed.

Species F (*Ctenolabrus rupestris*, L. ?). This egg, which measured ·67–·72mm., was obtained in June and July. It has no oil globule, and very probably is rightly referred to *Ctenolabrus rupestris* (Holt**). This form is common in Loch Fyne.

Species G. The egg labelled G in the Tables measured 1·12–1·16mm. in diam. (O.G. ·3mm. and over). It resembles very much the egg which I have diagnosed as that of the mackerel, differing from it slightly in diameter. It was captured in Loch Fyne in April, June, and July.

Bib (*Gadus luscus*, Will). The eggs which have been regarded as belonging to this species measured, on the average, 1·07mm. diam. A considerable number of eggs measuring exactly 1·07mm. were captured.

On the Occurrence of the Eggs.

The months in which the largest numbers of eggs were found in Loch Fyne are March, April, May, and June. The following Table shows the number of eggs for each month :—

* *Journal Mar. Biol Assoc.*, vol v. No. 2, p. 131.
† "Development of Teleostean Fishes." *Trans. Roy. Soc. Edin.*, vol. xxxv., pt. iii.
‡ Cunningham, "Marketable Marine Fishes," 1896, p. 277.
§ Holt, *Journal Mar. Biol. Assoc.*, vol. v., No. 1, p. 46.
‖ *Journal Mar. Biol. Assoc.*, vol. v., No. 1, p. 49.
¶ Eier u. Larven von Fisch. d. deutsch., Bucht. *Wissenschaftliche Meeresuntersuchungen von der Biologischen Anstalt auf Helgoland*, neue Folge, 2ter Bd. Hft. i., 1896.
** *Jour. Mar Biol. Assoc.*, vol. v., No. 2 p. 124.

Month.	No. of Eggs.	Month.	No. of Eggs.
January, . .	7	May, . . .	4,710
February, . .	136	June, . . .	5,409
March, . . .	3,297	July, . . .	1,703
April, . . .	9,717	August, . .	166

It will be noticed that the numbers given here for the months of February and March differ from those given in Tables V. and VI. During February and March the horizontal tow was much longer than during the succeeding months; and it is therefore necessary, as a basis for comparison, to reduce the numbers to a $\frac{1}{4}$-mile tow.

In April the largest number of eggs are to be found; and during the four months above mentioned the eggs of every species which were found during the eight months appeared. The *main spawning period* also of every species, with two exceptions, was found to occur between March and June.

In the accompanying Table, XII., the spawning periods of the different species are shown. The following symbols are used, viz.:—

* indicates that eggs were found during the month so marked.

X marks the month in which the largest number of the eggs of each species were captured.

x signifies that a large number (proportionally to the total of that species) of eggs of the species were captured.

[TABLE.

TABLE XII.

TABLE SHOWING THE SPAWNING SEASON OF EACH FISH,
AS DETERMINED BY THE OCCURRENCE OF THE EGGS.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.
Rockling, *Onos mustela*, and *tricirratus*, ...	*	*		X	x	x	*	*
Dragonet, *Callionymus lyra*, ...	*	*	*	x	x	X	*	*
Cod, *Gadus callarias*, ...		*	x	X	x	x	*	*
Haddock, *Gadus aeglefinus*, ...		*	X	x	x	*		
Whiting, *Gadus merlangus*, ...		*	*	X	x	x	*	*
Saithe, *Gadus virens*, ...		*	x	X	x	x	*	
Bib, *Gadus luscus*, ...		*	X	x	*	*	*	
Plaice, *Pleuronectes platessa*, ...			x	X	*	*		
Turbot, *Bothus maximus*, ...			*	*	x	X	x	*
Dab, *Pl. limanda*, ...			*	X	x	x	x	*
Flounder, *Pl. flesus*, ...			x	X	x	*	*	*
Gurnard, *Trigla* sp., ...			*	*	x	X	*	
Pollack, *Gadus pollachius*, ...			*	*	*	*		
Long Rough Dab, *Drepanopsetta platessoides*, ...			*	X	*	*		
Solenette, *Solea lutea*, ...			*	*	*			
Witch, *Pl. cynoglossus*, ...				*	*	X	*	*
Mackerel, *Scomber scombrus*, ...				*		*	X	
Ling, *Molua molva*, ...				*	*	*	*	
Poor-Cod, *Gadus minutus*,... ...				*	x	X	*	
Hake, *Merluccius vulgaris*, ...				*		*	*	*
Species G, ...				*		*	X	
Phrynorhombus unimaculatus (?),					*	X	*	*
Zeugopterus punctatus, ...					*	*		
Trachinus vipera, ...					*	*	*	
Lemon Sole, *Pl. microcephalus*, ...						x	x	*
Arnoglossus laterna, Gthr. (?) ...						X	x	*
Brill, *Bothus rhombus*, ...						*	*	
Ctenolabrus rupestris, L. (?) ...						*	*	

On the Spawning Periods of the Food Fishes.

Fulton* has described the spawning periods of a number of fishes as regards the East Coast of Scotland. It is interesting here to find how far the West Coast agrees with the conditions of the East Coast. For this purpose a comparison may be made between Fulton's observations and the data, so far as they are applicable, supplied by the work in Loch Fyne.

PLAICE. The spawning of the plaice, according to Fulton, from the examination of the fish, commences about the end of January, and continues through February and a part of March. The only ripe plaice captured in January by the "Garland" were taken on Smith Bank (Moray Firth). Fulton, referring to this fact, mentions that this fish seems to spawn earlier on the North Coast than further south. Masterman,† from a consideration of the published lists of eggs captured by the "Garland," fixed the spawning period of the plaice as extending from the beginning of February to about the 20th of May, with a maximum in mid-March.

In Loch Fyne no plaice eggs were found up to February 19th; but between the 14th and 19th of March a considerable number were found there. In April (11th to 19th) they were most abundant. They were still present in May, and in June the five stations furnished four eggs. Plaice eggs did not after that date appear in the tow-net collections. So far as the year 1898 is concerned, then, the spawning period of the plaice is later in Loch Fyne than on the East Coast.

COD. A spawning period from the end of February to the end of May, chiefly March and April, is given by Fulton for this fish. Masterman substantially agrees with this.

Two eggs of cod were captured on February 19th in Loch Fyne. In the following month the eggs were very common, and in April were extremely abundant. Twenty-eight days later, viz., May 9th-14th, the numbers had diminished by one-half. A fair number was captured in June; in July one or two examples were found in the loch. As regards this species, the spawning periods on the East Coast and in Loch Fyne correspond almost exactly.

HADDOCK. The haddock spawns on the East Coast from the end of January to the end of April or beginning of May (Fulton). In the Firth of Forth this egg has been obtained as late as June 13th (Masterman).

The month during which the eggs of this fish are most common in Loch Fyne is March. In April and May they are still present in considerable numbers. Spawning was continued into June. On January 20th, an egg which appeared to belong to this species was found on Station II. It was, however, only in February that they appeared in appreciable quantity. For Loch Fyne the spawning period appears to extend from the middle of February till the middle of June.

WHITING. The eggs of this fish appeared in February, were present in March, and reached their greatest abundance in April. In May the quantity equalled about half that of the previous month. In July and August the eggs were also captured. The spawning period apparently lasted, then, in 1898 from February till August. For the East Coast the spawning period is from early March to the third week of August, chiefly April (Fulton), a period which agrees closely with that of Loch Fyne.

SAITHE. First appearing in February, they were found up till June. One or two eggs captured in July and August were also referred to this fish.

* "The Spawning and Spawning Places of Marine Food Fishes": *Eighth Annual Report Fishery Board for Scotland*, Part III., p. 257; "Observations on the Reproduction, Maturity, and Sexual Relations of the Food Fishes": *Tenth Annual Report*, Ibid, p. 232.

† "A Review of the Work of the 'Garland' in connection with the Pelagic Eggs of the Food Fishes" (from the Firth of Forth). *Fifteenth Annual Report*, Ibid p. 219.

Turbot. The eggs of this form were first found in March, and the numbers steadily increased during the succeeding months, until the maximum was reached in June. They were fewer in July, and still persisted in August. From March to August, then, is the period in which spawning takes place in Loch Fyne. The spawning period on the East Coast lasts from April to July (Fulton). Masterman gives a period from mid-May to mid-July. In Loch Fyne the turbot, then, appears to spawn earlier than on the East Coast.

Mackerel. The largest number of the eggs of the mackerel was obtained in July, a considerable number having been taken in the preceding month. In April two eggs were captured; but in May they were not found in the tow-nets. The eggs of the mackerel have not so far been recorded from Scottish waters. This fish, it is, however, well known, spawns in Loch Fyne in July and August, and individuals with large roes are taken in considerable quantities in herring nets.

Lemon Sole. The eggs of this species were captured in June, July, and August. From the numbers of eggs obtained during these months spawning seems to take place principally in June and July. On the East Coast, May, June, and July are the months devoted to spawning (Fulton).

Brill. The eggs of the brill appeared in June and July, but in so small quantity that it is impossible to make any inference regarding the spawning period of this fish. So far these observations agree with those of Fulton in reference to the East Coast, though it spawns also in April and May.

Dab and Flounder. The eggs of these two forms are very closely associated as regards their distribution and the periods during which they may be captured with the tow-net. In Loch Fyne these eggs appear in March, and are found each month up to August. They are both found in greatest abundance in April, and after May the flounder eggs decrease in number at a greater rate than do the eggs of the dab. In July and August only a few solitary flounder eggs were found. Dab eggs were still present in considerable numbers in July.

For the flounder the spawning period on the East Coast is from the end of January until July, and for the dab the same period extends from the end of February to July (Fulton). Masterman gives for the flounder a period of from March 6th to June 22d, and for the dab a period from February 19th to August 29th. On the East Coast, then, these two forms appear to spawn earlier than they do in Loch Fyne.

Bib. A solitary egg of this form was found in February. In March the eggs of the bib were abundant. They continued on till July, diminishing rapidly in number after April. According to M'Intosh and Masterman,* the bib spawns in January and February. The period for Loch Fyne is much longer. Later in beginning, it lasts till July.

Poor-Cod. This species appears to begin spawning in April and continues doing so until July, the maximum being reached in June, although the number of eggs captured in May does not fall very far short of the June total. M'Intosh and Masterman give for this fish a spawning period of from March to June. In Loch Fyne the spawning period begins one month later, and is continued for a month over the East Coast period.

Long Rough Dab. During the months of March, April, May, and June the eggs of the long rough dab are to be found in Loch Fyne. In April the largest number of eggs are deposited. Fulton gives for the East Coast from the end of January to the end of April as the spawning period. M'Intosh and Masterman add the month of May to that period. In Loch Fyne spawning begins later and does not cease until June.

* *Op. cit.*

POLLACK. The eggs of pollack were found in Loch Fyne in March, April, May, and June. February (?) to May is given as the spawning period by M'Intosh and Masterman.

WITCH. The eggs of this form appear in Loch Fyne in April, and are to be found every month until August. May to September and May to July are the spawning periods given by Fulton, and M'Intosh and Masterman, respectively.

LING. The eggs of this fish were captured in April, May, June, and July, but not in sufficient numbers to warrant any inference as to the spawning period.

SOLENETTE. Three eggs only were obtained—one each in March, April, and May.

ROCKLING. The eggs of the different rocklings have not been separated, but the majority belong to the five-bearded species. Rockling eggs appeared in January along with the eggs of the dragonet, and were to be found in Loch Fyne right on till August. The largest number of eggs are found in April.

The curve of spawning of a fish does not rise gradually to its greatest height and then sink at a rate equal to that by which it rose. The rising portion of the curve is usually much steeper than the sinking portion. In other words, there is more regularity in the time of the opening of a spawning period than there is in ending it. Very shortly after spawning has commenced the majority of the species will be spawning, and the height of the spawning period is soon reached; but after the majority has ceased spawning a few individuals may carry on spawning for a month or more longer, and the curve acquires a very gentle downward slope. This may be seen by reference to Table XII., p. 96. It will be noticed that in many cases the height of the spawning of any one species takes place about a month or two months after spawning commences. The egg, however, is found for several months after the height of the spawning period is passed. In certain cases, which appear to be exceptions, the number of eggs dealt with is small, and therefore the date of the height of spawning may be wrongly fixed. A similar condition may be seen in the curves of spawning given by Fulton.*

DRAGONET. The eggs of dragonet occur during the first eight months of the year. One egg of dragonet and seven eggs of rockling were all the eggs obtained in January, and eggs of these two species occurred each month after. The largest number of eggs was obtained in June; considerable quantities were, however, also obtained in April and May. The curve of spawning for this form does not agree with the theory advanced above, but so far as this research is concerned it is the only important exception. According to M'Intosh and Masterman, the dragonet spawns from May to August. In Loch Fyne the spawning season begins four months earlier.

On the whole the spawning seasons which have been determined on the East agree very closely with the spawning seasons in Loch Fyne, so far as concerns the year 1898. The date when a species may commence spawning varies from year to year, and correspondingly the last date upon which the ova of that species are to be found in the sea may be earlier or later from year to year. Allowing for that annual variation, it is probable that with further investigation the disparity in the spawning periods which is supposed to exist between the East and West Coasts may be altogether eliminated or at least restricted to a few species.

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Stage of Development of the Eggs.

The development of the pelagic egg has been conveniently divided into five stages by Hensen and Apstein.* Hensen and Apstein, in comparing the eggs as to stage of development, contrast in one Table the number of eggs in the first stage with the total number of eggs (*p. 54*); and in a second Table (*p. 61*) compare the eggs of the first stage to the sum of the eggs in other stages. I have adopted the latter as the standard for comparison, and shall reduce the relation to a ratio for the sake of simplicity. They may be briefly described as follows :—

Stage α.—From the fertilisation of the egg up to the formation of the blastoderm and the germinal cavity.

Stage β.—From the formation of the blastoderm up to the closure of the blastopore. When the blastopore closes the embryo is half round the yolk.

Stage γ.—From the closure of the blastopore up to the point in development where the embryo is two-thirds round the yolk.

Stage δ.—From the end of Stage γ. up to the point where the embryo is three-quarters round the yolk.

Stage ϵ.—From the end of Stage δ up to hatching.

Figures of corresponding stages are given by Hensen and Apstein.

Nearly half of the eggs captured in Loch Fyne during 1898 were in the first stage of development (α). Of a total of 31,516 eggs, 15,000 belonged to Stage α; while the other stages, β, γ, δ, and ϵ, were represented by the numbers 5691, 6424, 2295, and 1987 respectively. The eggs in Stage α are not, on an average, more than two days old, and in number they nearly equal the eggs which have reached later stages of development. The proportion of α eggs to eggs in other stages varies in each month, and varies also for each station. In this connection attention will be restricted to the principal spawning months—viz., March, April, May, and June.

[TABLE.

* Hensen and Apstein. Die Nordsee-Expedition, 1895. Kiel, 1897.

TABLE SHOWING THE RATIO BETWEEN THE NUMBERS OF EGGS AT DIFFERENT STAGES OF DEVELOPMENT.

Stage.	α	β	γ	δ	ϵ	Ratio of α to χ $(\beta+\gamma+\delta+\epsilon)$.	Ratio of α to χ for the five stations.
March.							
Station I.	174	46	32	23	6	1·6 : 1	
,, II.	1607	912	609	293	185	·8 : 1	
,, III.	1287	250	146	146	112	1·9 : 1	1·2 : 1
,, IV.	246	72	35	13	7	1·9 : 1	
,, V.	1531	600	175	54	26	1·7 : 1	
April.							
Station I.	738	193	368	173	155	·83 : 1	
,, II.	778	256	799	507	960	·3 : 1	
,, III.	447	242	262	106	93	·6 : 1	·75 : 1
,, IV.	207	158	215	43	40	·45 : 1	
,, V.	2028	574	307	39	34	2 : 1	
May.							
Station I.	573	154	176	35	11	1·2 : 1	
,, II.	194	85	134	26	34	·7 : 1	1 : 1
,, III.	400	86	81	38	49	1·7 : 1	
,, IV.	182	44	92	42	28	·88 : 1	
,, V.	1056	287	676	189	38	·88 : 1	
June.							
Station I.	195	30	11	1	—	4·6 : 1	
,, II.	259	86	118	10	2	1·2 : 1	
,, III.	947	482	305	25	9	1·1 : 1	·68 : 1
,, IV.	80	56	134	81	33	·26 : 1	
,, V.	716	496	946	303	86	·39 : 1	
July.							
Station I.	390	46	8	—	2	6·9 : 1	
,, II.	266	30	7	1	—	7 : 1	·93 : 1
,, III.	76	35	20	—	—	1·3 : 1	
,, IV.	82	48	293	40	24	·2 : 1	
,, V.	102	69	117	37	17	·4 : 1	

The above Table has been prepared showing the ratio between the number of eggs in Stage α and the sum of the eggs in the remaining four stages (χ) for each station, and for all the stations in each month. During March the ratio of α to χ was 1·2 to 1; and on every station but one this ratio exceeded 1. This indicates that at the date in March when the experiments were carried out a large number of fish had just commenced spawning, and the newly deposited eggs exceeded in number those which had been spawned during the previous two or three weeks, and which were still unhatched. During the April trip the ratio was found to be less than 1—viz., ·75 to 1. At this date, then, spawning had abated somewhat, and the number of eggs which were being added to the water did not quite equal those developing there. From the collections made in May it is seen that spawning had again increased, and the ratio borne by α to χ equalled 1. In June there was a decrease in the number of newly spawned eggs; but in July they again nearly equalled in number the eggs at other stages of development. A comparatively small number of eggs were obtained in February, and of these the ratio of α to χ = ·7 to 1. The standard by which these different months are here compared is quite an arbitrary one, and is only used in order to show the relation between the numbers of eggs just spawned and the numbers of eggs present in the waters at certain dates. It simply indicates increase or decrease in α. In a single week after each of these dates it is quite possible that the ratio might have very materially altered. While we are dealing with the sum of the eggs of all species, the change from a minimum to a maximum spawning season for any individual species must also be taken into account. The large increase in the ratio of newly spawned eggs at any period is mainly due to the fact that a number of species begin spawning then. For example, in March the ratio of α to χ is equal 1·2. In February seven species were spawning, and in March other eight species commenced to spawn. At the same time two species, haddock and bib, had reached their greatest spawning period; but the numbers of their eggs are so small as not to affect the main result. At the height of the spawning period of a fish the number of eggs in each of the stages ought to be very nearly equal, or at least ought to show a greater tendency towards equality than they would do in early or late portions of said period.

In April six species commenced spawning, and for eight species this month was the main spawning time. We find, then, that the ratio of α to χ is diminished by one-fourth—viz., to ·75.

Twenty-one species were spawning in May, but none of these was at its *maximum*; three species commenced spawning. The ratio has increased, and now equals 1. The ratio decreases again in June—viz., to ·68. During this month seven species are at their main spawning period, and four species commenced spawning. In July the ratio is again increased—viz., to ·9. Twenty-two species are still spawning; five species have left off spawning.

The five stations vary as regards the numbers of eggs in Stage α. The presence of large numbers of eggs in the first stage of development in any area may be taken as *prima facie* evidence that they were spawned somewhere in the neighbourhood, since, on an average, such eggs are not more than two days old. By the data supplied by the Table an attempt might be made to infer the location of the principal spawning places. It must, however, be borne in mind that the transport of floating eggs from one place to another may take place with considerable rapidity, especially in cases where the surface water is acted upon for any length of time by the wind blowing in one direction, or when the tidal movement is great. (See p. 119.)

The proportion of eggs in each stage is shown diagrammatically in Plate III. A circle is used to represent 3600 eggs, and a segment of the circle proportional in size to their number is given to the eggs of each stage. The segments are contrasted by difference in shading. Fig. 1 gives the key to the shading adopted, segment I. referring to Stage α, II. to Stage β, III. to Stage γ, IV. to Stage δ, and V. to Stage ϵ. It is at once seen from an examination of the plate that spawning appears to take place chiefly in the vicinity of Station V., at the very head of the loch. In April and May especially the proportion of early eggs was very great; and in March also they exceeded the sum of the eggs of later development. Stations II. and III. are also probably closely associated with spawning places.

The eggs have so far been discussed without regard to species. Tables XIII. and XIV. give analyses of the eggs of the more important species with respect to the stage of development. Cod and haddock have been grouped together, as also have whiting and saithe.

TABLE XIII.—Analysis of the Eggs with respect to their Stage of Development.

	Plaice.					Cod and Haddock.					Whiting and Saithe.					Rockling.					Dragonet.				
	α	β	γ	δ	ϵ	α	β	γ	δ	ϵ	α	β	γ	δ	ϵ	α	β	γ	δ	ϵ	α	β	γ	δ	ϵ
March, Station I.,	3	5	2	..	..	5	..	..	4	..	9	1	3	7	3	65	26	14	9	3	17	3	4	..	..
,, ,, II.,	37	29	33	10	7	447	206	71	33	19	164	142	85	42	19	261	97	120	61	27	43	11	12	5	5
,, ,, III.,	12	5	8	4	3	320	44	43	15	8	219	57	26	34	31	59	9	5	6	4	14	6	4	1	1
,, ,, IV.,	1	..	..	..	..	100	47	16	5	3	21	5	2	1	..	32	4	2	2	1	1	..	..	..	..
,, ,, V.,	9	15	4	..	1	507	327	41	10	6	119	43	4	4	2	23	2	9	..	3	1	1	1	..	..
Total, -	62	54	47	14	11	1,379	624	171	67	36	532	248	120	88	55	440	138	150	78	38	76	21	21	6	6
April, Station I.,	3	7	27	8	8	84	17	17	23	23	38	15	40	19	27	81	16	60	21	5	28	12	32	7	2
,, ,, II.,	34	20	51	15	61	208	70	205	130	338	75	48	142	91	230	123	19	118	70	68	19	6	21	5	4
,, ,, III.,	1	2	6	3	5	167	109	85	38	45	149	72	76	28	32	13	3	14	2	3	6	2	2	1	..
,, ,, IV.,	1	..	1	..	..	66	84	103	25	23	32	46	50	12	11	14	..	5	2	..	2	1	3	..	..
,, ,, V.,	16	14	20	1	..	872	278	158	23	23	730	192	80	10	6	11	2	3	1	..	1	..	..	..	..
Total, -	55	43	105	27	74	1,397	558	568	239	452	1,024	373	388	160	306	242	40	200	96	76	56	21	58	13	6
May, Station I.,	..	..	..	..	..	12	15	20	8	2	39	21	32	9	7	198	38	53	9	..	35	8	12	1	1
,, ,, II.,	..	..	2	..	..	16	12	18	6	11	35	25	36	8	15	28	10	19	4	..	19	5	7	1	..
,, ,, III.,	3	1	2	1	2	57	9	13	6	15	120	25	20	15	19	23	4	5	4	..	16	3	3	..	..
,, ,, IV.,	..	..	1	..	..	40	20	45	20	10	50	14	27	18	15	5	1	..	..	..	3	1	2	..	..
,, ,, V.,	7	2	8	..	..	506	148	283	90	27	220	63	160	58	9	9	3	13	1	..	27	2	11	..	..
Total, -	10	3	13	1	2	631	204	384	130	65	464	148	275	108	65	263	56	90	18	..	100	19	35	2	1
June, Station I.,	1	..	..	..	..	2	5	1	..	..	1	1	1	1	..	6	5	1	..	..	15	3	..	..	..
,, ,, II.,	..	..	..	..	..	12	5	15	..	..	11	4	11	..	..	17	6	11	..	..	43	7	5	..	..
,, ,, III.,	1	1	..	..	..	79	36	21	3	4	99	76	16	4	1	79	38	34	2	..	112	42	32	1	..
,, ,, IV.,	..	..	..	..	..	9	7	4	3	6	15	17	30	22	..	9	2	10	2	1	2	..	2	..	..
,, ,, V.,	..	..	1	..	..	53	28	55	25	11	119	378	275	152	47	7	16	25	..	..	10	3	10	..	..
Total, -	2	1	1	..	..	155	81	96	31	21	245	476	333	179	48	118	67	81	4	1	182	55	49	1	..

TABLE XIV.—ANALYSIS OF THE EGGS WITH RESPECT TO THEIR STAGE OF DEVELOPMENT.

	Bib.					Flounder.					Dab.					Turbot.					Witch.				
	α	β	γ	δ	ϵ	α	β	γ	δ	ϵ	α	β	γ	δ	ϵ	α	β	γ	δ	ϵ	α	β	γ	δ	ϵ
March, Station I.,	34	6	3	3	..	40	5	5	1	..	..	1	..	..	..	1	..	..	..	..	..	..	..	..	..
,, ,, II.,	344	281	136	82	70	226	109	118	45	30	58	30	30	12	9	..	..	..	..	..	..	..	..	..	..
,, ,, III.,	457	112	43	70	43	151	11	11	11	15	52	7	8	4	3	..	..	..	..	..	..	..	..	..	..
,, ,, IV.,	20	3	7	3	1	51	9	3	3	2	18	4	3	..	..	..	..	..	..	..	..	..	..	..	..
,, ,, V.,	516	155	55	21	8	139	54	25	8	1	162	38	36	11	5	13	..	..	..	..	..	..	..	..	..
Total, -	1,371	557	244	179	122	607	188	162	68	48	290	80	77	27	17	14	..	..	..	..	..	..	..	..	..
April, Station I.,	54	20	34	34	29	415	85	108	39	36	34	15	31	12	12	1	1	1	..	..	..	..	..	..	..
,, ,, II.,	56	21	51	65	89	204	54	138	108	110	49	13	54	16	45	..	2	3	1	1	..	..	..	..	..
,, ,, III.,	..	7	3	5	1	63	20	35	16	1	21	17	11	4	3	1	1	1	..	..	..	..	..	..	..
,, ,, IV.,	1	2	1	1	..	58	17	27	1	..	9	1	5	1	4	..	..	..	..	..	..	..	..	..	..
,, ,, V.,	21	4	1	1	2	166	39	22	..	1	156	21	16	1	1	..	..	1	..	..	..	..	..	..	..
Total, -	132	54	90	106	121	906	215	330	164	147	269	67	117	34	65	2	4	6	1	1	..	..	..	..	..
May, Station I.,	18	4	6	1	..	179	43	27	2	..	18	8	11	3	1	14	5	2	..	..	..	..	..	..	..
,, ,, II.,	14	3	2	3	..	35	11	23	3	1	11	6	11	1	5	2	3	..	..	..	..	..	..	..	..
,, ,, III.,	1	1	3	..	..	96	22	22	7	5	22	10	2	..	5	12	2	1	..	..	..	..	..	..	..
,, ,, IV.,	2	..	1	2	..	38	5	11	..	1	18	2	1	..	..	..	..	..	..	..	..	..	..	..	..
,, ,, V.,	2	2	3	2	..	51	15	49	7	..	78	15	44	11	..	1	..	..	..	..	7	3	5	3	..
Total, -	37	10	15	8	..	399	96	132	19	7	147	41	69	15	11	29	10	3	..	..	7	3	5	3	..
June, Station I.,	..	..	..	..	..	24	3	1	..	..	21	2	..	..	..	2	..	..	..	..	12	1	2	..	..
,, ,, II.,	1	..	..	..	1	8	3	4	1	..	12	6	8	1	..	..	..	1	..	..	12	8	3	3	1
,, ,, III.,	5	7	6	..	..	24	11	6	1	..	87	59	43	2	..	7	2	..	..	..	29	11	5	..	..
,, ,, IV.,	..	1	1	..	..	2	3	8	1	..	8	5	7	1	1	1	1	..	..	..	6	9	43	35	28
,, ,, V.,	8	5	7	3	..	6	5	17	3	..	25	6	10	3	1	111	19	29	..	..	300	98	413	97	38
Total, -	14	13	14	3	1	64	25	36	6	..	153	78	68	7	2	121	22	30	..	..	359	127	466	135	67

In order that changes in the ratio of α to χ during succeeding months of the spawning season, such as are seen when the sum of the eggs is treated, may be found also in the eggs of one species, it is necessary that the eggs of that species be present in considerable numbers. In the case of those eggs which formed the bulk of the tow-net collections the gradations are well marked; but species which are represented by comparatively few eggs do not furnish evidence in support of the rule. Again, if the eggs of any one species were obtained in sufficient numbers, a more correct estimation of the changes in the ratio would be discovered. A Table has been prepared showing the ratio of α to χ for each month for a number of species.

[TABLE.

Showing the Ratios of α to χ for Different Species.

Month.	Plaice.			Cod.			Haddock.			Whiting.			Saithe.			Bib.			Dab.			Flounder.		
	α	χ	Ratio α to χ	α	χ	Ratio α to χ	α	χ	Ratio α to χ	α	χ	Ratio α to χ	α	χ	Ratio α to χ	α	χ	Ratio α to χ	α	χ	Ratio α to χ	α	χ	Ratio
March, ...	62	126	·5	1029	651	1·5	350	247	1·4	102	39	2·6	430	472	·9	1371	1102	1·2	290	201	1·4	607	446	1·3
April.	55	249	·2	1327	1778	·74	70	39	1·7	916	915	1	108	312	·34	132	371	·35	269	283	·9	906	856	1·09
May, ...	10	19	·5	568	760	·74	63	23	2·7	372	522	·7	92	74	1·2	37	33	1·1	147	136	1	399	254	1·5
June, ...	..	..	..	136	216	·66	19	23	·8	199	590	·3	46	446	·1	14	31	·4	153	155	·9	64	67	·95

Month.	Rockling.			Dragonet.			Turbot.			Lemon Sole.			Mackerel.			*Z. unimaculatus.*			*Arnoglossus laterna?*					
	α	χ	Ratio.	α	χ	Ratio.	α	χ	Ratio.	α	χ	Ratio.	α	χ	Ratio.	α	χ	Ratio.	α	χ	Ratio.			
March, ...	440	404	1·1	76	54	1·4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
April, ...	242	412	1·7	56	98	·57	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
May	263	412	1.58	100	57	1·7	29	13	2·2	..	..	..	..	..	..	24	16	1·5	..	..	..	..	..	..
June, ...	118	153	1·21	182	105	1·7	121	52	2·3	64	127	·5	19	30	·6	53	68	·77	246	138	1·7	..	..	..
July, ...	..	..	..	..	..	..	12	26	·46	112	58	1·9	25	181	·13	10	6	1·6	171	33	5·1	..	..	..

So far as this research bears evidence on the question, I shall take as the normal relation of α to χ, that given by the eggs of the cod. The spawning season of this form lasts from March to June, and during the four months the ratios are 1·5, ·74 ; ·74, and ·66 respectively. The ratios deduced from Hensen and Apstein's Table for the eggs of the cod are considerably smaller. For their second trip, which took place in the beginning of March, the ratio was ·6, and for their third trip, at the end of April, the ratio was then ·4. In the middle of February the ratio was ·8. In this case also, as the German authors point out, the proportion of early eggs is greater in the beginning of the spawning season, and diminishes towards the end of the season. The ratios which I found to exist in the case of the eggs of the cod differ to some extent from those given by the sum of the eggs of all species ; but the latter are not, owing to their referring to a mixture of eggs of species having different spawning seasons, likely to be identical with the true ratios of any one species. The experiments in Loch Fyne were carried out once a month ; but in order to accurately determine the normal relations between the number of eggs of each stage at different periods, continuous observation in a spawning area during the whole spawning season would be necessary. Weekly examination would be required in order to eliminate any irregularity or intermittence in spawning to which through meteorological or other conditions the whole body of spawning fish may be subject. Hensen and Apstein also point out how the disparity between the numbers of early and further advanced eggs may be due (1) to the fact that the eggs in Stage ϵ (about ready to hatch) may sink to a greater depth than the early eggs ; (2) to the destruction of the eggs in one way or another. From a consideration of the results of their North Sea expedition they are led to the conclusion that a very large percentage of the eggs die ; and that for every 100 eggs found in the water, 159 have been spawned and fertilised. And, further, of 100 eggs 35·9 only hatch. So far as my own observations in Loch Fyne go, I am unable to corroborate this estimate. On their second and third trips the German authors found, in certain collections consisting of 2600 eggs, 125 eggs of the fifth stage (ϵ), *i.e.*, one-twentieth of the whole. In Loch Fyne I obtained during the months of March, April, and May 6113 eggs, and of these 529, or one-eleventh, were in the fifth stage. On Station II., however, in April, of 887 cod eggs 332 were in the fifth stage, the remaining eggs being arranged as follows:—Stage α, 157 ; β, 67 ; γ, 201 ; δ, 130.

It is also necessary to remember the difference between a confined loch, like Loch Fyne, and the open sea. It is possible that many of the cod eggs collected in Loch Fyne were drifted in from the outside during their development, and this might increase the proportion of those found to be in late stages.

As to the suggestion that the eggs in advanced development sink, Hensen and Apstein (*o.c.*, *p. 62*) write regarding cod eggs:—"In 5 "vertical hauls, 22 eggs of the fifth stage were found at depths greater "than 20 metres [10 fathoms], and only one at a depth less than 5 metres "[2½ fathoms]. In 9 horizontal tows [surface], which produced 828 eggs, "only 15 eggs belonged to the fifth stage. The eggs in the last stage of "development then seek greater depths. They sink to regions which are "comparatively poor in living organisms, and where the darkness affords "them safe shelter."

My own records do not refer to a greater depth than 15 fathoms (27 metres). Only in rare cases were cod eggs of the fifth stage found deeper than 6 fathoms. The great majority was captured at depths less than 6 fathoms. I give here an analysis of all the eggs obtained on

Station II. in April, and it is seen that most of the advanced eggs were found close to the surface. This fact does not, of course, exclude the possibility that eggs do float at great depths, but it is conclusive proof that their doing so is not dependent upon the stage of development at which they have arrived.

STATION II., APRIL.

Depth in Fms.	α	β	γ	δ	ϵ
0	285	28	124	81	230
1	205	66	278	148	329
2	96	34	123	92	137
4	69	34	94	48	99
6	59	50	101	70	110
10	41	17	50	46	35
15	25	27	29	22	20

In the list of eggs published by Holt*, it is apparent that by far the largest number of eggs in his Stage III. [Stages δ and ϵ] were captured at the surface. On one occasion only—viz., off Mewstone, March 30th—was any considerable number of eggs of that stage taken in the bottom net.

Meek† also found in the shallow water off the coast of Northumberland that the eggs of any one stage in development were not characteristic of any particular depth. The same holds good for all species. In every case the vast majority of the eggs of Stage ϵ taken on any station were found within 6 fathoms of the surface. On Station II., in March, of 185 eggs of all species in Stage ϵ, 178 were taken within that depth. At Station III., in the same month, of 112 eggs only 17 were obtained at 10 and 15 fathoms; while of 960 eggs in Stage ϵ, captured on Station II. in April, 900 were found in the nets fishing between the surface and 6 fathoms. This is so for the following species :—Haddock, whiting, saithe, bib, dab, plaice, flounder, rockling, dragonet, mackerel, lemon sole, long rough dab. Of the other species present the numbers are too small to be of moment, but in no case do they disagree with the general statement made above.

The five stations show characteristic features in respect to the stages of the eggs to be found in their vicinities. Station II. is specially remarkable for the numbers of advanced eggs of almost every species. This is seen in each month, but is more particularly noticeable in April, as a glance at Table XIII. will show. During March and April all of the stations furnished considerable numbers of eggs in the stages γ, δ, and ϵ. On Stations IV. and V. in May and June advanced eggs were common, and in the case of certain species were found only in these localities. Station III. in May supplied a good number of eggs of the three later stages. Tables XIII. and XIV. give an analysis of the eggs of a number of species only; they are all that it is necessary to publish. The other species, from the scarcity of their eggs, do not demand special attention in this connection.

* *Jour. Mar. Biol. Assoc.*, vol. v., No. 2.
† *Report on Trawling Excursions*, Northumberland Sea Fisheries Committee, 1897.

On the Number of Pelagic Eggs in Loch Fyne.

In this part of the research Upper Loch Fyne only will be considered. Upper Loch Fyne is cut off sharply from the rest of the Clyde by its narrow entrance at Otter, 15 fathoms in depth. It is thus possible to consider it as, to some extent, an independent piece of water, and the data given by observations and experiments confined to this restricted area are perhaps more likely to lead to definite results on certain points than comparatively few observations scattered over a larger region.

In order to determine the number of eggs in Loch Fyne two methods were employed, viz.:—By means of nets towed *horizontally*, and by *vertical* hauls. Neither of these are other than approximately accurate. On each station seven nets were towed horizontally for a distance usually of one quarter-mile, at various depths below the surface. The upper edge of the ring of the top net was as far as possible on a level with the surface. The other six nets were at depths of 1, 2, 4, 6, 10, and 15 fathoms respectively. Each tow-net had a mouth 2 feet in diameter (radius $\frac{1}{3}$ yard), and it may be here taken for granted that it filtered, in travelling a quarter-mile, a column of water equal to the superficial area of its mouth multiplied by $\frac{1}{4}$ mile, *i.e.*, $= \frac{22}{7} \times \frac{1}{9} \times 506\frac{2}{3}$ cubic yards.

The mile here referred to is a sea mile, which equals $2026\frac{2}{3}$ yards.

I. The volume of water filtered by 7 nets $= 7 \times \frac{22}{7} \times \frac{1}{9} \times 506\frac{2}{3}$ cubic yards.

There are four stations (II., III., IV., and V.) in Upper Loch Fyne. Therefore the total volume of water filtered by the fleet of seven nets in working the four stations once $= 4 \times \frac{22}{7} \times \frac{1}{9} \times 506\frac{2}{3}$ cubic yards — $4954\frac{2}{27}$ cubic yards.

II. The water area of Loch Fyne at low water $= 28{\cdot}5$ square sea miles. The experiments were carried out in the upper stratum of water 15 fathoms in thickness. The volume of water sampled at the four stations is equal to the area $\times$ depth. $28{\cdot}5$ miles square $= 117{,}060{,}266\frac{2}{3}$ square yards. The volume of water sampled $= 117{,}060{,}266\frac{2}{3} \times 30$ cubic yards.

In order to obtain the number of eggs in the loch, the total number of eggs obtained on the four stations is to be multiplied by a *coefficient* which is found by dividing the volume of water in the upper stratum of 15 fathoms by the volume of water filtered in obtaining these eggs.

III. The COEFFICIENT $= \dfrac{117{,}060{,}266\frac{2}{3} \times 30}{4954\frac{2}{27}} = 708{,}872{\cdot}\dot{7}\dot{2}$

Two errors are introduced into the above calculation—(1) It is assumed that all the water which the net meets passes through it, but that is not the case. The cloth of the net in this case is of fairly open material (see p. 80), and the quantity of water which flows over the edge of the mouth is probably comparatively small. This error, however, has the effect of giving too low an estimate. (2) The second error is incurred by taking the whole surface area of the loch instead of only that portion of the area beneath which there is a depth of at least 15 fathoms. But as Loch Fyne is very deep, even close up to the edge, and since the eggs were for the most part obtained from depths of six fathoms and less, a depth which is found very near the shore, the error is probably a small one. This error has the effect of magnifying the result. The errors numbered 1 and 2 will therefore to a large extent neutralise one another. A few of the tow-net collections have been lost, and allowance will be made for these in the calculations.

During March the number of eggs of all species, when reduced to a quarter-mile tow, was 2913. If, then, we multiply this number by the coefficient, we should get approximately the total number of eggs in the loch at that time. In allowing for the loss of the contents of two of the nets, the factor has to be increased by one-thirteenth.

Thus the approximate number of eggs in Upper Loch Fyne at the time of the March trip = 2913 × (708,872 + 54,528) = 2913 × 763,400 = 2,223,784,000 eggs of all species.

The total number of eggs of each species, obtained by filtering the standard volume of water, is multiplied by the factor, and the approximate number of eggs of the species present in the loch at the time is obtained. This is done for each month, and the results are given in Table XV. In this case the eggs of cod and haddock are grouped, as likewise are whiting and saithe.

TABLE XV.—ESTIMATED NUMBERS OF THE EGGS OF CERTAIN SPECIES PRESENT IN UPPER LOCH FYNE AT THE PERIODS OF EXAMINATION.

[The numbers denote millions.]

	Plaice.	Cod and Haddock.	Whiting and Saithe.	Rockling.	Dragonet.	Turbot.	Witch.	Flounder.	Dab.	Bib.	Mackerel.	Lemon Sole.	Other Species.	Grand Total.	Average Number of Eggs to 1 Sq. Yard Water Surface.
January, .	..	..	..	·8	..	.	..	..	..	..	..	..	..	1	·009
February, .	..	6	31	40	1·2	..	..	..	..	..	..	..	..	79	·6
March, .	41	603	231	156	22	9	..	246	122	626	..	..	172	2228	18·9
April, .	178	2161	1491	333	51	7	..	765	317	238	..	..	192	5734	48·9
May, . .	20	961	674	91	70	14	12	285	175	29	..	..	340	2671	22·7
June, .	2	266	824	183	190	121	809	73	202	38	34	135	793	3670	31·3
July, .	..	17	23	55	43	28	64	1	113	4	144	85	316	893	7·6
August, .	..	3	7	4	21	3	26	..	14	..	..	5	7	91	·7
Total, .	241	4017	3281	862	398	182	911	1370	943	935	178	225	1820	15,367	..

The quantitative estimation of plankton has been carried to a high degree of accuracy by Hensen. An adaptation of the vertical net invented by him he found to be applicable to the estimation of pelagic ova in the North Sea.

In Upper Loch Fyne vertical hauls with the net described on page 80 were made at four stations, but they were unfortunately found to be too few in number to give reliable results.

In Loch Fyne, which is a comparatively small area, the eggs are not by any means equally distributed through its waters. Four vertical hauls were therefore too few upon which to base any approximately accurate calculation. When the work was begun the difficulty caused by the diversity in richness of the water at different points was not foreseen, and was not even expected. Owing, then, to the vertical hauls being so few in number, a single haul on a comparatively rich station introduces, in estimating the total number of eggs, a serious error which only a very large number of hauls would eliminate. The distance between Stations IV. and V. is a little less than four miles, but still, during every month but July, Station IV. was poorer to a remarkable degree than Station V. The distances between Stations II. and III. and between III. and IV. are eight and nine miles respectively. These distances are comparatively small, and one might have been led to expect that the strong tidal currents of Loch Fyne would have effectually distributed the eggs over its whole area. But that is not so. The question of the effect of the tidal current on the eggs will be discussed later. In the North Sea Hensen asserts that there is extremely little dispersion of the eggs; that the eggs remain on the whole very near the locality where they were extruded. In this reference Hensen excepts areas near the shore, where there are local currents which may tend to cause dispersion. If the eggs were equally spread over the loch, the contents of the vertical net would bear a fixed ratio to the contents of the horizontal nets for every station; but this is not found to be the case. In April, for example, the following numbers of eggs were obtained for each station :—Station I., horizontal, 1625 eggs (vertical, 9 eggs); Station III., horizontal, 1150 (vertical, 127); Station IV., horizontal, 663 eggs (vertical, 16); Station II., horizontal, 3297 eggs (vertical, 54); Station V., horizontal, 2982 eggs (vertical, 52). A similar want of relation between the numbers for the stations during the other months can be seen on reference to Tables IV. to XI. This fact shows that even on *one station* the eggs are not equally distributed *as regards number*; and as the length of the station in that month, April, was one quarter-mile, it is evident that the diversity and variation in richness of different parts of the water are so great that no practicable number of vertical hauls would be sufficient to give a correct estimate of the numbers of ova present. A similar, though not quite so marked, want of relation is to be seen also in the quantities of copepods taken by the horizontal and vertical nets respectively. (*Vide* Tables IV.-XI.

In so far as Loch Fyne is concerned, then, the only method by which even an approximate estimate of the number of eggs may be arrived at is that of examination by means of horizontal towing.

The calculated number of eggs which were floating in Loch Fyne at the time of each visit is given in the vertical column marked "Grand Total." The examination of the stations occupied one week each month, and the number of eggs stated in the above column may be taken as approximately representing, within necessarily wide limits, the number of eggs in the loch during that week. There was an interval of three weeks between the end of one trip and the beginning of the next. During the interval eggs were spawned and hatched, and it is by no means an easy matter to make an allowance for them in the attempt to arrive at the total number of eggs which have been there. One unknown factor, at least, has to be reckoned with, and that is, Does spawning take place regularly or intermittently? We know that for the individual spawning is intermittent, but how is the majority of the spawning fish affected? Does the majority of the fish spawn simultaneously, and simultaneously leave off spawning?; or is there during, say, the main spawning month a somewhat similar number of ova extruded daily? Another point to be considered is the length of incubation. This is dependent on the temperature of the water. In Table XVI. are given the temperatures of the water at the surface, 7½ and 15 fathoms, at the times of the different trips. During March, April, May, and June the surface temperature varied from 6·5 to 14·4 deg. C.; for 7½ and 15 fathoms, the extremes were 7·6 deg. and 10 deg. 8·5 deg. C. may be taken as a rough average for the period of four months. At a temperature of 8 deg. C., according to Dannevig*, the plaice egg hatches in 14½ days, haddock in 13, cod in 13, whiting in 10, and flounder in 5½ days.

If spawning were known to proceed in a regular curve without spasmodic periods of activity, it might be comparatively easy to estimate the probable number of eggs that had been spawned in the intervals between the trips; but nevertheless I am inclined to the view that in doubling the numbers of each species no serious over-estimate will be made. Much, indeed, might be said in favour of a larger increase. So far, however, this is a matter of opinion and not founded on exact data. The totals, therefore, given at the bottom of the Table probably represent the *minima* for each species during the eight months.

Out of a total of 30,700 millions of eggs of thirty-two species estimated to be present in the loch in 1898, 8,000 millions were the eggs of cod and haddock. These were the eggs which appeared in greatest profusion, although the eggs of the whiting and saithe were not far short of that number. It may be worth while here to give the estimated totals for the period.

	Plaice.	Cod and Haddock.	Whiting and Saithe.	Turbot.	Mackerel.	Lemon Sole.
Estimated Number of Eggs present in Upper Loch Fyne during the seven trips — Feb.-August	241,800,000	4,020,000,000	3,281,000,000	182,000,000	178,000,000	225,000,000
Estimated Number of Eggs in Upper Loch Fyne during the First Eight Months of 1898	483,600,000	8,040,000,000	6,562,000,000	364,000,000	356,000,000	450,000,000

As a basis of comparison with other areas, the number of eggs to each square yard of water surface is given in Table XV. Henson and Apstein estimate for the North Sea 92·5 eggs and fishes for each square metre. My observations give for the period from March to July the average number of eggs for each square yard of water surface at 25·8 eggs.

Comparison between the numbers of Ova and the volume of Copepoda, etc., found on each Station.

The meshes of the tow-nets were sufficiently small to retain a portion of the plankton—viz., the Copepoda and Zoëæ. All the collections were preserved and roughly measured in cubic centimetres. The Copepoda were transferred to spirit, and when they had settled at the bottom of the vessel, the volume was read off. With this method a certain quantity of spirit is necessarily included in the volumes obtained; it is simply a rough and ready means of comparison between stations and months. In order to give an indication of the absolute quantity, the number of Copepods in a certain volume—for example, ·5 or 1cc.—was from time to time counted. The number of individuals in 1cc. varied from month to month in accordance with the kind of Copepods present. In certain collections large Copepods—*e.g.*, *Calanus finmarchicus*—alone were present; in others the vast majority were young forms, and in still other collections the large and small Copepoda were mixed in various proportions. In order to satisfactorily overcome this great diversity in the quality of the takes, Hensen's plankton method, as the most accurate one, would require to be adopted; but the

* *Thirteenth Annual Report Fishery Board for Scotland*, Part III., p. 149.

estimation of the plankton was not an essential part of the investigation. I have therefore not attempted to estimate exactly the quantities of plankton, and have taken the rough volumetric measurement as a sufficient standard of comparison in the present case.

In Tables IV.–XI. are given the volumes of Copepoda taken in each net, on each station. With the volume of the take there is given, by means of letters, some indication of the composition of the collection. The letters used and their significations are as follows:—a = large Copepoda, *e.g.* from about 2·2–3·5mm. in length (cf. *Calanus*); y = small Copepoda, *e.g.* from ·8–1·6mm. in length; E = pelagic Crustacean eggs,* apparently belonging to a Copepod. This egg measures ·35mm. in diameter. There is a large perivitelline space, and the zona has a diameter of ·65mm. It was obtained in all stages from that of early segmentation to the formation of the *nauplius*. The letters *l.q.* mean large quantity; Z means Zoëæ, and M, Hydromedusæ; C stands for Copepoda.

When the letters are used without numbers each signifies, if used *alone*, that the take consists wholly of the one form which the letter stands for; when accompanied by other letters the presence of individuals of that form is noted. In order to show the proportions in which the Copepoda, Zoëæ, Medusæ, etc., are present, figures are joined with the letters, and signify that so many parts of the collection consist of one or the other group. Thus 2 y., 1 a., 3 Z., 5 E., M, serve to record that the tow-net collection consists of 2 parts of small Copepods, 1 part large Copepods, 3 parts Zoëæ, 5 parts pelagic Crustacean eggs; M indicates the presence of *Hydromedusæ.*

The following particulars refer to the relation between the volume and the number of Copepods in different months and on different stations. They may serve as a basis for comparison with other localities.

JANUARY. Station I., Vertical Net, Volume 6·5cc.=1531 Copepods.
FEBRUARY. ,, III., ,, ,, 1·5cc.=360 ,, 19 Zoëæ.
,, ,, IV., ,, ,, 5·5cc.=1828 ,,
MARCH. ,, I., ,, ,, 2cc.=276 ,, 9 Zoëæ; 59 Crustacean eggs.
,, ,, II., ,, ,, 1cc.=95 Copepods; 50 Zoëæ; 180 Crustacean eggs.
,, ,, ,, 6-fm. Net, ,, ·5cc.=334 Copepods (y.); 198 Zoëæ; 521 Crustacean eggs and *Nauplii.*
APRIL. ,, I., 1-fm. Net, Volume 6·5cc. (4 y., 1 a.)=3,500 Copepeds.
MAY. ,, I., Vertical Net, 1,000 Copepods (2 y., 1 a.)=2·5cc.
,, ,, II., ,, 1,000 ,, (1 y., 2 a.)=3cc.
,, ,, III., ,, 1,000 ,, (a.)=5cc.
,, ,, IV., ,, 500 ,, (a.)=2·5cc.
,, ,, V., ,, 500 ,, (mainly a.)=3cc.
JUNE. ,, I,, ,, 500 ,, (a.)=3·5cc.
,, ,, II., ,, 500 ,, (a.)=3cc.
,, ,, III., ,, 500 ,, (1 y., 1 a.)=2cc.
,, ,, IV., ,, 500 ,, (a.)=4cc.
,, ,, V., ,, 500 ,, and Zoëæ, (1 y., 2 a., 3 Z.) =2cc.
JULY. ,, III., 15-fm. Net, 500 ,, ,, (1 y., 1 a., 2 Z.) =1·5cc.
,, ,, IV., Vertical Net, 493 ,, (average size, 2·1mm.) and 7 Zoëæ=1·75cc.
,, ,, V., ,, 485 ,, (average size, 2·1mm.) and 15 Zoëæ=1·5cc.

Nyctiphanes norvegica and *Euchæta norvegica*, though usually confined to great depths, have been found by Murray † at the surface at certain

* Found also in St. Andrew's Bay. *Vide* M'Intosh, *Tenth Annual Report Fishery Board for Scotland*, Part III., p. 301.

† Murray—"The Effects of Winds on the Distribution of Temperature in Sea and Fresh-Water Lochs of the West of Scotland." *Scottish Geographical Magazine*, July 1888.

states of the tide and during strong winds. At Station II. in February one specimen of *Nyctiphanes* and sixteen examples of *Euchæta* were taken in the surface net, and five *Euchæta* in the vertical net; on Station IV. in the same month the vertical net furnished one *Nyctiphanes*. In March on Station II. one *Nyctiphanes* was found in the surface net, and three examples in the one-fathom net. A number of young *Nyctiphanes* were taken at the surface on Station II. in July, and in the vertical net on Station I. one *Euchæta* was obtained. In February at Stations II. and IV. when the examinations were made the tide was at half-ebb, and the wind was N.W., force 3, and S.W., force 4, respectively. In March at Station II. the tide was again at half-ebb, and the wind, which was W., was of force 5. At Station II. in July the wind was westerly and light; the tide, 1 hour flood.

A chart has been prepared giving the curves formed by the volumes of Copepods, etc., taken in the horizontal nets during the period of eight months (Plate IV., B). A separate curve has been made for each station. The vertical axis is divided into centimetres, each of which represents a volume of 100cc. of Copepoda, etc. The curves are distinguished from one another by the different colour and character of their lines; in addition, the curve is labelled throughout with the number of the station to which it refers. In C (*ib.*) is given the curve for the total volume of Copepoda obtained each month. It is fairly regular, though rising abruptly in April. In January, February, and March the Copepoda remained fairly constant in quantity. During March, as will be seen from reference to Table VI., there were large quantities of pelagic Crustacean—probably Copepod—eggs in the waters of Loch Fyne, but they were confined mainly to Stations I., II., and IV. In the following month the numbers of Copepoda increased enormously, and from reference to Chart B it will be seen that the increase took place mainly on Stations III. and IV., although all of the stations show very great increments. The increase is due to reproduction—which in the group of Copepoda appears to be extremely rapid—and the collections are almost entirely composed of young Copepods of all stages; so far as can be roughly judged, the form most abundant is *Calanus finmarchichus*. Calderwood * referred to the "appearance of Copepods in greater and greater numbers until, when the herring fishing is at its height, the Copepods are in vast abundance. At this season the prevailing species is *Calanus finmarchicus*, which occurs in sufficient numbers in certain places to colour the surface of the water. It is the species which serves as the principal food of the Loch Fyne herring during the summer." Murray † also records the occurrence of vast numbers of crustacean, fish, and other eggs coincident with the appearance of immense floating banks of diatoms between the end of January and the first of May. In April the temperature of the water at Stations III. and IV. was higher than at Station I., and that may to some extent account for the fact that the Copepoda at the former stations reproduced their species so much more rapidly than at Station I. In May, while the total volume of Copepoda remained the same as in April, great change had taken place at the different stations. The quantities on Stations I., II., and V. had steadily risen, while Station III. showed a fair decrease, and Station IV. a decrease almost as rapid and extensive as its former rise. The depletion of Station IV. may be in part due to drift, but if that were so, the same drift which robbed Station IV. ought to re-supply it from Station V. In May, then, the main mass of the Copeopoda was further down the loch than in the previous month.

* Calderwood—"Notes on the Copepods of Loch Fyne," *Fourth Annual Report of the Fishery Board for Scotland*, p. 147.

† *Op. cit.*

Whether this is to be ascribed to a drifting of the mass of Copepoda from one locality to another, or whether it is that the Copepoda in different localities reproduce in succession and not simultaneously, or whether it is owing to their having sunk to a lower level than 15 fathoms, is not easily settled. In June, on Station I., the rapid increase seen during the previous month was maintained, and the well-known condition of the water of Lower Loch Fyne, as regards Copepoda, is attained. Brook,* in noticing this fact, said—"Whether the myriads of *Calani* are bred in Loch Fyne [Lower Loch Fyne is here referred to] or enter it in the spring I have not determined. It is, however, a significant fact that the herring enter Loch Fyne as the Crustacean becomes abundant, and begin to leave it again as the stock gets exhausted. In July the number of *Calani* decreases rapidly, and in September was reduced to that found in the beginning of the year." The statements contained in the preceding sentence are correct so far as they are used with reference to the surface water; but proof is wanting that they are true so far as the deep waters are concerned. The herring does not usually enter Loch Fyne until May. They are then to be found in Upper Loch Fyne, but statistics are wanting at present which would serve to connect the movements of the herring absolutely with the appearance of Copepods in abundance. That the presence of the Copepoda is what attracts the herring to Loch Fyne is probable. It might therefore be possible to in some way announce the probable arrival, or perhaps to locate shoals of herring by data afforded by an examination of the pelagic life of the water. This has been done for the Baltic by the Norwegian observer Hjort.† During the first month of the herring fishing in Loch Fyne success is very slight indeed. Comparatively few herrings are in the loch, and their capture is a mere lottery. An amplification of this plankton work in Loch Fyne and other districts might afford important results. Data of importance would be obtained, and these might in some measure help to reduce the element of chance which governs the herring fishing.

In June all the stations except I. showed great diminution in the number of Copepods, but in the following month the numbers increased at the head of the loch (IV. and V.), and in the remaining three stations no more Copepoda were obtained than in March. The diminution on Station I. was excessively rapid. In August all the stations became still poorer, and reached a stage in which Copepoda were practically altogether absent from the surface down to 15 fathoms. Where the Copepoda went to is a question of some importance. That they were drifted out of the loch is not by any means probable. The reasonable explanation is that they sink to lower depths. In August tow-nets were used on the "Garland" at various depths down to 80 fathoms, and at 40 fathoms Copepods were found to be abundant. There are in the present research no data referring to greater depths than 15 fathoms, and so it is not possible to say whether or not the same wealth of Copepoda did or did not exist at the greater depths contemporaneously with the abundance in the 15-fathom stratum. The question as to the depths at which Copepoda and pelagic ova float will be treated later.

On reference to the curves formed by the number of eggs, A and C, Plate IV., we see that, as in the case of the Copepoda, there is a sudden rise in April, but whereas in the case of the latter, Stations III. and IV. were most concerned, Stations II. and V. were responsible for the increase in eggs. Station IV. showed a very sudden decrease in Copepods in

* *Fourth Annual Report Fishery Board for Scotland*, p. 47.

† Hydrographic Biological Studies of the Norwegian Fisheries. Christiania, 1896.

May, and Station II. showed a corresponding diminution in the quantity of eggs. The remaining two stations decreased slightly, III. as regards Copepods and V. as regards eggs. The ova increased in June on Stations III. and V., but remained at the other stations fairly constant in number. July witnessed a large fall in the total, though two of the stations—viz., I. and IV.—showed a slight upward tendency. In August the eggs practically vanished, as did the Copepoda.

The curve formed by the Copepoda is a regular though very steep one. The curve for the eggs shows two peaks, indicating, what has been already noticed, a reduction in spawning during May.

On the Levels at which Pelagic Eggs and Copepoda Float.

The question as to what conditions affect the vertical distribution of pelagic eggs and Copepeda is an interesting one. That pelagic ova are not absolutely confined to any one depth is well known, since tow-nets attached to a bottom trawl when in shallow water usually bring up some eggs. While it is of course possible that in all cases some eggs may be taken from the surface by such open nets while descending and ascending, the total number of eggs captured cannot be always accounted for in this way. M'Intosh,* referring to the pelagic eggs obtained by the *Garland* in St. Andrews Bay in 1891 and 1892, says:—"Generally speaking, the bottom trawl-like tow-nets, or other tow-nets used on the bottom, gave the largest number of ova, and besides, they were most productive of fishes, and these at a more advanced stage." The depth on the stations in St. Andrews Bay varies from 6 to 12 fathoms. In the Firth of Forth at Stations V. and II., where there are depths of 25 and 13 fathoms respectively, a considerable number of eggs were obtained in the bottom net. At Station V., Firth of Forth, a tow-net at 12 fathoms produced about 100 eggs, and a net towed 6 to 10 fathoms under the surface on Cross-section II. is credited with about 1500 eggs. One-fathom tow-nets on Cross-section I. contained large collections of eggs. On the majority of the stations of the "Garland," the depth on which exceeds 20 fathoms, eggs were conspicuous by their absence in the net attached to the trawl. Other collections of eggs described in the reports by Masterman,† Williamson,‡ Wallace,§ Kyle,‖ lend additional evidence in support of this statement.¶ In the report by Kyle there are collections made in Loch Fyne at various depths up to $6\frac{1}{2}$ fathoms. At the latter depth considerable numbers of eggs were obtained at the head of the loch, and above Otter Spit; but the net at 1 fathom produced a greater number than either the 6-fathom or $2\frac{1}{3}$-fathom net. The collections made at the latter depth were smaller than those made at 6 fathoms.

The buoyancy of a pelagic egg is, as Fulton** has proved, due to the "entrance into the ovum of a large quantity of watery fluid of low specific gravity." The same author found "a considerable variability in the specific gravity of the eggs of the same species and of the same female." A batch of fertilised eggs of the plaice in the multicelled stage had a specific gravity ranging from 1024–1026. Cunningham†† found that for

* *Tenth Report of the Fishery Board, Part III.*, p. 301.
† *Eleventh Report* ,, ,, p. 250.
‡ *Thirteenth Report* ,, ,, p. 258.
§ *Fourteenth Report* ,, ,, p. 223.
‖ *Fifteenth Report* ,, ,, p. 246.
¶ *Vide* also Scott, *Sixteenth Report of the Fishery Board.*
** "On the Growth and Maturation of the Ovarian Eggs of Telostean Fishes," *Sixteenth Report of the Fishery Board*, p. 88.
†† *Journal Mar. Biol. Assoc.*, i., 1889, p. 25.

the mackerel different individual ova vary in specific gravity within narrow limits. Hensen and Apstein (*op cit*) say—"Since the specific gravity of the eggs seems to adjust itself to the density of the water, what governs their vertical distribution has yet to be demonstrated. Out of 446 eggs, 104 were floating at a depth of 5 metres [$2\frac{1}{2}$ fathoms]; of 148 eggs, 28 were found at the same depth, 43 at 20 metres [10 fathoms], and the others—viz., 77—at still greater depths." In this connection Holt ‡ remarks—"I have no hesitation in saying that the buoyancy of an egg in ordinary offshore water is subject to fluctuations which are explicable neither by species, degree of development, nor obvious physical and meteorological causes." It is not surprising that, in a property requiring so exact an adjustment as the specific gravity of the egg, considerable variations should occur. It is well known that considerable variation occurs in the size of the egg; a certain amount of variation in specific gravity must almost necessarily also be present. This fact then offers a sufficient explanation of the fact that the eggs do not all float at one depth. It is very improbable that the specific gravity of an egg will, on its extrusion, change through its contact with sea water. Whether during the development of the embryo a change in specific gravity occurs in consequence of physiological processes may be in the meantime disregarded. The eggs will rise to levels where the specific gravity of the water is equal to their own, and while the main mass of the eggs will be found floating within certain limits of depth, a considerable number will have remained scattered at various greater depths; and even if the main mass does not lie very close to the surface, certain examples will have made their way there. This is borne out by the study of the distribution of eggs in Loch Fyne. *Cf.* also Meek—Report on the Trawling Excursions of Northumberland Sea-Fisheries Committee, 1897.

The ova in the surface stratum of water 15 fathoms deep in Loch Fyne were found distributed at various depths, but the majority were obtained between the surface and 6 fathoms. On certain occasions no eggs were taken at a greater depth than 6 fathoms; and as a rule the mass of eggs was found to float closer to the surface than 4 fathoms. I have prepared a Table showing diagrammatically the numbers of ova taken in the nets at different depths on each station (*vide* Plate V.). The unshaded figures refer to pelagic eggs. The breadth of the figure at each depth is proportional to the number of eggs taken at that level. The depth is shown along the vertical margin. Thus at the depth where the figure is broadest the majority of the eggs was taken. The varying breadth indicates the unequal dispersion of the ova. The figures are not all made on one standard. In the space at disposal that would have been impossible. Some of the collections contain very few eggs, and in order to have a figure consisting of something more than one line, a larger unit was required than for the large collections. They, however, show at what depth the main mass of eggs was floating, and what proportion that mass bore to the rest. In certain cases the figure indicates that the majority of eggs was within two feet of the surface (0 fathoms in Plate), and as the depth increased the number of eggs gradually and regularly decreased in numbers, thus giving a regularly tapered outline to the figure. (*See* Station I., April, May, and July; Station II., March and July; and Station III., March.) Others show that the main mass floated a little below the surface—*e.g.*, 1 fathom; and from that level downwards the figures taper gradually. (*See* Station II., April; Station III., June; Station IV., June.) Again the majority may be found at 4 fathoms—*e.g.*, Station I., March; Station IV., April and May; Station V., April. There is no

‡ *Jour. Mar. Biol. Assoc.*, vol. v., No. 1.

indication in any of the figures of the main mass of eggs being as deep down as 6 fathoms (except in Station II., May, and the superiority of this net over the others is a slight one), but there are several cases in which proportionally a considerable number of eggs were obtained at that level (Station IV., March, April, and May; and Station V., July). Another fact displayed by the figures is, instead of the eggs appearing mainly at one level and diminishing regularly in number as they recede from it, two different levels may be found well supplied with eggs, while between them a much less rich region is found. This is shown at Station I. in March and Station III. in June, where the intervening levels—viz., 1 and 2 fathoms—are respectively poorer than the levels immediately above and below. Again, intervening regions may be almost destitute of eggs—*e.g.*, at 4 fathoms in Station III., February; 2 fathoms, Station V., July and August. In short, so great is the diversity that it is very difficult to reduce the facts to any fixed rule. One point is noticeable, and that is how generally a large proportion of the eggs were found within two feet of the surface. At Station V. in April, July, and August, when the surface water was of low salinity—*e.g.*, 1·52, 1·319, and 1·739—no eggs were obtained in the surface net. They were, however, found at 1 fathom. This shows that the low salinity did not extend much below the surface. On Station IV. in April, and Station V. in June, eggs were obtained within two feet of the surface, but they were few in number. The salinities in these localities were, in the months referred to, 2·31 and 2·75. The fact of the presence of the eggs within two feet of the surface shows that the water of low salinity was confined to within less than two feet of the surface.

In Tables IV.–XI. is given the volume of Copepoda taken in each net, and from these data shaded figures have been drawn on a plan similar to that adopted for the eggs. The breadth of the figure at any depth is proportional to the volume of Copepods taken at that level. A glance at the shaded figures shows a point in which they differ very much from the figures of the egg collections—viz., in the acuteness of their apices. While it was common to find a large proportion of eggs at the surface, the rule in April, May, June, July, and August was that a very minute proportion of Copepoda was to be found within two feet of the surface. In February and March this was found to be the case on certain stations; on most of the stations in January, however, and certain stations in February and March, a considerable proportion of the total amount of Copepoda was found floating close to the surface.

Station V. is a notable exception for January. On reference to the Salinity Table (XVI), p. 130, the absence of Copepoda from the surface would appear to be due to lower specific gravity of the surface water. This is the case with regard to certain stations—viz., Station V. in January, and Station IV. in April, May, June, July, and August. At the latter station in May, June, and July, although the surface water was of less than normal salinity—viz., 2·8, 2·49, and 2·72 per cent. of total salts—the respective specific gravities being 24·6, 21·8, and 23·2—large numbers of ova were floating close up to the surface. This indicates a point of great difference in the behaviour of eggs and Copepods—namely, that pelagic eggs may be found in considerable numbers close to the surface at a time when the surface water is of a comparatively low salinity, while Copepoda are withdrawn to lower depths. A condition of lower salinity does not, however, explain the absence of Copepoda from the surface on all occasions. Whether this may be due to the fact that the work was carried on in daylight only, is possible. It is well known, from the results of the "Challenger" and other Expeditions, that the pelagic fauna sinks in daylight and comes to the surface at night. But as all the experiments were carried out in Loch Fyne during the day, such a reason would not agree with the fact that a considerable proportion of the Copepoda was found at the surface on several stations in January, February, and March, and at Station III. in April, and at Station II. in July. Variations similar to those seen in the figures for the egg collections are to be seen in those of the Copepods. In many cases the figures take a spindle shape, tapering upwards and down from the level where the majority is floating, which at Station I., May, and Station IV., June, is at six fathoms. We have also barren intermediate regions represented, viz., at six fathoms on Station II., March, and at ten fathoms Station V., July. On the whole, however, the Copepod figures are more regularly spindle-shaped than the egg figures. The amount of vertical dispersion is greatest in January, February, and March, and in July and August, while during April, May, and June the Copepoda in the 15-fathom stratum are on most of the stations concentrated at a depth of four to six fathoms. This concentration coincides with an increase in the salinity of the water. In August the Copepods had almost entirely disappeared from the 15-fathom stratum at Stations I. and II. On Station I. the seven horizontal nets produced 39 Copepods; at Station II. 41 Copepods were taken at 15 fathoms; and 8 Copepods in the remaining six nets. A few Copepods were found at Station III. from four fathoms down, and on Station IV. four individuals were captured at the surface. At fifteen fathoms they were fairly numerous. Station V. furnished the largest number of Copepods, but they were in small quantity. The figure which is introduced into the Table for that station is greatly exaggerated in order to bring out the relations of the quantities at different depths. On the whole, the centre of suspension for Copepoda is lower than that of the eggs. The close association of pelagic eggs with Copepods results in their being eaten by the herring. Brook found pelagic eggs in the stomach of that fish.

Note.—In the preparation of the figures in Plate V. an allowance is made for the fact that the nets, in sinking to the depth at which they are intended to fish, capture a certain number of eggs and Copepods. They fish also while being hauled to the surface. The nets the takes of which would be most affected by this fact are the 10 and 15 fathoms nets, and since the area of the mouth of one of the horizontal nets is very nearly equal to half the area of the vertical net, the collection taken in the vertical net on the station is regarded as approximately equal to what the horizontal net captures in its downward and upward journeys. This quantity is therefore subtracted from the takes of the 10 and 15 fathoms nets on each station.

On the Drift of the Eggs.

Fulton's * investigations in connection with the currents of the North Sea, while resulting in the determination of the direction and rates of the surface currents, have so far not resulted in proving the depth of these currents. In Loch Fyne, according to Mill, † "the tidal current is not "merely superficial. That the tide sweeps across at Otter to its full "depth is proved from salinity observations. . . . The current of ebb "tide evidently affects the water to a considerable depth, at any rate in "the Gortans basin. . . . An average velocity of 1 knot for the "surface current appears from the Admiralty charts to be the maximum "estimate of the surface tidal currents in Loch Fyne. At that rate, since

* "On the Currents of the North Sea," *Fifteenth Annual Report Fishery Board for Scotland*, Part III., p. 270.

† Clyde Area (*op. cit.*).

"the ebb stream lasts about one hour longer than the flood, a given "particle of water on the surface would be carried one mile down the "loch by each tide, supposing the weather calm." He states that "the "tidal current, according to the Admiralty publications, enters Loch Fyne "at Otter at the rate of $3\frac{1}{2}$ knots, passes through the Gortans Basin at "2 knots, increasing to $2\frac{1}{2}$ at Minard Narrows, but then slackening until, "off Dunderawe, near the head of the loch, it is reduced to 1 knot." In 1896 (8th September) the result of observations made by Mill * on the tidal current at Otter gave a rate of about $\frac{3}{4}$-knot an hour for the last half of the flood, and about 1 knot an hour for the ebb. "A great "accession of fresh water on the surface must necessarily, by raising "the level, accelerate the ebb tide. . . . On the other hand, after a "long dry spell, the tendency of evaporation would be to lower the "general level, and so accelerate the flood tide."

In the absence of sufficient data bearing upon the tidal currents over the whole loch, it is not possible to effectively discuss the effects which these currents have on the distribution of the pelagic eggs. It is very clear, however, that, from the rate of the current in the Gortans basin and at Otter, a large proportion of the eggs floating at Station II. will probably be carried out into Lower Loch Fyne with each ebb. From Station III. those eggs at least which were close to the surface would be subject to drift, and should in a few days arrive at Otter. From Stations IV. and V., however, taking the drift down the loch at the average of 1 knot per day, the eggs would be hatched long ere they reached the Gortans basin. The surface eggs would be all subject to the drift, but how far any eggs floating at some depth below the surface would be affected only further investigations can determine. It is at least evident that those eggs which vary by having a specific gravity a little less than the average will be first acted on by surface currents, and so the variation in specific gravity in the eggs of a species has an important bearing upon their distribution. It may at least be confidently stated that a large number of eggs spawned in Upper Loch Fyne go to enrich the waters of the lower loch. It must, however, be borne in mind that the spawning of the fishes in Loch Fyne has been inferred only from the presenee of their floating eggs there, and not from an examination of the fishes themselves. From the fact that large numbers of eggs in the later stages of development were found on Station II., it might be inferred that they had drifted there from regions further up or further down the loch. Murray has shown that the winds are important factors in the formation of currents.† He has shown for Loch Fyne that a strong southerly wind will heap up the surface waters at the head of the loch, while the place of the water transported from regions further down the loch is partly supplied by the upwelling of water from below. Strong southerly winds, as well as flood tide, may carry into Loch Fyne the ova which are floating outside, and so two causes might be cited for the occurrence of large numbers of advanced eggs at Station II.—viz., (1) a drift down the loch through currents due to northerly winds and the ebb tide, and (2) transport of eggs from the lower loch into the upper loch by currents induced by southerly winds and the flood tide.‡

The Copepoda will also be subject to the various currents, but, from the fact that they on the average float at greater depths than the eggs, their drift must be slower. It is not, therefore, probable that the presence of vast numbers of young Copepods on the lower stations, subsequent to their appearance at the head of the loch, is in any important respect due to drift.

* *Fifteenth Annual Report of the Fishery Board*, Part III., p. 270.

† Murray. "The Effects of Winds on the Distribution of Temperature in Sea- and Fresh-Water Lochs of the West Coast of Scotland." *The Scottish Geographical Magazine*, July 1888.

‡ *Vide* in this connection Petersen, "Pelagic Life of Faeno Sound." Copenhagen, 1893.

On the Larval and Post-Larval Fishes obtained in Loch Fyne.

A detailed list of the young fishes which were taken in the tow-nets with the pelagic ova and other forms is given below. The identification of the specimens was not rendered easier by the fact that they were preserved along with the Copepoda, etc. I had not the opportunity of separating them at the time from the rest of the tow-net collection, and in many cases it was almost impossible to identify even the genus of the fish. Preservation in formalin was found to answer very well, so far as the retention of black pigment is concerned ; other pigments disappeared.

The labour of identification was very materially lightened for me by the kind assistance rendered by Professor M'Intosh, who, in addition to naming a number of the specimens, also placed his collection of young fishes at my disposal for the purpose of comparison. In a number of cases the genus to which the form belongs is alone given.

The species represented are the following :—Cod (*Gadus callarias*), *Cottus bubalis*, *Cottus* (sp.), *Cyclopterus lumpus*, Dab (*Pleuronectes limanda*), Flounder (*Pl. flesus*), *Gobius minutus*, *Gobius* (II.), Gunnel (*Centronotus gunnellus*), *Lepadogaster bimaculatus*, *Liparis montagui*, Long Rough Dab (*Drepanopsetta platessoides*), Mackerel (*Scomber scombrus*)? *Onos* (sp.) (*Motella*), Pipe-fish (*Syngnathus*, sp.), Plaice (*Pl. platessa*), Saithe (*Gadus virens*).

Species B.—The forms included under this designation are mainly mackerel, but since, in the case of the very small examples, some confusion may arise between that fish and the species of *Cottus* and *Trachinus*, they have been placed under a general term.

Station II., 20th January,	Surface ; 2 *Cyclopterus lumpus*, 2 and 4 cm.
Station II., 17th February,	15-fm. Net ; gunnel, 10mm.
,, III., 18th ,,	1-fm. Net ; gadoid, 7mm.
,, V., 19th ,,	Surface, *Cyclopterus lumpus*, 23mm.
Station II., 16th March,	Surface, larval *Onos* (sp.).
	1-fm. Net ; gunnel, 9mm.
	2-fm. Net ; larval Pleuronectid (Dab ?), 2mm.
	4-fm. Net ; gunnel, 8mm. ; 2 *Cottus* (sp.), 3·5mm. ; 3 *Onos* (sp.), 3mm.
	6-fm. Net ; Pleuronectid, 2mm. ; *Onos* (sp.), 3mm.
	10-fm. Net ; 8 *Onos* (sp.), 3·5mm. ; Pleuronectid, 2mm. ; *Cottus* (sp.), 5mm.
	15-fm. Net ; *Onos* (sp.), 3mm.
Station III., 17th March,	Surface ; gunnel, 7·5mm.
	1-fm. Net ; 2 gunnels, 9 and 10mm.
	10-fm. Net ; 2 gunnels, 10mm.
	Vertical Net ; larval cod, 3·5mm.
Station V., 19th March,	4-fm. Net ; gunnel, 12mm.
	6-fm. Net ; *Gobius minutus*, 3mm.
	15-fm. Net ; 2 gunnels, 18mm.
Station I., 11th April,	Surface ; larval plaice, 4mm.
	6-fm. Net ; larval cod, 3·5mm. ; *Cottus* (sp.), 9mm.
	10-fm. Net ; ,, 3mm. ; gunnel, 14·5mm. ; larval *Gbius minutus*.
Station II., 14th April,	Surface ; 3 larval Pleuronectids, 2·5mm.
	1-fm. Net ; larval cod, 3mm. ; gadoid, 3mm. ; pleuronectid, 2mm. ; 4 larval long rough dab, 4mm.
	2-fm. Net; *Gobius minutus*, 7·5mm. ; gadoid larva.
	4-fm. Net ; cod, 4mm. ; 2 pleuronectids, 2·5 and 3mm. ; 2 gunnels, 11 and 13mm. ; *Gobius minutus*, 5mm.
	6-fm. Net ; 2 cod, 6mm. ; cod, 3mm. ; flounder, 3mm. ; 6 pleuronectids, 2·5mm. ; 6 *Gobius minutus* ; Species B, 5·5mm.
	10-fm. Net ; 6 cod, 3·5mm. ; saithe, 3·5mm. ; long rough dab, 5mm. ; *Lepadogaster bimaculatus*, 3mm. ; 11 *Gobius minutus*, 3·5–5mm.

Station II.—*contd.*
15-fm. Net; cod, 5·25mm.; gadoid (saithe ?), 5mm.; 2 pleuronectids, 3·5mm.; 2 *Onos* (sp.), 4mm.; 8 *Gobius minutus*, 2·5–4·5mm.; Species B, 4mm.
Vertical Net; plaice, 5·5mm.; gunnel, 11·5mm.; *Gobius minutus*, 3·5 and 4·5mm.

Station III., 19th April,
Surface; *Cottus*, 3·5mm.
1-fm. Net; 3 plaice, 8–11mm.; *Lepadogaster bimaculatus*, 10·5mm.; 2 gunnels, 17 and 20mm.; *Gobius minutus*, 7mm.; Species B, 4mm.
2-fm. Net; *Gobius minutus*, 5mm.; 11 Species B, 4–7mm.
4-fm. Net; 7 cod, 3·5mm.; 2 *Cottus bubalis*, 10 and 13·5mm.; 4 *Gobius minutus*, 4–6mm.; 2 Species B, 5mm.
6-fm. Net; 3 cod, 3mm.; 2 long rough dab, 4·5mm.; 4 *Gobius minutus*, 5–6mm.; 4 Species B, 4·5–8·5mm.
10-fm. Net; cod, 4mm.; gadoid, 3·5mm.; 8 *Gobius minutus*, 3–6·5mm.; gunnel, 12mm.; 8 Species B, 4–5mm.
15-fm. Net; 3 cod, 3 and 3·5mm.; 2 *Gobius minutus*, 3·5 and 6mm.; Species B., 8mm.
Vertical Net; cod, 3mm.; 2 Species B, 3·5 and 4·5mm.

Station IV., 18th April,
2-fm. Net; Species B, 3·5mm.
10-fm. Net; cod, 4·5mm.; 2 *Gobius minutus*, 4mm.
15-fm. Net; cod, 3·5mm.; gunnel, 16mm.

Station V., 16th April,
Surface; *Gobius minutus*, 3·5 mm.
2-fm. Net; *Cottus* (sp.), 8mm.
4-fm. Net; 6 *Cottus* (sp.), 5–11mm.; Species B, 5mm.
6-fm. Net; *Gobius minutus*, 4mm.
10-fm. Net; 3 *Cottus* (sp.), 6·5–7·5mm.; gunnel, 15mm.; *Gobius minutus*, 6mm.
15-fm Net; cod, 4mm.; 3 *Cottus* (sp.), 6–7mm.; 3 gunnels, 14–21mm.
Vertical Net; *Cottus* (sp.), 5mm.

Station I., 9th May,
15-fm. Net; *Cottus* (sp.), 4mm.; *Gobius minutus*, 5·5mm.

Station II., 11th May,
4-fm. Net; *Cottus* (sp.), 5·5mm.; *Gobius minutus*, 6·5mm.
15-fm. Net; Species B, 3·5mm.
Vertical Net; *Gobius minutus*, 3·5mm.

Station III., 12th May,
1-fm. Net; *Gobius minutus*, 6·5mm.; 17 Species B, 3·5–6·5mm.
2-fm. Net; 24 Species B, 4–6·5mm.
4-fm. Net; plaice, 8mm.; 10 *Gobius minutus*, 3–7·5mm.; 68 Species B, 3·5–6·5mm.
6-fm. Net; plaice, 10·5mm.; 2 *Cottus* (sp.), 4 and 5mm.; 9 *Gobius minutus*, 3·5–9mm.; *Gobius* (sp.), 6mm.; 68 Species B, 3·5–9mm.
10-fm. Net; gadoid, 8mm.; 12 *Gobius minutus*; long rough dab, 10·5mm.; 25 Species B, 3·5–6·5mm.
15-fm. Net; 9 cod, 3·5–4mm.; gunnel, 18·5mm.; 5 *Gobius minutus*, 3·5–6mm.; Montagu's sucker, 8mm.; 22 Species B, 3–7mm.
Vertical Net; 2 cod, 3·5mm.; *Cottus* (*bubalis* ?), 8mm.; 4 *Gobius minutus*; 7 Species B, 3–5mm.

Station IV., 13th May,
1-fm. Net; *Gobius minutus*, 3mm.
4-fm. Net; *Gobius minutus*, 4·5mm.; Species B, 3mm.
6-fm. Net; 5 cod, 3mm.; 2 *Gobius minutus*, 3mm.
10-fm. Net; cod, 3mm.; gunnel, 18·5mm.; Species B, 3mm.
15-fm. Net; cod, 3mm.

Station V., 14th May,
1-fm. Net; 2 cod, 3mm.; *Lepadogaster bimaculatus*, 5·5mm.; 3 *Gobius minutus*, 3–6mm.; Species B, 5mm.
2-fm. Net; 3 *Lepadogaster bimaculatus*, 4·5–7·5mm.; *Cottus* (sp.), 4·5mm.; 7 *Gobius minutus*, 3·5–4·5mm.; 3 Species B, 4mm.
4-fm. Net; 10 cod, 3·5–5·5mm.; 11 *Cottus* (sp.), 5–8mm.; 12 *Gobius minutus*, 3–6·5mm.; 13 Species B, 3·5–6·5mm.; sucker, 3mm.; 10 *Gobius* (II.), 5 and 8mm.; 2 pleuronectids, 2·5mm.
6-fm. Net; 16 cod, 3·5–7·5mm.; 6 gadoids, 4–6·5mm.; 20 *Cottus* (sp.), 5–9mm.; 16 Species B, 4·5–6·5mm.; 11 *Gobius minutus*, 5mm.; 4 *Gobius* (II.), 5–9mm.
10-fm. Net; 8 cod, 3-5-7mm.; *Cottus bubalis*, 8mm.; 9 *Gobius minutus*, 4–7mm.; 2 Species B, 3 and 4mm.; 2 *Gobius* (II.), 4 and 9mm.
15-fm. Net; 7 *Gobius minutus*, 3–5mm.; Species B, 4·5mm.; *Gobius* (II.), 9·5mm.

Station I., 6th June,
4-fm. Net; 2 Species B, 4 and 11·5mm.
6-fm. Net; gadoid; *Cottus* (sp.), 4mm.

Station II., 8th June,
Surface; Species B, 3mm.
1-fm. Net; 2 *Gobius minutus*, 2·5 and 3mm.; 2 Species B, 3mm.
2-fm. Net; 2 *Gobius minutus*, 3·5mm.; Species B, 3mm.
4-fm. Net; 5 Species B, 3·25–8mm.
6-fm. Net; 5 Species B, 3·5–5mm.
10-fm. Net; 3 *Gobius minutus*, 5mm.; 2 young pipe fish; 4 Species B, 3.5–5mm.
15-fm. Net; *Gobius minutus*, 6·5mm.; 3 mackerel, 3–6mm.
Vertical Net; Species B, 3·5mm.

Station III., 9th June,
2-fm. Net; *Gobius minutus*, 3mm.
4-fm. Net; 2 *Gobius minutus*, 3·5 and 6·5mm.; larval pleuronectid; 6 Sp. B., 3–8mm.
6-fm. Net; 9 Species B, 4–8mm.; *Gobius* (II.,) 4mm.
10-fm. Net; 7 *Gobius minutus*, 4–7mm.; 10 Species B, 4–6mm.
15-fm. Net; 14 *Gobius minutus*, 5–6mm.; 21 Species B, 4–7mm.
Vertical Net, 2 *Gobius minutus*, 7mm.; Species B, 6mm.

Station IV., 10th June,
2-fm. Net; cod, 3mm.; gadoid, 4mm.
4-fm. Net; Species B, 5mm.
10-fm. Net; *Gobius minutus*, 3mm.; *Gobius* (II.), 4mm.
15-fm. Net; *Gobius minutus*, 7·5mm.

Station V., 10th June,
Surface; Montagu's sucker, 5mm.; 2 Species B, 5mm.; 3 *Gobius* (II.), 6–7·5mm.
1-fm. Net; 2 Species B, 4·5mm.; 2 *Gobius* (II.), 4mm.
2-fm. Net; larval plaice; cod, 3mm.; 11 Species B, 3–6mm.; 6 long rough dabs, 4mm.
4-fm. Net; gadoid, 12mm.; 29 Species B, 5–8mm.; 2 *Gobius* (II.), 4 and 9mm.
6-fm. Net; 6 Species B, 5–8mm.; 4 *Gobius* (II.), 7–10mm.
10-fm. Net; 11 Species B, 3·5–10mm.; 4 *Gobius* (II.), 6–10mm.
15-fm. Net; 4 Species B, 4–7·5mm.; 2 *Gobius* (II.), 3·5 and 7mm.
Vertical Net; cod, 3mm.; 4 Species B, 3–4·5mm.; *Cottus* (sp.) 5·5mm. 16 *Gobius* (II.), 3–8mm.

Station I., 5th July,
4-fm. Net ; Species B, 6·5mm.
6-fm. Net ; 6 *Gobius* (II.), 3·5–6mm.
10-fm. Net ; Species B, 3mm. ; 2 *Gobius* (II.), 5mm.
15-fm. Net ; *Gobius minutus* ; *Gobius* (II.), 4·5mm.
Vertical Net ; cod, 3mm. ; *Gobius* (II.), 9mm.

Station II., 6th July,
Surface, 2 *Cyclopterus lumpus*, 7 and 13mm.; *Gobius minutus*, 6mm.
1-fm. Net ; 3 *Gobius* (II.), 3–7mm.
2-fm. Net ; 2 *Gobius* (II.), 4 and 8mm.
6-fm. Net ; *Gobius* (II.), 4mm.
10-fm. Net; *Gobius* (II.), 3·5mm.
15-fm. Net ; Species B, 3mm.; *Gobius* (II.), 4mm.

Station III., 8th July,
Surface ; *Cyclopterus lumpus*, 13mm.
15-fm. Net ; *Cottus* (sp.), 8mm.; 2 *Gobius* (II.), 3·5 and 5mm.

Station IV., 7th July,
Surface ; *Gobius minutus*, 3mm.
1-fm. Net ; 6 *Lepadogaster bimaculatus*, 3–5mm.; 7 *Gobius minutus*, 3–8mm.
2-fm. Net; *Lepadogaster bimaculatus*, 3·5mm.; *Gobius minutus*, 8mm.
4-fm. Net; *Lepadogaster bimaculatus*, 4mm.; *Gobius* (sp.), 4·5–8mm.; 2 Species B, 4 and 5mm.
6-fm. Net; *Lepadogaster bimaculutus*, 5mm.; 6 *Gobius minutus*, 5·5–10mm.; 16 *Gobius* (II.), 3·5–8mm.; Species B, 4·5mm.
10-fm. Net ; 2 *Gobius* (II.), 6·5mm.
15-fm. Net ; *Gobius* (II.), 8mm.
Vertical Net, *Lepadogaster bimaculatus*, 4mm.; Species B, 3·5mm.

Station V., 7th July,
Surface ; 30 *Lepadogaster bimaculatus*, 3·5–6mm.; 1696 *Gobius minutus*, 4–10·5mm.; larval mackerel, 3·5mm.; 2 Species B, 4·5mm.
1-fm. Net; 2 *Lepadogaster bimaculatus*, 5 and 5·5mm.; 48 *Gobius minutus*, 4–8mm.
2-fm. Net; *Lepadogaster bimaculatus*, 4mm.; 31 *Gobius* (II.), 3–5·5mm.
4-fm. Net; 2 *Lepadogaster bimaculatus*, 4 and 6mm.; 4 Species B, 6mm.; 20 *Gobius minutus*, 5–8mm.
6-fm. Net ; 18 *Gobius minutus*, 4–8mm.
10-fm. Net; 3 *Lepadogaster bimaculatus*, 4–6mm.; 12 *Gobius minutus*, 4–11·5mm.
15-fm. Net; 2 *Lepadogaster bimaculatus*, 5 and 9·5mm.; *Gobius minutus*, 5·5mm.
Vertical Net, *Lepadogaster bimaculatus*, 5·5mm.; 28 *Gobius minutus*, 5–6mm.

Station I., 8th August,
4-fm. Net; larva, 3mm.
6-fm. Net ; ,,
15-fm. Net ; cod, 3mm.

Station II., 9th August,
Surface ; *Lepadogaster bimaculatus*, 4mm.
6-fm. Net ; *Gobius* (sp.), 3·5mm.
10-fm. Net ; *Gobius* (sp.), 4mm.
15-fm. Net ; *Gobius* (sp.), 3mm.; 3 *Lepadogaster bimaculatus*, 3 and 4mm.

Station III., 9th August,
10-fm. Net ; *Gobius* (sp.), 3mm.
15-fm. Net; *Lepadogaster bimaculatus*, 9mm.; 2 Species B, 3 and 3·5mm.

Station IV., 9th August,
6-fm. Net ; *Gobius minutus*, 3mm.

Station V., 9th August,
Surface ; *Gobius minutus*, 3·5mm.
1-fm. Net; gadoid, 5mm.
4-fm. Net ; *Gobius* (sp.), 4·5mm.
6-fm. Net ; 3 *Gobius minutus*, 6–7mm.
10-fm. Net ; *Lepadogaster bimaculatus*, 10mm.; *Gobius* (sp.), 4·5mm.
15-fm. Net ; *Lepadogaster bimaculatus*, 8mm.; 4 *Gobius minutus*, 5–7mm.

Notes on the foregoing List.

In the list of young fishes, certain of them are recorded of sizes which are palpably too small. Many of the larval and post-larval forms were distorted and injured, and it was only possible to give approximate sizes.

Gobius (II.).—The forms labelled *Gobius* (II.) differ from *Gobius minutus* in the following points:—There is no black pigment on the dorsum in *Gobius* (II.), whereas *Gobius minutus* has a patch of pigment consisting of two large stellate corpuscles and a smaller third, on the dorsum, a little in front of the tail. In the latter the black pigment on the ventrum consists of a row of fairly large detached corpuscles extending along the mid-ventral line of the abdomen, and continued behind the anus for some distance towards the tail. In *Gobius* (II.), on the middle line of the abdomen the pigment is represented by a thin black line. Behind the anus the line is double for a short space, and is then replaced by several large pigment corpuscles. This description refers to preserved specimens of 7mm. length.

Species B., as mentioned above, includes more than one species, but the majority consists of a form which I have referred to the mackerel.

Mackerel (?)—Several stages have been drawn by Miss Walker, St. Andrews (Plate VI., fig. 1—7 and 12). The youngest example, 4mm. in length, is characterised by a large amount of jet black pigment, laid down in a very definite arrangement. The brain is covered by a patch of stellate pigment corpuscles (Plate VI., fig. 16), while along the dorsum a broad row of minute spots extends to within a short distance of the base of the tail fin. It is indistinctly divided into two rows. Just behind the anus there is a distinct lateral band, formed by a short row of pigment spots along the lateral line. Over the abdomen (fig. 1c.) are scattered minute spots, specially concentrated in the rectal region. They are continued behind the anus in a broad row to a point below the end of the dorsal pigment row. In Fig. 2, a specimen 1mm. longer than the preceding, the arrangement of the pigment is exactly similar. In this and the following stage, of 5·5mm. in length (fig. 3), the pigment is intensified, the bar behind the anus being more prominent. The dorsal pigment has now become definitely arranged in two rows, one along each side of the marginal fin. The pigment on the head is laid down in a heart shape, and is separated from the outer end of the dorsal rows by a little gap devoid of pigment. In Fig. 4, which represents a specimen of 6·5mm., the pigment rows have broadened; the anal rows, widely separated at the anus, approach each other as they proceed towards the base of the caudal fin. The minute black spots on the abdomen and sides have increased greatly in number. At 8·5mm. (fig. 7) the whole body, with the exception of a little portion anterior to the base of the tail fin, is covered with the minute spots. The bar on the tail is to some extent hidden by the increase in pigmentation. On the dorsum the pigment consists of large stellate corpuscles (fig. 1b). The ventral appearance is shown in Fig. 1c. The dorsal fins, two in number, are indicated indistinctly in the earliest form, but it is only at the last stage referred to that they are prominent. The first dorsal (7 fin rays *ca*) is situated a little posterior to the pectoral region; the second dorsal (10–11 fin rays *ca*) begins at a point on the dorsum immediately above the rectum. The anal fin (9–10 fin rays *ca*) in its origin and breadth closely resembles the second dorsal. Fig. 6 shows a form a little smaller than that shown in Fig. 7. In general form and in the arrangement of the pigment it is exactly similar to the preceding specimens, but it differs in the character of the pigment. In this case the pigment on the sides and abdomen, instead of consisting of minute black spots, is in the form of large dark brown stellate corpuscles, giving the little fish an almost black colouration. This difference in pigmentation may, however, be of no importance, since in life the minute spots in the other specimens would no doubt be stellate. It may perhaps be sufficiently explained by the assumption that in one case the corpuscles remained expanded after death, while in the other they contracted. The largest specimen of the series—viz., one 11·5mm.—is damaged (fig. 12). Each example, with the exception of 1 and 2, had very characteristic teeth. In Fig. 7 two long recurved teeth were present in front in the lower jaw, one on each side of the symphysis of the mandible. Behind these on each side were two triangular teeth. In the upper jaw three teeth, similar to those of the lower jaw, were found on each side. The front tooth, recurved like that on the mandible, was not quite so prominent as the latter. The smallest form in which the teeth were noticed was Fig. 3, where the two recurved teeth and one or two triangular teeth were present. The blunt shape of the head is a feature of note in this species. The only young forms hitherto described that resemble the above are the young mackerel sketched by Holt.* From the general resemblance between my specimens and those recorded by Holt, as regards general form, arrangement of the fins, and the possession of teeth, I am convinced that the fishes I have described above are the young of the mackerel (*Scomber scombrus*). A larval mackerel was captured on Station V. on 7th July. It exactly resembles the larval mackerel described by Cunningham.†

Lepadogaster bimaculatus was frequently met with in the tow-nets. The most noticeable points in this form are the truncated head, and the pigment, which is uniformly scattered over the body, with the exception of the posterior third of the tail and the top of the head. In the smaller examples—*e.g.*, fig. 8b, figs. 9 and 10—the head is quite free of pigment. In the largest specimen sketched—viz., fig. 11—the pigment has begun to appear on the top of the head. The pigment from either side of the abdomen extends downwards and forwards, meeting in the hyoid region. A V-shaped arrangement is then given to the pigment on the under surface of the head (figs. 8c and 11c). The above specimens do not show the sucker. In older examples—viz., of a length of 10mm.—the sucker is well developed, and in one at 8mm. it is seen indistinctly. The latter also shows the V-shaped arrangement of pigment in the hyoid region. The pigment in those from 7·5–10mm. long is, as described by M'Intosh and Masterman,‡ laid down in four more or less regular longitudinal rows of large corpuscles on the side of the body. A semicircular curve of pigment follows the outline of the mid-brain. No other pigment is present on the head. In an example of 5mm. length the pigment consisted of large chromatophores, instead of minute spots as in those sketched. It is probable that those post-larval forms which were put into the preserving fluid when alive retain their chromatophores in an extended condition, while those which were killed in the net exhibit a pigmentation consisting of minute spots. The bulging eyes were characteristic of all the examples. The short stumpy pectorals were well seen in specimens from 5mm. upwards. In the specimen 10mm. in length, the V-shaped arrangement of pigment in the hyoid region was absent. The larva of this species has been described by Holt.§

* *Jour. Mar. Biol. Assoc.*, vol. v., No. 2.
† *Op. cit.*
‡ *Op. cit.*
§ *Scientific Trans. Roy Dublin Soc.*, vii., I., 1891, p. 447.

ANALYSIS OF THE COLLECTION OF FISHES.

	11	March	April.	May.	June.	July.	Aug.	Totals.
Cod,	...	1	31	55	3	1	1	92
Plaice,	...	...	5	2	...	...	...	7
Gadoids,	...	...	5	8	2	...	5	20
Pleuronectids,	...	3	20	4	...		...	27
Species B.,	...	...	33	267	140	11	2	453
L. bimaculatus,	...	...	...	...	...	...	...	57
Other Fishes,	...	...	...	...	...	...	...	2279

TOTALS FOR EACH STATION.

Station I.,	...	...	6	2	4	12	3	27
,, II.,	1	22	71	3	33	12	7	149
,, III.,	1	5	77	300	72	4	4	463
,, IV.,	...	...	6	14	6	47	1	74
,, V.,	1	4	22	184	92	1872	14	2189

TOTAL NUMBER OF FISHES FOR EACH NET.

Fathoms,	0	1	2	4	6	10	15	Vertical
Number of Fishes,	2752	121	115	261	281	195	155	55

Grand Total, - 2,935 young fishes.

The collection of fishes is marked by the very small proportion of the young of the food-fishes. Out of a total of 2935 fishes, 143 only belonged to the Gadcid and Pleuronectid genera. Of these, the majority were cod, plaice being represented by seven individuals. Twenty undetermined Gadoids and 27 Pleuronectids completed the total of these genera. Of Species B, a large number of specimens were obtained—viz., 453. On the other hand, a fairly large number of other forms, which, however important they may be as food for more valuable fishes, are not of themselves of any commercial importance, were obtained. The absence of the food-fishes is probably accounted for by the fact that the nets did not fish deep enough at the time. The vertical distribution of young fishes in their early post-larval stages is not very well understood, and the reason why the young of coarse fishes are found in large numbers in the upper zone, while the young of food fishes are absent, is a matter deserving attention. It will be noticed in the Table giving the numbers of fishes for each net, that the vast majority were found at the surface. The total 2752 here given is, however, made up almost wholly of one catch—viz., that made on Station V. in July—when 1729 fishes, almost entirely

Gobies, were captured at the surface. All the other stations during the seven months from February to August only contributed 23 individuals to the surface net. Leaving out the special collection made at Station V., it is seen that the number of fishes increases regularly with the depth, to a maximum at 4–6 fathoms, deeper than which level it steadily decreases. The cod which appear in the collection are all very small, and had been newly hatched, which fact seems to indicate that the post-larval stages are not passed in water of less depth than 15 fathoms in Loch Fyne. Of course it is necessary at present to except the shallow shore waters. It is possibly simply a withdrawal from the surface waters where it has been hatched to the bottom, at whatever depth that may be. On the stations the bottom lay usually at a depth considerably over 15 fathoms. The post-larval young of the coarse fishes then appear to be found mainly at a depth of 4–6 fathoms below the surface. The cod larvæ were found in every net, except the surface. The plaice were found at the surface, 1, 4, and 6 fathoms. The inference then seems to be warranted that most of the food-fishes on hatching leave the region in which the eggs are floating, and their place is occupied by fishes hatched from demersal eggs. M'Intosh and Masterman say that the young cod, shortly after reaching a length of ·33 inches, retire from the upper waters and seek the lower regions of the sea. "It is "instructive to compare the change of habitat of the growing plaice and "that of the sand-eel. In the former, life is commenced in the surface "water, and as the embryo advances in its development it is drifted "towards the shore. Here the little larva, set free from its prison, "migrates gradually but surely to the bottom in shallow water. In the "other case the embryo embarks on its existence (in the winter-spawning) "in fairly deep water, and embedded in the dark still sand. From this "secure retreat the larval form emerges, and with increased size it works "it way upwards to the light and warmth, and eventually disports itself "in the surface water, a prey to many a foe."* Petersen † found in Faeno Sound "that the fry of almost all fishes with pelagic eggs which occur "there, except *Motella*, are much rarer than the fry of those which deposit "their eggs on the bottom." He discusses the fact very fully from the points of view of the salinity of the water, and the currents which running in the neighbourhood may affect their distribution. The Table recording the larvæ obtained by Holt ‡ at Plymouth does not afford corroborative evidence. The larvæ of fishes having pelagic eggs were more numerous than those hatched from demersal eggs.

The position in the water in which the young forms are floating will have an important bearing on their distribution. A portion of them at least will be subjected to surface currents, and ere they pass through their post-larval stage may be transported long distances. Thus, while the distribution of fishes having pelagic eggs is effected in the egg stage, the young hatched from demersal eggs are carried away by currents during the post-larval stage. An interesting mode of distribution is noted in connection with the specimens of *Cyclopterus lumpus* captured. They were found at the surface on drifting pieces of *Fucus*. Holt § found young *Liparis* among drift weed at the surface.

PHYSICAL OBSERVATIONS.

Table XVI. gives the temperature and salinity observations made during the first eight months of 1898 on the stations where the other work

* M'Intosh and Masterman, *op. cit.*
† Petersen, *op. cit.*
‡ Holt, *op. cit.*
§ Holt, *Trans. Dublin Royal Soc.*, 1891.

was carried on. The temperature of the air and particulars regarding weather and tide are given in the Tables recording the numbers of pelagic ova. The salinities were obtained from Mill's Papers,* and from Dittmar's "Physical and Chemical Results of the 'Challenger.'"

The highest temperature for the surface water was found in August, when, on Station V., it registered 15·8°C. The lowest for the surface was in February and March—viz., 6·7° at Station V. in February, and 6·5° in the same region in March. The lowest temperature at $7\frac{1}{2}$ fathoms was also found on Station V.—viz., 6·9° in February, while the highest at that depth was 11·4° at Station I. in August. The lowest temperature at 15 fathoms was met with at Station V. in February, and the highest was at Station II. in August.

The lowest salinity was found on Station V., in March, when the surface water was quite fresh. The surface water of Station I. in June had the highest salinity—viz., 3·34. At $7\frac{1}{2}$ fathoms the salinity varied from 2·58, Station V. in January, to 3·38, Station III. in June. The water at 15 fathoms had its lowest salinity in January at Station IV.—viz., 2·72, and its highest, 3·5, at Station III. in June.

The temperature of the air varied from 4°C. in February to 18·5° on 10th of June.

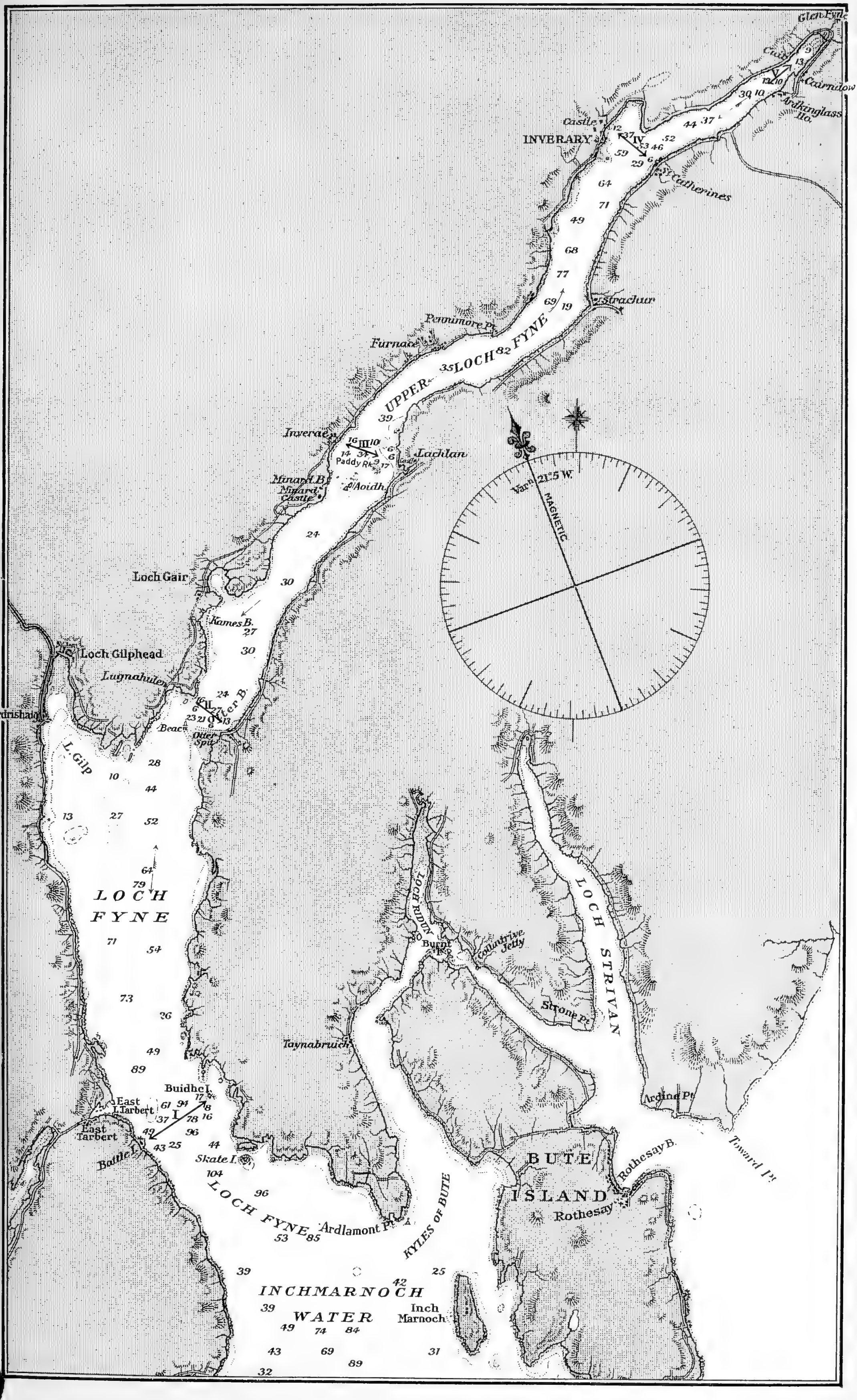
[TABLE.

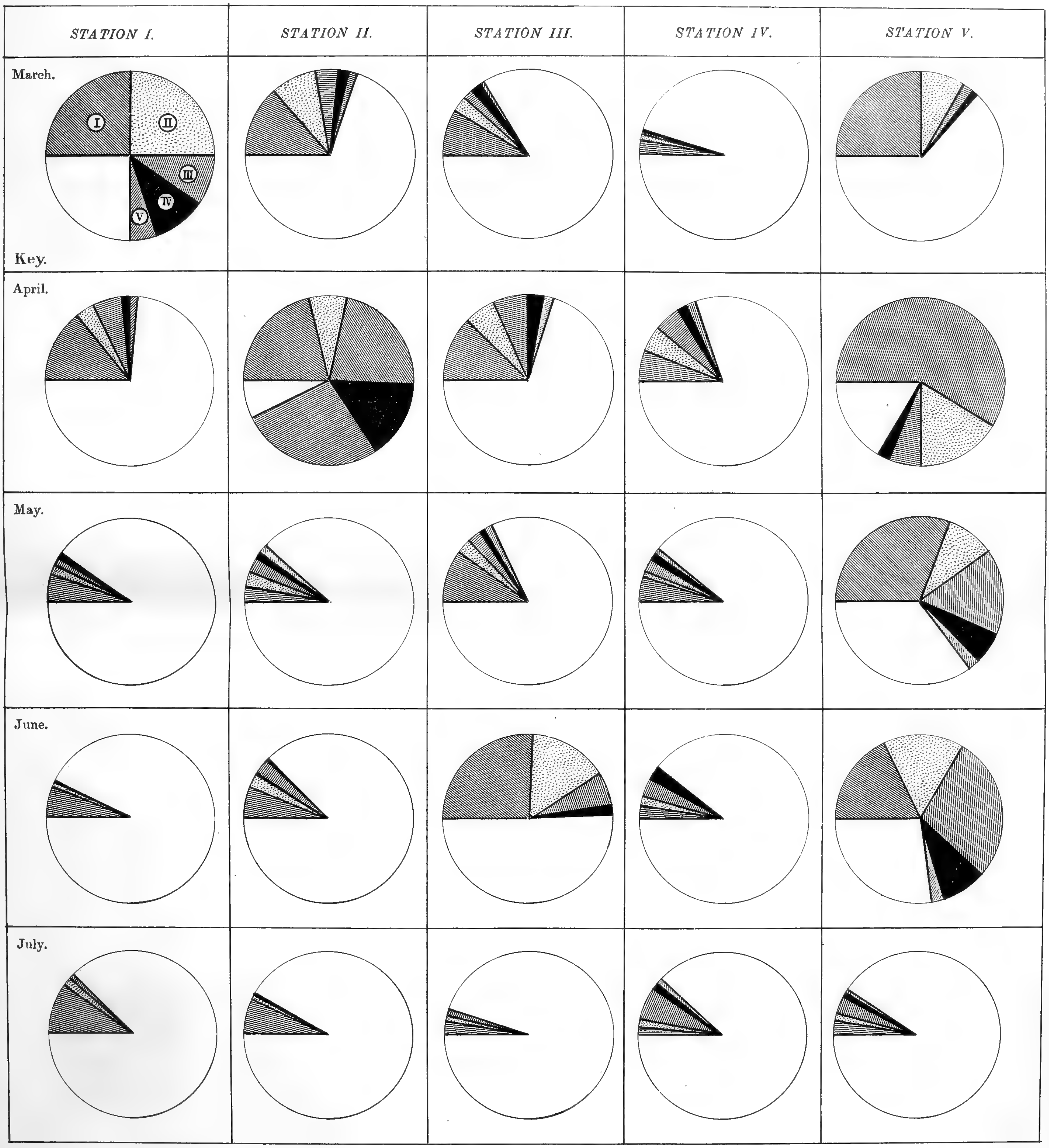
* "Report on the Physical Observations in the Forth and Clyde." *Ninth Annual Report of the Fishery Board.* "Report on the Physical Observations on the Forth, Tay, and Clyde." *Eleventh Report*, Ibid., "Clyde Area" *op. cit.*

TABLE XVI.—PHYSICAL OBSERVATIONS: TEMPERATURE, SPECIFIC GRAVITY, AND SALINITY* OF WATER OF LOCH FYNE, 1898.

		January. I.-17th, II.-20th, III.-20th, IV.-19th, V.-19th.			February. I.-14th, II.-17th, III.-18th, IV.-19th, V.-19th.			March. I.-14th, II.-16th, III.-17th, IV.-18th, V.-19th.			April. I.-11th, II.-14th, III.-19th, IV.-18th, V.-16th.			May. I.-9th, II.-11th, III.-12th, IV.-13th, V.-14th.			June. I.-6th, II.-8th, III.-9th, IV.-10th, V.-10th.			July. I.-5th, II.-6th, III.-8th, IV.-7th, V.-7th.			August. I.-8th, II.-9th, III.-9th, IV.-9th, V.-9th.		
	Depth in Fathoms.	Temperature °C.	17·5 St.	Salinity.	Temperature °C.	17·5 St.	Salinity.	Temperature °C.	17·5 St.	Salinity.	Temperature °C.	17·5 St.	Salinity.	Temperature °C.	17·5 St.	Salinity.	Temperature °C.	17·5 St.	Salinity.	Temperature °C.	17·5 St.	Salinity.	Temperature °C.	17·5 St.	Salinity.
Station I.,	0	8·9	26·2	3·08	8	26·5	3·1	7·4	26·7	3·14	8·1	27	3·21	9·25	26·6	3·18	9·2	27·6	3·34	10·7	..	..	12	26·6	3·24
	7½	..	..	..	..	..	..	..	..	..	8	27·2	3·22	9·25	26·7	3·19	9	..	..	10·5	27·4	3·32	11·4	26·8	3·26
	15	8·7	26·3	3·1	8·2	26·3	3·08	7·7	27	3·19	8	27·3	3·24	9·25	26·7	3·19	..	..	..	9·2	27·7	3·36	11·2	26·8	3·26
Station II.,	0	8·7	26·1	3·06	6·9	23·9	2·62	7·6	26·7	3·14	8·2	26·9	3·19	8·9	27	3·22	10	27·5	3·32	10·2	27·4	3·32	10·6	26·4	3·16
	7½	8·3	26·4	3·1	..	..	..	..	..	..	8·1	27·1	3·22	..	..	..	10	27·6	3·34	9·8	27·5	3·32	10·5	26·7	3·21
	15	8·3	26·2	3·06	8	26	3·01	7·6	26·7	3·14	8·1	27·2	3·24	8·25	27·1	3·22	9·5	27·7	3·36	9·2	27·6	3·4	12	26·3	3·19
Station III.,	0	7·2	14	1·849	5·3	15·9	2·063	8	26·8	3·16	8·9	23·3	2·56	9 (?)	25·7	3	12	26·5	3·22	15	25·2	3·1	11·5	24·9	2·93
	7½	8·2	24·6	2·77	8	26·1	3·03	8	26·9	3·18	8·4	26·2	3·06	8·6	..	..	9·7	27·8	3·38	10·3	27·2	3·29	10·8	26·9	3·26
	15	8·3	25·2	2·89	8	24·6	2·76	7·9	26·9	3·18	8·3	26·6	3·14	7·5	..	..	10	28·4	3·5	9·7	27·5	3·32	10·3	†24·9	2·89
Station IV.,	0	7·8	23·3	2·52	6·7	23·9	2·51	8·2	23	2·5	9·3	20	2·31	9·3	24·6	2·8	14·4	21·8	2·49	14	23·2	2·72	15	20·4	2·26
	7½	..	..	..	8·2	25·4	2·93	8	24·1	2·68	8·5	25·8	3	8·25	..	..	8·6	27·7	3·34	10·9	26·8	3·24	10·8	26·4	3·18
	15	7·8	24·3	2·72	8·7	25·9	3·03	8·1	26·2	3·05	8·2	26·2	3·06	8·1	..	..	8·3	28·3	3·44	9·2	27·4	3·3	10	†23·3	2·58
Station V.,	0	7·7	4·1	·562	6·75	24	2·64	6·5	1·49	·000	9	11·3	1·52	9·8	15·3	2·06	12·2	23·7	2·75	16·6	8·3	1·319	15·8	11·6	1·739
	7½	7·8	23·6	2·58	6·9	24	2·64	8	25	2·81	8·3	26·2	3·06	8·1	..	..	8·7	27·6	3·32	10	26·2	3·1	10·4	26·4	3·16
	15	8	24·4	2·74	7·2	26	3·01	8·1	25·6	2·95	8·2	26·6	3·14	8·2	..	..	8·6	27·8	3·36	8·6	27·2	3·24	10	26·2	3·1

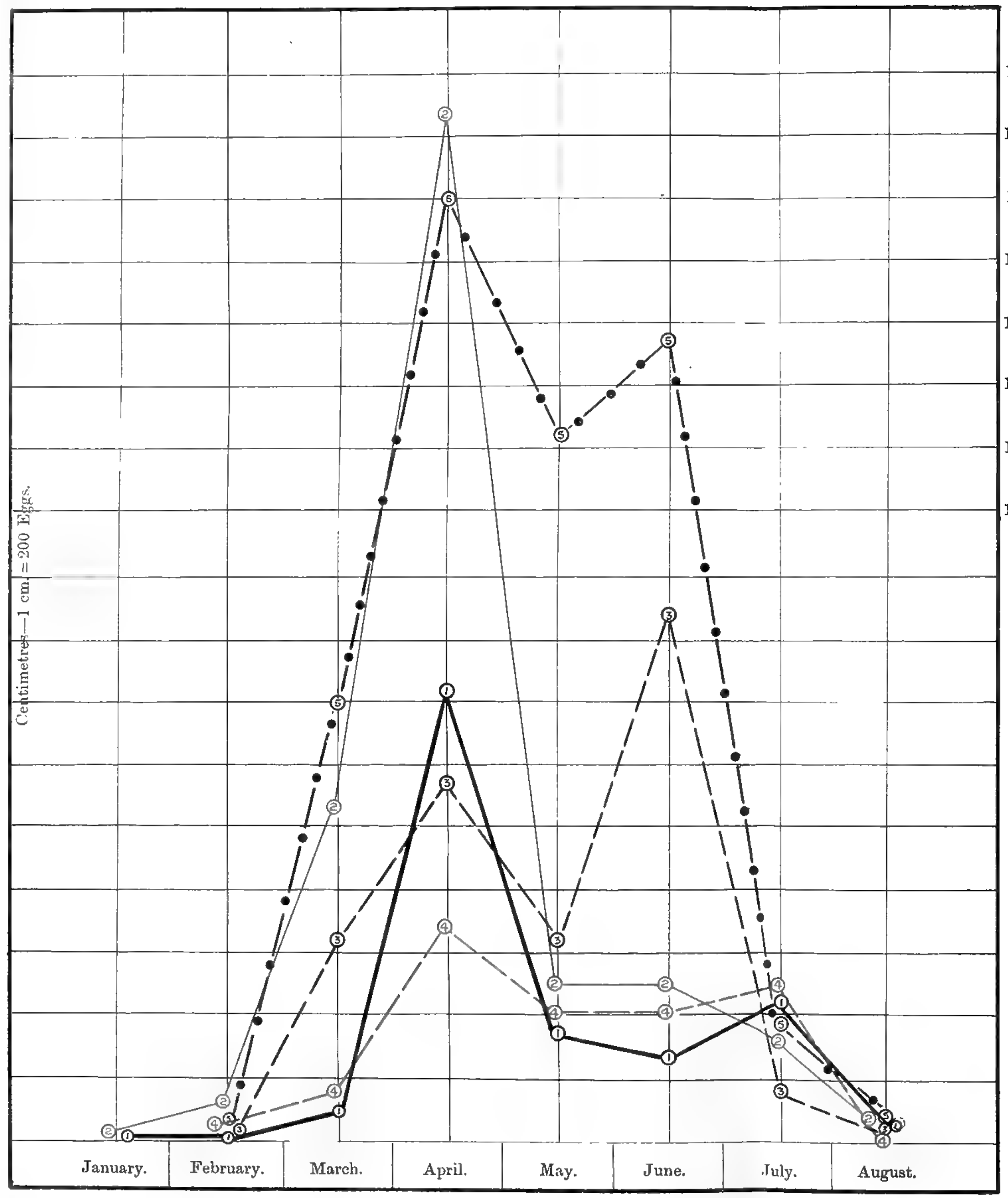
* Salinity: Percentage of total Salts. † Of doubtful accuracy.


Glen Fyne
Cairndow
Ardkinglass Ho.
Castle
INVERARY
St Catherines
Strachur
Pennymore Pt
Furnace
UPPER LOCH FYNE
Inverae
Lachlan
Paddy Rk
Minard B.
Minard Castle
Var. 21°5 W.
MAGNETIC
Loch Gair
Kames B.
Loch Gilphead
Lugnahulen
Ardrishaig
Otter B.
Beach
Otter Spit
L. Gilp
LOCH FYNE
LOCH RIDDY
Burnt I.
Colintrive Jetty
LOCH STRIVAN
Strone Pt
Taynabruich
Buidhe I.
East L.Tarbert
East Tarbert
Battle I.
Skate I.
LOCH FYNE
Ardlamont Pt
KYLES OF BUTE
Ardine Pt
Toward Pt
Rothesay B.
BUTE ISLAND
Rothesay
INCHMARNOCH WATER
Inch Marnoch

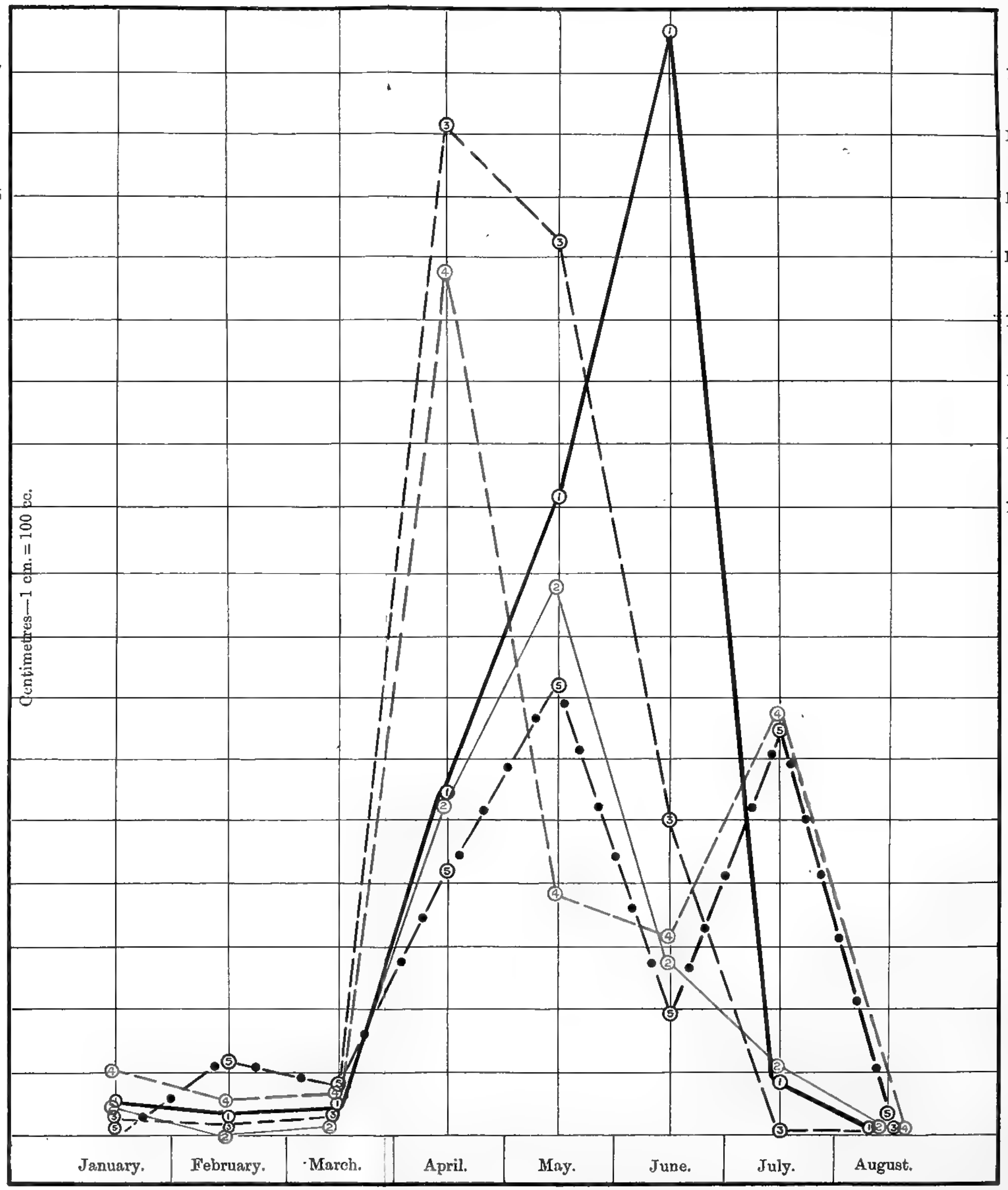

STATION I.
STATION II.
STATION III.
STATION IV.
STATION V.
March.
Key.
I
II
III
IV
V
April.
May.
June.
July.

1
1
1
1
1
1
1
1
9
8
7
6
5
4
3
2
1

A.—Curve of Total Eggs for each Station.

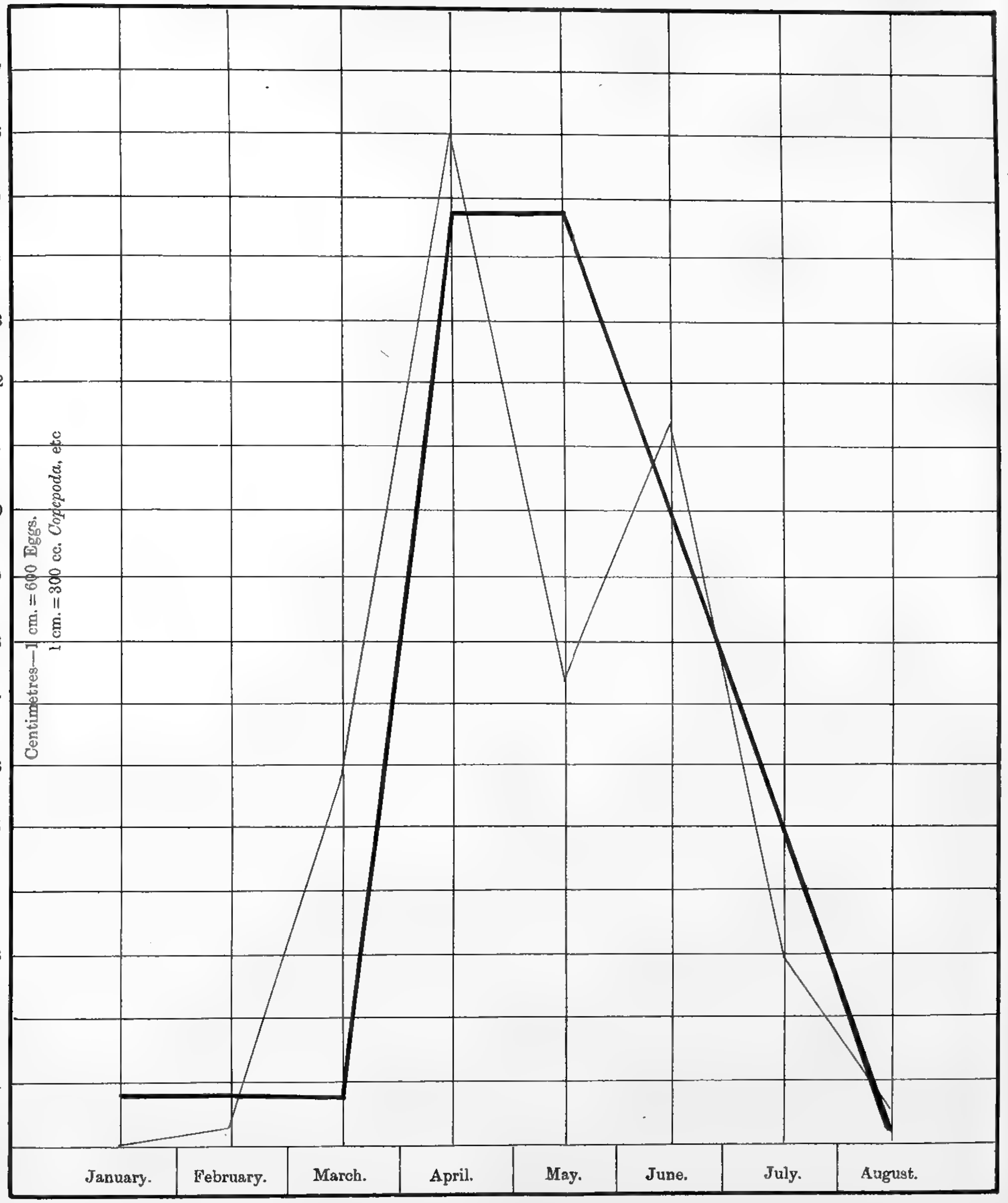


B.—Curve of Total Volumes of *Copepoda* for each Station.



STATION I. ①
STATION II. ②
STATION III. ③
STATION IV. ④
STATION V. ⑤

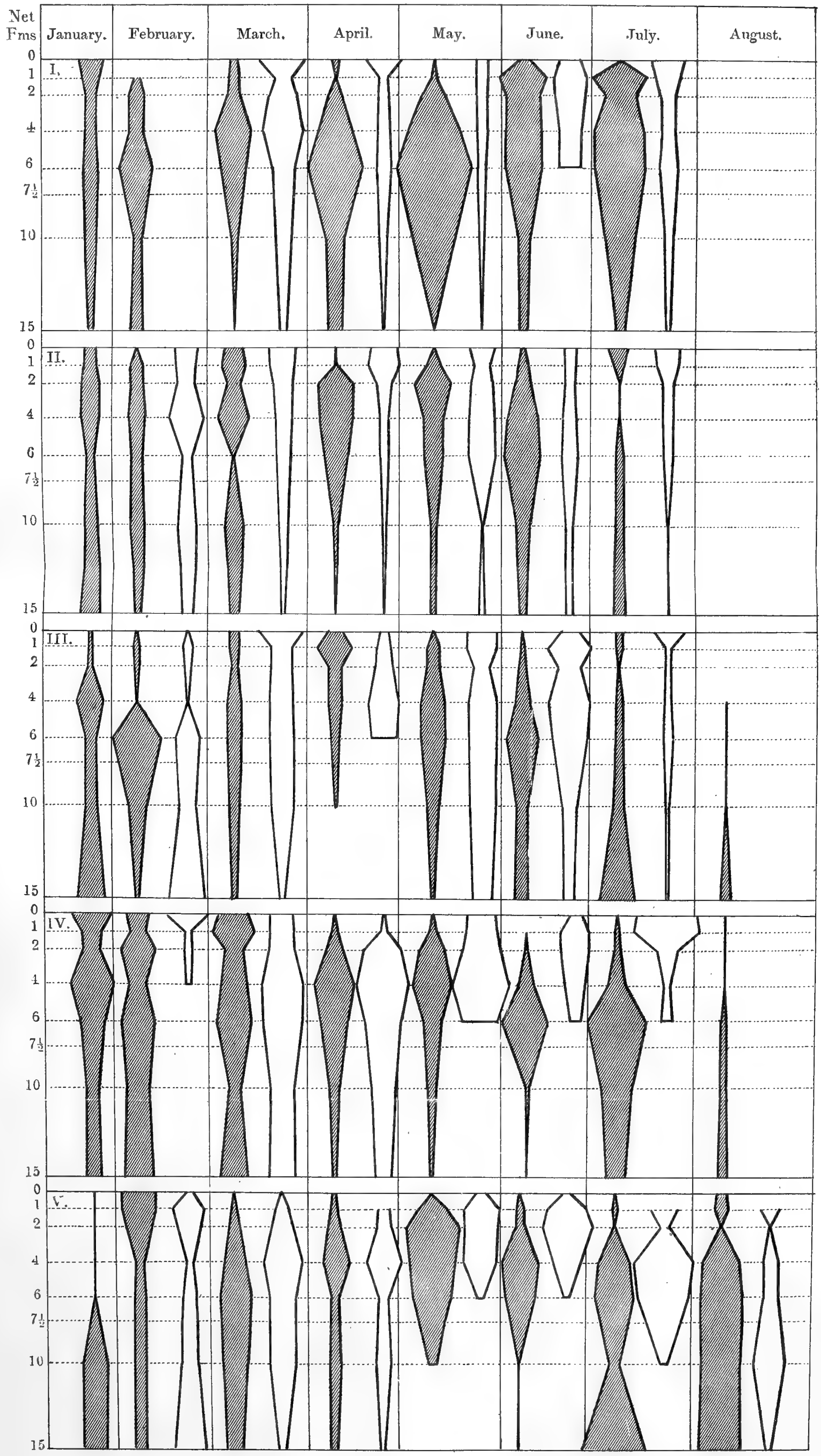
C.—Curves of Eggs and *Copepoda* for each Month.

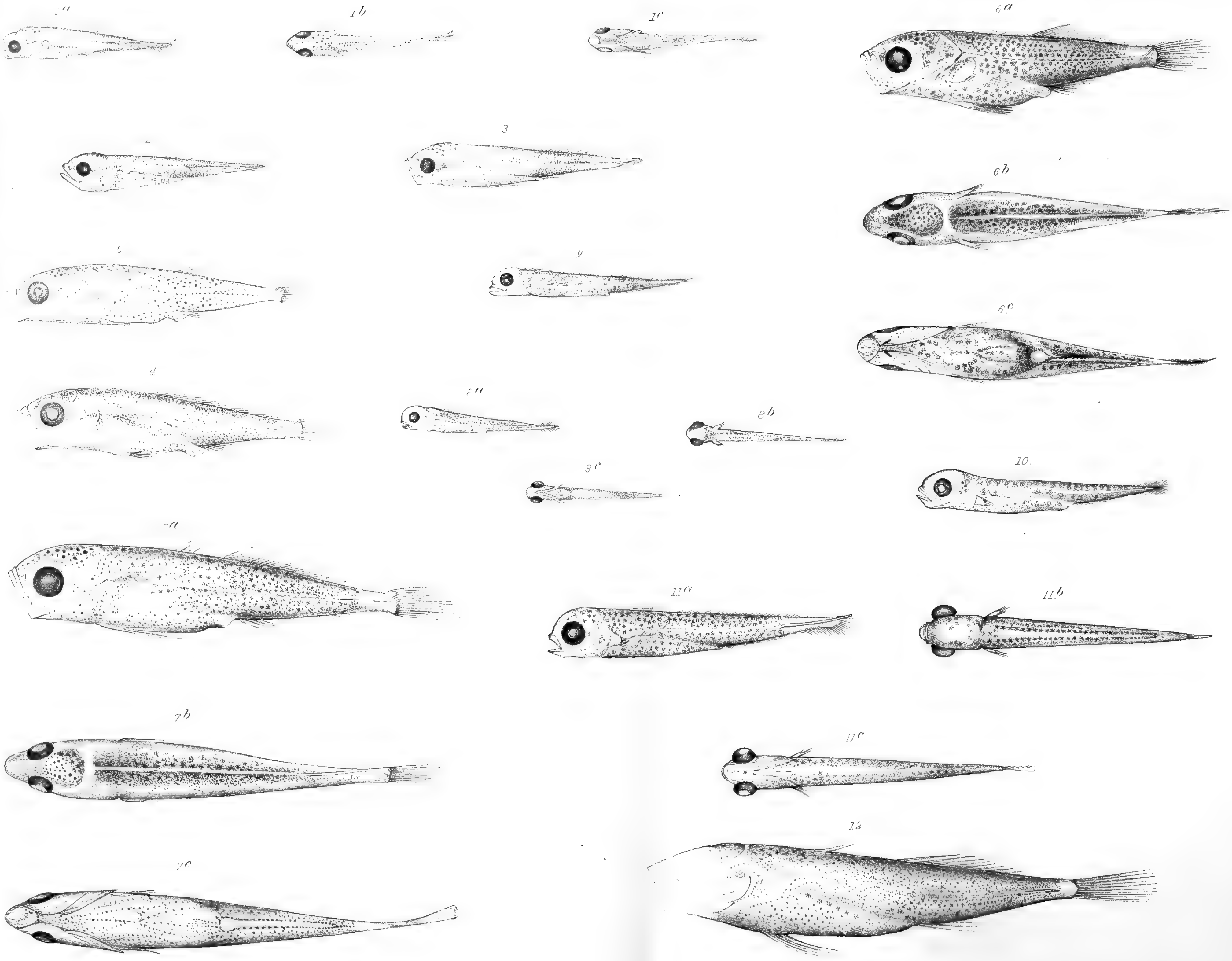


Red—Curve of Eggs.
Black—Curve of *Copepoda*.

DIAGRAMMATIC REPRESENTATION of the Vertical Distribution of Pelagic Eggs and *Copepoda* in the upper 15 fathoms deep stratum, Loch Fyne.

Plain figures—Pelagic Eggs. Shaded figures—*Copepoda*.





ADA WALKER, *delt.*

DESCRIPTION OF PLATES.

Plate II.—Chart of Loch Fyne, showing position of the five stations. (See p. 79.)

Plate III.—Shows diagrammatically the number of eggs in each stage of development obtained in the different stations. (See p. 102.)

Plate IV.—Curves formed by the numbers of Pelagic Eggs and by the volumes of Copepoda obtained on each station. (See p. 114).

Plate V.—Diagrammatic representation of the Vertical Distribution of Pelagic Eggs and Copepoda. (See p. 117.)

Plate VI.—

Figs. 1a, 1b, 1c—Lateral, dorsal, and ventral views of an example of mackerel 4mm. in length.
Fig. 2—Specimen of the same about 5mm. long.
Fig. 3— ,, ,, 5·5 ,,
Fig. 4— ,, ,, 6·5 ,,
Fig. 5— ,, ,, 6·5 ,,
Figs. 6a, 6b, 6c— ,, 8mm., lateral, dorsal, and ventral views.
Figs. 7a, 7b, 7c— ,, 8·5 ,, ,, ,,
Fig. 12— ,, ,, 11·5mm.
Fig. 8a, 8b, 8c—Lateral, dorsal, and ventral views of an example of *Lepadogaster bimaculatus* about 4mm. long.
Fig. 9—The same, 4·5mm. long.
Fig. 10— ,, 5 ,,
Fig. 11a, 11b, 11c—Lateral, dorsal, and ventral views of an example of the preceding measuring 5·5mm.

III. THE INVERTEBRATE FAUNA OF THE INLAND WATERS OF SCOTLAND.—REPORT ON SPECIAL INVESTIGATION.

By Thomas Scott, F.L.S., Mem. Soc. Zool. de France. (Plate VII.)

Contents.

INTRODUCTORY.

In my paper on the Invertebrate Fauna of the Inland Waters of Scotland (published in Part III. of the Sixteenth Annual Report of the Fishery Board for Scotland), it is stated in the preliminary remarks that, at the request of the Fishery Board, a certain number of the fresh-water lochs of Scotland were being examined at more or less regular intervals in order that some information might be obtained concerning the effect produced on the invertebrate fauna of these lochs by the changes incidental to the different seasons of the year, and to discover whether the various organisms living in the different lochs were, or were not, equally susceptible to seasonal variation.

This special work has now been completed, and a description of the results obtained—so far as they relate to the crustacean inhabitants of the various lochs examined—is embodied in the following pages.

Before proceeding to give a description of the results, it will be necessary to state briefly the names of the lochs examined, and the method adopted in their examination.

The lochs selected for special investigation were the following:—Forfar Loch, near the town of Forfar; Loch Leven, Kinross; Loch Lomond and Loch Katrine; Loch Arklet, situated between Loch Lomond and Loch Katrine; Loch Achray, Trossachs; Loch Doon, Ayrshire; and Duddingston Loch, near Edinburgh. Loch Lomond and Loch Katrine are deep-water lochs; Loch Arklet and Loch Doon are upland lochs, and situated at a considerable elevation above sea level; Forfar Loch, Loch Leven, and Duddingston Loch are comparatively shallow lochs; Loch Achray is a small loch, and seems to be merely an expansion of the River Teith, which, issuing from the Trossachs end of Loch Katrine under the name of Achray Water, spreads out into Loch Achray in its eastward course.

These lochs were examined at intervals of about three months, and the method adopted in their examination was somewhat as follows:—At a suitable part of each loch tow-net gatherings were collected in the open water by means of a rowing-boat. Two tow nets, made of silk and of different degrees of fineness, were used; the coarser one had about forty-five meshes to the inch, which, when the net was wet, were sufficiently close to capture very small entomostraca; the other was much finer, having at least four times as many meshes to the inch, and was used for the collection of diatoms, infusoria, and similar minute organisms. Hauls were made at various depths, but usually not below ten fathoms, as I find from the examination of a considerable number of the lochs of Scotland that, with few exceptions, representatives of all the free-swimming Entomostraca are to be obtained between the surface and ten fathoms. These organisms appear to be distributed all through the water—at least in the case of lochs that are shallow—and also to a considerable extent where the water is of great depth—as in Loch Morar; generally, however, it is found that under twenty or thirty fathoms the catches become smaller the deeper the net is worked. Loch Lomond and Loch Katrine were tow-netted at both the upper and lower ends. Along with the tow-net work the temperature of the water, the direction of the wind, and the state of the weather were recorded. In the case of the deep lochs three temperature readings were taken—viz., at the surface, at five fathoms, and at ten fathoms. In the case of shallow lochs, where the depth did not exceed five or six fathoms, the temperature of surface and bottom only was taken. Moreover, in addition to the tow-net work in the open water, the shore, where suitable, was also examined by means of a hand net (a small net mounted on a ring fixed to the end of a staff or pole) worked about amongst the vegetation along the shore. Interesting results were sometimes obtained in this way, and generally, though individuals were much fewer than in the tow-net gatherings, the variety of organisms was greater. The gatherings collected with the tow nets and hand nets were transferred to separate bottles and preserved in methylated spirit for subsequent examination.

In the preliminary remarks in last year's paper on the fresh-water lochs already referred to, it was also stated that, besides the examination of the eight lochs previously mentioned, a somewhat similar series of observations was being made in the three lochs in the line of the Caledonian Canal—viz., in Loch Ness, Loch Oich, and Loch Lochy. These lochs have been tow-netted at various times by the s.s. "Garland" when passing to and from the West Coast. This work was attended to principally by Mr. F. G. Pearcey, naturalist on board the vessel. Various circumstances connected with the work of the "Garland" prevented these lochs from being examined with the same regularity as the others. The results of the two series of observations are described separately.

The thermometers used in all these investigations were the Negretti and Zambra deep-sea reversing thermometers, as used on board the "Garland."

In describing the results of the examination of these lochs, each loch will be considered apart from the others. After referring to any point of interest concerning the loch itself, the temperature of the water and the other physical observations connected therewith that were recorded each time the loch was visited will be first referred to; a list of the free-swimming entomostraca that have been captured in the tow-nets will be given next; and afterwards a list of the species of crustacea and mollusca obtained in the shore gatherings. Questions relating to seasonal variation, distribution of species, etc., will also be discussed; while notes on a number of the rarer and more interesting species obtained are added at the end.

The Entomostraca, being the most important group of the higher fresh-water invertebrates, will, along with other crustacean species, be noticed in the present paper; any mollusca observed will also be included; but the lower forms, the infusoria and micro-algæ, will be treated separately later on.

The following Table gives the names of the various lochs referred to in the present paper and the dates on which they were examined:—

First Series.

Names of the Lochs.	Dates of Examination.				
	1897.		1898.		
Loch Achray, ...	Sept. 10	Nov. 27	Mar. 17	June 28	
Loch Arklet, ...	,, 9	,, 26	,, 15	,, 27	
Loch Doon, ...	,, 16	Dec. 10	,, 31	July 7	
Duddingston Loch, . .	,, 1*	,, 15	,, 2	June 15	Sept. 16
Forfar Loch, ...	July 24*	Nov. 3	,, 4	,, 16	,, 15
Loch Leven, ...	Sept. 3	Dec. 16	,, 3	,, 13	
Loch Lomond—Upper end, .	Aug. 20	Nov. 25	,, 15	,, 29	
,, Lower end, .	,, 20	,, 24	,, 22	,, 21	
Loch Katrine—Upper end, .	Sept. 9	,, 26	,, 16	,, 27	
,, Lower end, .	,, 10	,, 26	,, 16	,, 28	

* Duddingston Loch and Forfar Loch were not tow-netted at these dates.

Second Series.

Names of the Lochs.	Dates of Examination. 1897.			1898		
Loch Lochy, ...	Aug. 6	Oct. 27	Dec. 8	Jan. 24	Aug. 4	Oct. 6
* Loch Ness, ...	,, 6	,, 28	,, 6	,, 25	,, 3	,, 7
Loch Oich, ...	,, 6	not examined.	,, 7	,, 24	,, 4	,, 6

* Loch Ness was tow-netted at three places—off Castle Urquhart, off Foyers, and off Port Clair.

I. FIRST SERIES OF LOCHS EXAMINED.

Description of the Results.

In describing the results of the examination of the first series of lochs, I propose to consider them in the following order:—Loch Lomond, Loch Arklet, Loch Katrine, Loch Achray, Forfar Loch, Loch Leven, Duddingston Loch, and Loch Doon.

(1) Loch Lomond.

Loch Lomond, besides being the largest, is also the deepest of the series of lochs now under consideration. Its elevation above the sea is also less than that of the others, being, according to the Ordnance Survey map, only twenty-three feet above sea level. The chain of islands that stretches across the loch from Balmaha to a little south of Luss divides it into two unequal portions that differ greatly from each other not only in general outline but also as regards depth of water. The greatest depth of that portion south of the islands appears not to be more than thirteen or fourteen fathoms, but on the upper side the depth rapidly increases to over thirty fathoms, and from Rowardennan to the head of the loch depths of eighty and ninety fathoms are reached in several places. The deepest part, however, is about a mile to the south of Inversnaid Hotel, where, according to the Admiralty chart, soundings of one hundred and one fathoms have been obtained. It is probable that there may be parts of the loch between Tarbet and Inversnaid even deeper than this, for I have heard it asserted by one who was a very careful observer that he obtained a sounding considerably beyond one hundred fathoms.

The shores of Loch Lomond, especially of the upper portion of the loch, are not very favourable to the existence of an abundant shore fauna. There is comparatively little vegetation along the sides of the loch amongst which the non-swimming organisms can find shelter. Parts of the shore at the lower end were found to be better adapted as a habitat for such forms, and, when examined, yielded fairly good results.

The lower end of the loch—from Balloch Pier northwards toward the island of Inchmurrin—was tow-netted on 18th August and 24th November 1897; and from Balmaha to outside of Clairinch Island on March 22nd and 21st June 1898. The upper end of the loch off Inversnaid was tow-netted in August, November, March, and June. Different portions of the shore were also examined. That portion extending between Luss and Inverbeg was examined on 20th August 1897, under very unfavourable conditions as to weather, there being a more or less steady downpour of rain all the time. On 23rd November a large part of the shore between Balmaha and Rowardennan was examined, while that portion from Balmaha southwards to near the mouth of the River Endrick was examined on 22nd March and 21st June 1898.

Temperature Observations.

The examination of the loch included, as already stated, not only tow-net experiments, but the recording of the temperature of the water and other necessary physical observations. The annexed Table shows the various temperature readings observed each time the loch was examined.

TABLE SHOWING TEMPERATURE AND OTHER PHYSICAL OBSERVATIONS.

Position.	Date.	Hour.	Temperature.				Wind.		Weather.	Surface Movement of Water.
			Air.	Water.			Direction.	Force.		
				Surf.	5 Fms.	10 Fms				
Upper end of loch, off Inversnaid.	1897. Aug. 20	6 p.m.	*Degs.* ..	*Degs.* 60·0	*Degs.* 59·8	*Degs.* 54·9	Westerly.	Light.	Dull; fair.	Slight ripple.
	Nov. 25	1.30 p.m.	45·0	48·0	48·0	48·0	Easterly.	Squally.	Dull; fair.	Irregular.
	1898. Mar. 3	2 p.m.	46·5	42·6	42·5	42·2	S. West.	Light	Dull: sh'wry	Movem'nt moderate.
	June 29	11 a.m.	..	60·0	54·8	49·2	S. East.	Light, squally.	Hazy; inclining to rain.	Slight ripple,
Lower end—(1) North of Balloch Pier. (2) Off Balmaha.	Aug. 19	Noon.	..	60·7	4 fms. 60·3	..	N. West.	Light.	Showery.	Slight ripple.
	Nov. 24	10 a.m.	..	47·8	5 fms. 48·0	..	Easterly.	Light.	Dull; fair.	Slight ripple.
	Mar. 22	2 p.m.	49·5	42·0	23 ft. 42·0	..	S. West.	Light.	Cloudy.	Slight ripple.
	June 21	1.30 p.m.	62·5	61·1	5 fms. 59·7	..	S. Westerly.	Light.	Clear; warm.	Slight ripple.

I desire specially to state here that the temperature readings in this and similar Tables throughout the present paper are according to the Fahrenheit scale; also, that the readings are those of the thermometer used—they are not corrected readings; and, as different thermometers may not give exactly the same reading (the one with the other), the true temperature of the water may be a little greater or a little less than that stated in the Table. The purpose of these Tables, therefore, is to show not so much the exact temperature of the water, but rather the variation of temperature at the different depths and at the different seasons.

It will be observed in the Table given above that the readings for August and June, taken at the upper end of Loch Lomond, show a more or less rapid decrease of the temperature of the water from the surface to the depth of ten fathoms, but that the difference was not so great in August as it was in June. It will also be observed that the readings recorded in November and March exhibit little or no difference between the surface and under-surface temperatures, and that the readings for March are several degrees under those for November.

The study of temperatures, when intended to be exact, is somewhat difficult owing to many circumstances relating to wind, weather, currents, etc., requiring to be considered. Speaking generally, however, the reason for the differences referred to above may probably be the following:—In June the summer heat, though it readily influences the surface water, has so far only been able to a small extent to affect the under-surface water, but though, as the heat continues, it may not greatly increase the surface temperature, its influence extending downwards gradually raises for a considerable distance that of the under-surface water. The difference between the temperature at the surface and at ten fathoms on 29th June 1898 was 10·8 degrees; but on the 20th August 1897 the difference was only 5·1 degrees. By the time November is reached the summer heat has given place to colder weather, and one of the results of this is that the surface temperature of the water is lowered and becomes more and more uniform with that of the water beneath the surface. As the winter advances it tends to reduce the temperature of the water still further; but though the lowest readings of the present series of observations are those taken in March, it is probable that the average lowest readings may occur earlier in the year. Definite information on such points would, however, require a special and lengthened series of observations.

At the lower end of the loch the water, being comparatively shallow, did not show the same amount of variation between the surface and under-surface temperatures in August and June. The surface temperature was rather lower in March, but slightly higher for the other months.

Pelagic Entomostraca Captured by the Tow-Nets.

Free-swimming entomostraca did not appear to be very plentiful in Loch Lomond, and they were less frequent in November and March than in August and June. Fourteen species were obtained in the tow-net gatherings collected during the four visits to the loch, but only a few of the species occurred in all the gatherings. The two tow-nets already described were used, and gatherings were collected to the north of Balloch Pier, off Balmaha, and off Inversnaid. The following Table contains the names of all the species captured by the tow-nets, and the localities and dates where they were obtained.

[TABLE.

Table containing the Names of Entomostraca Captured in Tow Nets, with Date and Place of Capture.

Abbreviations used:—ab., abundant; c., common; fr., frequent; f., few; r., rare; 0, none.

Names of the Species.	1897.				1898.			
	Lower end. August 19.	Upper end. August 19.	Lower end. Nov. 24.	Upper end. Nov. 25.	Lower end. March 22.	Upper end. March 15.	Lower end. June 21.	Upper end. June 29.
Copepoda—								
Diaptomus gracilis G. O. Sars.	r.	f.	* f.	r.	* r.	f.	* r.	* fr.
Cyclops strenuus, Fischer	fr.	f.	f.	fr.	r.	f.	r.	fr.
Cyclops leuckarti, Claus	r.	0	0	0	0	0	0	0
Cyclops viridis (Jurine)	0	0	0	0	0	r.	0	0
Cyclops albidus (Jurine)	0	0	0	0	r.	0	r.	0
Cladocera—								
Sida crystallina (Müller)	0	0	0	0	0	0	fr.	0
Simocephalus vetulus (Müller).	0	0	r.	0	0	0	0	0
†*Daphnia lacustris* G. O. Sars.	c.	f.	ab.	c.	fr.	fr.	fr.	fr.
Bosmina longirostris (Müller).	0	0	0	0	0	0	f.	0
Bosmina longispina Leydig.	r.	f.	f.	0	r.	0	fr.	fr.
Eurycercus lamellatus (Müller).	0	0	0	0	0	0	fr.	0
Polyphemus pediculus (Linn.).	r.	f.	0	0	0	0	fr.	fr.
Bythotrephes longimanus Leydig.	fr.	f.	r.	0	0	0	0	f.
Leptodora hyalina Lilljeborg.	c.	f.	0	0	0	0	r.	f.

It will be observed, in glancing at the distribution of the various organisms, that only three of the species occurred in all the gatherings. *Polyphemus* and *Leptodora*, though apparently distributed more or less all over the loch at the date when the August and June gatherings were collected, seem to have disappeared in November and March, as no specimens were observed in the gatherings then collected. *Bythotrephes* was frequent in the gathering collected on the 19th August, but became rarer as the year advanced. No specimens were collected in March, while in June a few only were obtained at the upper end of the loch. It will also be observed that *Cyclops viridis* and *C. albidus* among the Copepoda, and *Sida*, *Simocephalus*, and *Eurycercus* among the Cladocera, occurred in only one or two of the gatherings. The term "pelagic" can scarcely be applied to these forms in the sense in which it is applied to *Diaptomus gracilis*, *Cyclops strenuus*, or *Daphnia*. The species referred to were almost all collected in comparatively shallow water; and their presence in the gatherings in which they occur may be due to the net having passed near to some aquatic vegetation. In comparing the seasonal distribution of the various species mentioned in the Table, *Daphnia lacustris* appears

* *Diaptomus gracilis* was more frequent in the fine silk tow-net gatherings than in the gatherings collected with the other net.

† No male *Daphnia* was observed in any of the gatherings; but the females were found, frequently with pseudova, in almost every gathering.

to be the one least affected by the changes incidental to the different times of the year when the gatherings were collected; *Diaptomus gracilis* and *Cyclops strenuus* come next—these two, though more plentiful in the warmer months, are apparently able, to a certain extent, to withstand the greatly reduced temperature of the water during winter; but *Leptodora* and *Bythotrephes* are evidently distinctly affected by seasonal influences. Further remarks bearing on these questions will be found in the sequel.

The Shore Fauna collected by Hand-Net.

The crustacea collected by hand-net along the shores of Loch Lomond represented, as is usually the case, a much greater variety of forms than those collected by tow-net, but individuals were less plentiful. As already stated, three different portions of the shore were examined:—(1) That part of the shore between Luss and Inverbeg; (2) between Balmaha and Rowardennan; and (3) between Balmaha and the mouth of the River Endrick (two examinations being made of this part). A considerable number of crustacean species were obtained, and also several species of mollusca. The names of all the species are given in the annexed Table, with the localities and dates of capture.

TABLE CONTAINING THE NAMES OF MOLLUSCA AND CRUSTACEA OBTAINED IN HAND-NET GATHERINGS, WITH DATE AND PLACE OF CAPTURE.

The abbreviations are the same as in the other Table.

Names of the Species.	Localities and Dates.			
	Between Luss and Inverbeg August 20th, 1897.	Between Balmaha and Rowardennan. November 23rd, 1898.	Between Balmaha and Mouth of the Endrick. March 22nd, 1898.	Between Balmaha and Mouth of the Endrick. June 21st, 1898.
MOLLUSCA.				
Pisidium fontinale (Drap.),	0	0	r.	0
Pisidium nitidum, Jenyns,	0	0	r.	r.
Valvata piscinalis (Müller),	0	0	r.	f.
Planorbis albus, Müller,	0	0	r.	f.
,, *nitidus*, Müller,	0	0	0	fr.
,, *glaber*, Jeffreys,	0	0	r.	0
Physa fontinalis (Linn.),	0	r.	f.	f.
Limnæa peregra (Müller),	0	0	0	r.
,, *palustris* (Müller),	0	0	r.	0
,, *truncatulus* (Müller),	0	r.	r.	0
CRUSTACEA: AMPHIPODA.				
Gammarus pulex (Penn.),	f.	r.	r.	0
ISOPODA.				
Asellus aquaticus (Linn.),	0	0	r.	f.
COPEPODA.				
Diaptomus gracilis, G. O. Sars,	f.	r.	0	0
Cyclops strenuus, Fischer.	f.	f.	0	0
,, *leuckarti*, Claus,	f.	0	0	0
,, *viridis* (Jurine),	0	f.	0	f.
,, *albidus* (Jurine),	0	0	0	f.

TABLE CONTAINING THE NAMES OF MOLUSCA, &c.—*continued.*

Names of the Species.	Localities and Dates.			
	Between Luss and Inverbeg August 20th, 1897.	Between Balmaha and Rowardennan. November 23rd, 1898.	Between Balmaha and mouth of the Endrick. March 22nd, 1898.	Between Balmaha and mouth of the Endrick. June 21st, 1898.
COPEPODA—*continued.*				
,, *dybowskii*, Lande,	0	0	0	fr.
,, *bicuspidatus*, Claus,	0	0	0	r.
,, *vernalis*, Fischer,	0	r.	fr.	r.
,, *bisetosus*, G. O. Sars,	0	r.	0	0
,, *serrulatus*, Fischer,	f.	fr.	r.	f.
,, *fimbriatus*, Fischer,	0	r.	0	0
Canthocamptus staphylinus (Jurine),	0	r.	fr.	r.
,, *minutus*, Claus,	0	0	f.	r.
,, *hirticornis*, T. Scott,	0	0	0	r.
,, *schmeilii*, Mrázek,	0	0	0	r.
Attheyella crassa (G. O. Sars),	f.	r.	r.	fr.
,, *pygmæa* (G. O. Sars),	f.	r.	fr.	r.
,, *zschokkei* (Schmeil),	f.	r.	0	0
Moraria anderson-smithi, T. & A. Scott,	f.	r.	f.	0
OSTRACODA.				
Cypria ophthalmica (Jurine),	0	0	f.	f.
Cyclocypris lævis (Müller),	0	r.	f.	r.
,, *serena* (Koch),	0	0	0	r.
,, *globosa* (G. O. Sars),	0	r.	r.	0
Cypris obliqua, Brady,	0	0	0	r.
Herpetocypris reptans (Baird),	0	0	r.	f.
Cypridopsis villosa (Jurine),	f.	0	0	0
Pionocypris vidua (Müller),	0	f.	r.	fr.
Candona candida (Müller),	f.	r.	f.	r.
,, *fabæformis* (Fischer),	0	0	0	r.
,, *compressa* (?), Koch,	0	0	r.	r.
,, *acuminata* (Fischer)	0	0	0	r.
,, *hyalina*, B. and R.,	f.	r.	0	0
Darwinula stevensoni, B. and R.,	0	0	0	0
**Cytheridea lacustris* (G. O. Sars),	0	r.	0	0
Limnicythere inopinata (Baird),	0	0	0	r.
CLADOCERA.				
Simocephalus vetulus (Müller),	0	0	0	f.
Daphnia lacustris, G. O. Sars,	f.	f.	f.	0
Bosmina longirostris (Müller),	r.	r.	0	f.
,, *longispina*, Leydig,	f.	0	f.	0
Eurycercus lamellatus (Müller),	f.	r.	r.	0
Acroperus harpæ, Baird,	f.	r.	0	0
Alonopsis elongata, G. O. Sars,	f.	fr.	0	r.
Camptocercus rectirostris, Schœdler,	0	r.	0	r.
Alona guttata, G. O. Sars,	f.	0	r.	0
,, *rustica*, T. Scott,	0	r.	0	0
,, *quadrangularis* (Müller),	0	r.	0	r.
,, *affinis* (Leydig),	f.	0	0	0
,, *costata*, G. O. Sars,	0	0	0	r.
Alonella exigua (Lilljeborg),	f.	0	0	f.
Pleuroxus trigonellus (Müller),	0	r.	0	fr.
,, *uncinatus*, Baird,	0	0	0	r.
Harporhynchus falcatus, G. O. Sars,	f.	0	0	0
Chydorus sphæricus (Müller),	0	fr.	r.	f.
,, *globosus*, Baird,	0	r.	fr. (jun.)	0
,, *barbatus* (Brady)	f.	f.	0	r.
,, *cœlatus*, Schœdler,	0	0	0	r.
Monospilus dispar G. O. Sars,	0	0	0	r.
Polyphemus pediculus (Lin.)	f.	0	0	0

* The *Cytheridea* was obtained in sand from the bottom of the loch between Balloch Pier and Inchmurrin.

The total number of species of crustacea obtained in the hand-net gatherings was sixty-one, and of the mollusca nine. The formula shows the number of species belonging to each of the groups of crustacea—Amphipoda (1), Isopoda (2), Copepoda (3), Ostracoda (4), and Cladocera (5)—obtained in the different gatherings, and also the total number in each gathering. (The figures are now in the formula in place of the names.)

Date.	August 20.	November 23.	March 22.	June 21.
Numbers of the Groups,	1, 2, 3, 4, 5.	1, 2, 3, 4, 5.	1, 2, 3, 4, 5.	1, 2, 3, 4, 5.
Number of Species in each Group, - -	1, 0, 8, 3, 12.	1, 0, 11, 5, 12.	1, 1, 7, 7, 6.	0, 1, 12, 11, 13.
Total Number in each Gathering, - -	23.	29.	22.	26.

Moreover, the total number of species belonging to each of the five groups obtained in all the four gatherings is, as shown by the Table :—Amphipoda, one species; Isopoda, one species; Copepoda, nineteen species; Ostracoda, sixteen species; and Cladocera, twenty-four species. It will be observed that a few somewhat rare forms were obtained in the Loch Lomond gatherings, the following of which may be mentioned here :—*Cyclops dybowskyii*, Lande (this has not been found in any other loch in Scotland); *Canthocamptus schmeilii*, Mrázek (so far, the only localities for this species in Britain are Loch Leven, Loch Lomond, and one or perhaps two other Scottish lochs); *Monospilus dispar*, G. O. Sars (this species has been observed in only a few places in Scotland).

It is probable that some of these shore forms, as well as of those that live in the more open water, are affected by the changes incidental to the different seasons; but to obtain satisfactory evidence of this would require a lengthened investigation, because the influences that react on these shore forms are more complex. They are, for example, more likely to be subjected to greater extremes of heat and cold. Moreover, droughts may occur in spring or summer or autumn that will have a much greater influence on these organisms than upon those that live out in the open water—at least, if the water be of moderate depth. The effect of floods will also have a more perceptible influence on the shore fauna, and these are phenomena that are not necessarily incidental to any particular season. It is probable that the curious changes that are sometimes observed in the distribution of the non-pelagic entomostraca may be due to accidental causes such as these, and not to the usual seasonal changes.

During two of my visits advantage was taken of the opportunity to examine a small loch near Loch Lomond, called the Dhu Lochan. The Dhu Lochan is distant about two miles from Rowardennan, and near the road leading south to Balmaha. A small stream issues from its north end, and, after a somewhat circuitous course, falls into Loch Lomond. This little loch was examined with the hand-net, and a considerable number of interesting Entomostraca were found in it. A number of them were similar to those found in Loch Lomond, but the following comparatively rare species are additional to those recorded for that loch :—*Cyclops nanus*, G. O. Sars; *Cyclops affinis*, G. O. Sars; *Scapholeberis mucronata* (Müller); *Streblocercus minutus*, G. O. Sars; *Drepanothrix dentata* (Euren); *Acantholeberis curvirostris* (Müller); *Ilyocryptus sordidus* (Lievin); *Alonella nana* (Baird); *Peracantha truncata* (Müller).

(2) Loch Arklet.

This loch is situated in the valley that stretches across from Inversnaid on Loch Lomond to Stronachlacher on Loch Katrine. It is a small loch, being only about a mile in length, by about four or five hundred yards broad. Loch Arklet is surrounded on all sides by rising ground, except towards the west; and therefore, though it is much nearer to Loch Katrine, the stream which issues from it—called the Arklet Water—flows westward into Loch Lomond, forming, where it terminates, the well-known Falls of Inversnaid.

Loch Arklet, according to the Ordnance Survey maps, is about four hundred and sixty feet above the sea; it is therefore considerably above Loch Lomond or even Loch Katrine. The depth of the loch at the deepest part is a little over ten fathoms, but this depth is of limited extent. At my visit on 27th June 1898 I got a sounding at sixty-one and a half feet.

This loch was visited on 9th September and 26th November 1897, and on 15th March and 27th June 1898.

Loch Arklet is the property of Mr. Dunsmure of Brenachoil and Inversnaid Lodge. Through the influence of Sir John Murray I obtained liberty to make an examination of the loch, and had also a rowing-boat placed at my service. Moreover, Mr. Dunsmure very kindly sent his head gamekeeper to assist me, and him I found most obliging and helpful.

Temperature and other Physical Observations.

On account of the situation and limited dimensions of Loch Arklet the temperature of the water was found to differ to some extent from that of Loch Lomond. The annexed Table shows the temperature readings obtained on the four occasions the loch was examined :—

Date.	Hour.	Temperature.				Wind.		Weather.	Surface Movement of Water.
		Air.	Water.			Direction.	Force.		
			Surf.	5 fms.					
1897.		*Degs.*	*Degs.*	*Degs.*	*Degs.* 7 fms.				
Sept. 9	6 p.m.	..	56·9	55·6	55·0	Variable.	Light.	Fine.	Smooth.
Nov. 26	11 a.m.	46·4	45·0	45·0	10fms. 45·0	S. Westerly.	Squally.	Dull. sh'wry.	Somewhat rough.
1898.									
Mar. 15	5 p.m.	46·5	38·4	38·9	10fms. 39·0	Southerly.	Squally.	Cold, sh'wry.	Somewhat rough.
June 27	4 p.m.	63·5	61·0	58·3	10fms. 54·0	Easterly.	Light.	Cloudy, fine.	A slight ripple.

The surface reading for 9th September is fully three degrees Fahrenheit below that of Loch Lomond for the corresponding date. All the readings for November are also three degrees lower, and the surface reading for March is nearly four degrees less than that of the same date for Loch Lomond. It will also be observed here, as in the case of Loch Lomond, that the temperature of the water at the different depths in November and March is uniform or nearly so. The June readings for Loch Arklet, both surface and under-surface, are higher than those for the upper end of Loch Lomond; the temperature at ten fathoms shows a difference of nearly five degrees. The difference between the lowest and highest of the surface readings for Loch Arklet is 22·6 degrees, while between the lowest and highest at ten fathoms the difference is 15·0 degrees. In the case of Loch Lomond the difference between the maximum and minimum temperatures at the surface and at ten fathoms at the upper end is respectively 17·4 degrees and 12·7 degrees. The differences in the temperatures of the two lochs will no doubt vary more or less from year to year, but will probably still be considerable.

Pelagic Entomostraca captured by the Tow-nets.

The tow-net examination of Loch Arklet yielded some interesting results as regards the seasonal distribution of some of the species. *Holopedium gibberum*, one of the most remarkable species of the Cladocera in Britain, was moderately common in the tow-net gatherings collected in September and November 1897. When the loch was examined in June 1898 the species was abundant all through the water; a haul was made at different parts, and though the net was only towed for about ten minutes each time, it captured at each haul a large quantity of this Cladoceran. On the other hand, when the loch was visited on the 15th of March not a trace of *Holopedium* could be seen, though several hauls were made to find out if the species had drifted to any particular part of the loch, or had temporarily left the surface and was living near the bottom, but it had completely disappeared. It may also be mentioned that in June, when the *Holopedium* was so abundant, other species previously observed were now either very scarce or absent in the gatherings collected, as if they had been more or less crowded out by this particular Cladoceran. Another point of interest may be noticed here as to certain differences in the catches made by the coarse and fine tow-nets. When the loch was examined in March the gatherings collected by both nets were comparatively small, and *Diaptomus gracilis*, one of the Copepods captured, though scarce in that collected by the coarser net, was moderately common in the other. When the circumstances connected with these captures are considered, it seems as if the reverse of this might have been expected. The coarser net is fine enough to catch even smaller organisms than this *Diaptomus*, and as it allows the water to pass through it more freely than the fine net does, a greater quantity of water passes into the net, and it also passes in more quickly, and thus allows free-swimming organisms less time to clear out of the way. With regard to the fine net, the meshes are so fine that the water does not pass very readily through them. This net has therefore a tendency to push the water out in front of it while it is being towed. An Entomostracan has thus a better opportunity to escape being captured by this tow-net than by the other; yet, as stated above, a greater number of *Diaptomus gracilis* were obtained by the fine net than by the coarser one. The annexed Table contains the names of all the species captured in the tow-nets, and the dates when captured.

[TABLE.

Table containing the Names of Entomostraca Captured by the Tow-Nets, with Date of Capture.

Abbreviations as before.

Names of the Species.	1897.		1898.	
	Sept. 9th.	Nov. 26.	Mar. 15.	June 27.
Copepoda.				
Diaptomus gracilis, G.O., Sars, - -	0	f. (fr. in fine net).	f. (c. in fine net).	f. (in fine net only).
Cyclops strenuus, Fischer, - - -	0	r.	0	0
,, *viridis*, (Jurine), - - -	0	r.	r.	0
,, *albidus*, (Jurine), - - -	r.	0	0	0
,, *fimbriatus*, Fischer, - - -	0	0	0	r.
Cladocera.				
Holopedium gibberum, Zaddach, - -	c.	c.	0	ab.
Sida crystallina, Müller, - - -	0	r.	0	0
* *Daphnia (?) longispina*, Leydig, var. *aquilina*, - - - - - - -	c.	c.	f.	f.
Polyphemus pediculus (Linn.), - -	0	0	0	f.
Bythotrephes longimanus, Leydig, - -	fr.	0	0	f.
Leptodora hyalina, Lillj. - - -	fr.	0	0	0

It will be observed that the *Daphnia* was the only species which was obtained in all the four gatherings. *Bythotrephes* was observed in the September and June gatherings, but not in the others, and *Leptodora* occurred only in the September gatherings. It may be also noted that Infusoria (*Ceratium*, etc.) and micro-algæ were much less frequent in the June gatherings collected by the fine net than in those collected during the other months.

The Shore Fauna Collected by the Hand-Net.

Forty-two species of Crustacea were obtained in the gatherings collected by hand-net round the shores of Loch Arklet. They all belong to the Entomostraca, and comprise fourteen species of Copepoda, seven species of Ostracoda, and twenty-one species of Cladocera. A few comparatively rare forms—such as *Cyclops macrurus*, *Canthocamptus inornatus*, *Harporhynchus falcatus*, *Acantholeberis curvirostris*—were observed in these gatherings; but such rare forms will be more particularly referred to under "Notes on the Species." The following are the names of all the species of Entomostraca observed in the gatherings collected round the shores of the loch.

* Males and ephippial females of this *Daphnia* were frequent in the November gathering.

TABLE CONTAINING THE NAMES OF ALL THE ENTOMOSTRACA OBSERVED IN THE HAND-NET GATHERINGS.

The abbreviations are the same as in previous Tables.

Names of the Species.	Dates. 1897. Sept. 9.	Dates. 1897. Nov. 26.	Dates. 1898. March 15.	Dates. 1898. June 27.
COPEPODA.				
Cyclops bisetosus, G. O. Sars, - -	0	r.	f.	0
,, *viridis* (Jurine), - - -	0	r.	r.	0
,, *albidus* (Jurine), - - -	0	r.	0	0
,, *fuscus* (Jurine), - - -	f.	0	0	0
,, *serrulatus*, Fischer, - - -	f.	r.	r.	0
,, *macrurus*, G. O. Sars, - -	f.	0	0	0
,, *fimbriatus*, Fischer, - - -	f.	0	0	0
Canthocamptus staphylinus (Jurine), -	0	r.	0	0
,, *minutus*, Claus., - -	0	0	r.	0
,, *inornatus*, T. Scott, -	0	r.	0	0
Attheyella crassa (G. O. Sars), - -	f.	r.	fr.	f.
,, *pygmæa* (G. O. Sars), - -	f.	0	fr.	f.
,, *zschokkei* (Schmeil), - -	0	r.	0	0
Moraria anderson-smithi, T. & A. Scott,	f.	0	f.	r.
OSTRACODA.				
Cypria ophthalmica (Jurine), - -	f.	f.	f.	f.
Cyclocypris serena (Koch), - - -	0	0	0	f.
,, *lævis* (Müller), - - -	r.	f.	(?) r.	0
,, *globosa* (G. O. Sars), - -	0	r.	r.	0
Candona candida (Müller), - - -	f.	fr.	f.	0
,, *kingsleii*, B. and R., - -	f.	f.	f.	f.
,, *hyalina*, B. and R., - -	0	f.	0	0
CLADOCERA.				
Sida crystallina (Müller), - - -	r.	0	0	f.
Bosmina longirostris (Müller), - -	f.	0	r.	0
Drepanothrix dentata (Euren), - -	f.	r.	0	0
Acantholeberis curvirostris (Müller), -	f.	f.	0	f.
Ilyocryptus sordidus (Lievin), - -	f.	0	0	0
Eurycercus lamellatus (Müller), - -	f.	r.	0	f.
Acroperus harpæ (Baird), - - -	f.	0	0	f.
Alonopsis elongatus, G. O. Sars, - -	f.	f.	0	f.
Graptoleberis testudinaria (Fischer), -	f.	r.	0	0
Alona intermedia, G. O. Sars, - -	f.	r.	0	0
,, *rustica*, T. Scott, - - -	f.	r.	f.	f.
,, *guttata*, G. O. Sars, - - -	f.	0	0	0
Alonella nana (Baird), - - -	f.	0	0	0
,, *exigua* (Lilljeborg), - -	f.	r.	0	0
Peracantha truncata (Müller), - -	f.	0	0	fr.
Harporhynchus falcatus, G. O. Sars, -	f.	0	0	r.
Chydorus sphæricus (Müller), - -	f.	r.	f.	fr.
,, *barbatus* (G. S. Brady), -	f.	f.	r.	0
,, *(?) latus*, G. O. Sars, - -	0	0	r.	0
,, *cœlatus*, Schœdler, - -	f.	r.	0	f.
Polyphemus pediculus, (Linn.), - -	f.	0	0	f.

The annexed formula will show, for comparison, the number of species belonging to each of the three groups represented in the Table, that were found in each of the four gatherings. The following abbreviations are used in this formula:—Co., Copepoda; Os., Ostracoda; and Cl., Cladocera.

Date, - - - -	9th Sept. 1897.			26th Nov. 1897.			15th Mar. 1898.			27th June 1898.		
The groups represented,	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.
No. of Species belonging to each group, - -	7	4	20	8	6	11	7	5	5	3	3	11
Total No. of Species in each gathering, -	31			25			17			17		

The differences in the numbers of the species belonging to each of the groups, as brought out in the formula, may partly be accounted for by the difference in the time of the year when the gatherings were collected. Some of the species are probably more local than others in their distribution, even in the same loch; and as exactly the same parts of the shore may not have been examined on each of the four visits, this also may to some extent account for the differences referred to. It may also be stated that very few molluscs were observed in any of the gatherings collected here.

(3) Loch Katrine.

According to the reduced Ordnance Survey map, Loch Katrine is about eight miles in length, and has an average width of about three-quarters of a mile; and if a line be drawn from Trossachs pier at the lower end to the upper end where the stream that flows down Glen Gyle enters the loch, it will be found to stretch in a direction nearly W.N.W. $\frac{3}{4}$ W. The loch has a somewhat serpentine form, so that, while the upper half curves slightly to the south of the line I have indicated, the lower half bends nearly as much to the north. Moreover, if a line such as that suggested be drawn between the two ends of the loch, it will be found that the point where it touches the north shore is almost midway between the upper and lower ends. The normal level of Loch Katrine, as stated on the map, is three hundred and sixty-four feet above the sea, or about one hundred feet below the level of Loch Arklet; even the bottom of Loch Arklet at the deepest part is nearly forty feet above the surface of Loch Katrine. Loch Katrine is very deep in some parts; it would appear from the latest soundings that in Scotland the only lochs that exceed it in depth are Loch Morar, Loch Ness, and Loch Lomond.

Loch Katrine was tow-netted at both the upper and lower ends during September and November 1897, and March and June 1898. The steamer that plys on Loch Katrine in connection with the summer traffic is aid up during the winter and early spring months, and thus it is not so convenient in the winter season to get to or from the upper end. But on the two occasions when I visited the loch in November and March, Mr. Dunsmure whose kindness I have already alluded to, sent his yacht to Stronachlacher and conveyed me thence down the loch to the Trossachs pier.

Temperature and other Physical Observations.

Temperature observations at both the upper and lower ends of Loch Katrine were made on 9th and 10th September and 26th November 1897, and on 16th March and 27th and 28th June 1898. The readings obtained and the other records connected therewith are entered in the annexed Table.

TABLE SHOWING TEMPERATURES, &c.

Position.	Date.	Hour.	Temperature.				Wind.		Weather.	Surface Movement of Water.
			Air.	Water.			Direction.	Force.		
				Surf.	5 Fms.	10 Fms.				
			Degs.	*Degs.*	*Degs.*	*Degs.*				
Upper end, off Stronachlacher.	1897. Sept. 9	1 p.m.	..	57·4	54·8	53·3	Variable.	Light.	Fine; mild.	Smooth.
	Nov. 26	2 p.m.	..	46·8	47·0	47·0	Westerly.	Squally.	Showery.	Moderate.
	1898. Mar. 16	10 a.m.	46·7	41·0	41·3	41·7	Westerly.	Squally.	Very sh'wry.	Rough at times.
	June 27	2 p.m.	62·9	58·0	55·0	48·5	Easterly.	Light.	Dull; warm.	Slight ripple.
Lower end, vicinity of Ellen's Isle.	1897. Sept. 10	10 a.m.	..	56·0	50·0	49·0	Variable.	Light.	Fine; slight frost.	Smooth.
	Nov. 26	4 p.m.	..	46·8	47·0	47·0	Westerly.	Squally.	Showery.	Moderate.
	1898. Mar. 16	3 p.m.	..	41·6	42·0	42·1	Westerly.	Squally.	Very sh'wry.	Somewhat rough.
	June 29	[illegible] .m.	62·9	58·4	55·0	47·7	N. Westerly.	Light.	Cloudy; fine.	Slight ripple.

The temperature observations as shown in this Table exhibit in some of their aspects a close resemblance to those of Loch Lomond. If, for example, the readings for the upper end of Loch Katrine, where the water is moderately deep, and not so likely to be influenced by temporary changes as shallow water, be compared with those for the upper end of Loch Lomond it will be found that though the readings for Loch Katrine are lower, the difference between the surface temperature and the temperature at ten fathoms is, taking all the four readings, nearly the same for both lochs. This is more clearly brought out by placing the two series of differences side by side, thus:—

Loch Lomond—Upper End.		Loch Katrine—Upper End.	
Difference between the Temperature at the surface and at ten fathoms on		Difference between the Temperature at the surface and at ten fathoms on	
	Degrees.		*Degrees.*
August 26, 1897, -	5·1	September 9, 1897, -	4·1
November 25, 1897, -	0·0	November 26, 1897, -	0·2
March 3, 1898, - -	0·4	March 16, 1898, - -	0·6
June 29, 1998, - -	10·8	June 27, 1898, - -	10·7

In the first of the above series, Loch Katrine shows a difference of one degree less than Loch Lomond, but it will be observed that the date of the Loch Katrine reading is nearly a fortnight later than that of the other, which may account for at least part of this discrepancy. With the exception of the first reading, however, the variation of temperature in the two lochs is seen to be fairly uniform.

Pelagic Entomostraca Captured by the Tow-Nets.

Entomostraca and other invertebrates were scarcer in Loch Katrine than in any of the other lochs examined. The following Table contains a list of all the species captured by the tow-nets at both the upper and lower ends of the loch. The abbreviations used are the same as in the other Tables.

Names of the Species.	1897.				1898.			
	Lower end, Sept. 10.	Upper end, Sept. 9.	Lower end, Nov. 26.	Upper end, Nov. 26.	Lower end, March 16.	Upper end, March 16.	Lower end, June 28.	Upper end, June 27.
COPEPODA.								
Diaptomus hircus, G. S. Brady,	0	0	0	0	0	f.	0	0
,, *gracilis*, G. O. Sars,	0	r.	f.	r.	f.	fr.	0	c.
Cyclops strenuus, Fischer,	r.	f.	r.	r.	0	0	r.	fr.
,, *viridis* (Jurine),	r.	0	0	0	0	0	0	0
,, *albidus* (Jurine),	f.	0	0	0	0	0	0	0
,, *fimbriatus*, Fischer,	0	0	0	0	0	r.	0	0
Attheyella crassa, (G. O. Sars),	0	0	0	0	0	r.	0	0
CLADOCERA.								
Sida crystallina (Müller,)	r.	0	0	0	0	0	0	r.
Bosmina longispina, Leydig,	c.	f.	f.	r.	r.	r.	c.	fr.
Daphnia falcata, G. O. Sars,	0	f.	f.	f.	0	f.	0	c.
Eurycercus lamellatus, (Müller),	f.	0	0	0	0	0	0	0
Polyphemus pediculus, (Lin.),	f.	0	0	0	0	0	f.	fr.
Bythotrephes longimanus, Leydig,	f.	c.	r.	r.	r.	0	fr.	c.
Leptodora hyalina, Lilljeborg,	r.	f.	0	0	0	0	fr.	0

Diaptomus hircus was only obtained once during all the four visits, and it was captured with the fine tow-net. *Diaptomus gracilis* was, as on previous occasions, usually more frequent in the gatherings collected with the fine tow-net, but *Bythotrephes* and *Leptodora* were more plentiful in the coarser net; *Leptodora* was entirely absent from the gatherings collected during the colder months. *Attheyella* and one or two of the *Cyclops*, as well as *Sida* and *Eurycercus*, were probably captured near the shore or by the net having been dragged through some aquatic plants. The largest gathering was that collected at the upper end of the loch in

June; *Daphnia* and *Bythotrephes* were moderately common in the gathering collected at this time with the coarser net, while *Diaptomus gracilis* was common in that collected with the fine net. *Cyclops strenuus* and *Polyphemus* appeared to be more frequent in the upper part of the loch, and *Bosmina* and *Leptodora* in the lower part, as shown by the Table.

It may also be mentioned that Infusoria and diatoms were fairly common in the gathering collected with the coarser tow-net at the upper end of the loch in June, as well as in the fine tow-net. This shows that the coarser tow-net, though more open than the other, was yet fine enough to capture these minute organisms, and therefore the cause of its being less efficient in the capture of *Diaptomus* than the fine net, is the more perplexing.

The Shore Fauna Collected by Hand-Net.

The sides of Loch Katrine do not generally present conditions very favourable to shore-dwellers. An examination of the shore about Stronachlacher yielded scarcely anything that differed from the tow-net captures. The following are the species obtained after a careful examination of a considerable portion of the shore at this place:—Copepoda—*Cyclops serrulatus*, very few. Cladocera—*Bosmina longirostris*, *Eurycercus lamellatus*, *Acroperus harpæ*, *Alonopsis elongatus*, *Alona affinis*, and *Chydorus sphæricus*, all of which were scarce.

At the lower end of Loch Katrine the shore between the Trossachs pier and Ellen's Isle was examined, and yielded much better results than the shore at the upper end. This part of the loch was therefore examined on each of the four occasions when the loch was visited, and a list of the species observed in the four gatherings collected here is contained in the annexed Table.

[Table.

TABLE CONTAINING THE NAMES OF CRUSTACEA OBSERVED IN THE HAND-NET GATHERINGS COLLECTED AT THE LOWER END OF LOCH KATRINE.

Abbreviations as before.

Names of the Species.	Dates. 1897. Sept. 10.	1897. Nov. 27.	1898. March 16.	1898. June 28.
AMPHIPODA.				
Gammarus pulex (Penn.),	0	0	0	f.
COPEPODA.				
Diaptomus gracilis, G. O. Sars,	0	f.	0	0
Cyclops strenuus, Fischer,	0	f.	0	0
Cyclops viridis (Jurine),	0	f.	0	f.
,, *vernalis*, Fischer,	f.	0	0	f.
,, *bicuspidatus*, Claus,	0	r.	f.	0
,, *fuscus* (Jurine),	0	0	0	f.
,, *albidus* (Jurine),	f.	0	0	0
,, *serrulatus*, Fischer,	f.	f.	0	f.
,, *fimbriatus*, Fischer,	f.	0	0	0
Canthocamptus staphylinus (Jurine),	f.	fr.	fr.	0
,, *inornatus*, T. Scott,	0	r.	f.	0
,, *minutus*, Claus,	f.	f.	f.	0
Attheyella crassa (G. O. Sars),	f.	fr.	fr.	f.
,, *pygmæa* (G. O. Sars),	f.	0	f.	f.
Moraria anderson-smithi, T. & A. Scott,	f.	fr.	r.	0
OSTRACODA.				
Cypria ophthalmica (Jurine),	0	fr.	fr.	f.
Cyclocypris serena (Koch),	r.	f.	0	f.
,, *lævis* (Müller),	0	0	f.	0
,, *globosa* (G. O. Sars),	0	f.	fr.	f.
Candona candida (Müller),	r.	fr.	f.	r.
,, *Kingsleii*. B. and R.,	r.	f.	0	...
,, *hyalina*, B. and R.,	r.	r.	r.	...
CLADOCERA.				
Daphnia galeata, G. O. Sars,	0	0	0	f.
Bosmina longirostris (Müller),	f.	0	r.	0
Eurycercus lamellatus (Müller),	0	0	0	f.
Acroperus harpæ, Baird,	f.	0	0	f.
Alonopsis elongata, G. O. Sars,	f.	0	0	f.
Alona affinis (Leydig),	f.	r.	0	f.
,, *quadrangularis* (Müller),	0	r.	0	0
,, *intermedia*, G. O. Sars,	f.	0	0	0
,, *guttata*, G. O. Sars,	f	0	r.	r.
Alonella nana (Baird),	f.	0	0	r.
,, *exigua*, G. O. Sars,	f.	0	0	r.
Pleuroxus trigonellus (Müller),	f.	0	0	0
Peracantha truncata (Müller),	0	0	0	r.
Harporhynchus falcatus, G. O. Sars,	0	0	0	r.
Chydorus sphæricus (Müller),	f.	f.	f.	f.
,, *barbatus* (Brady),	f.	r.	0	r.
,, *cœlatus*, Schœdler.	0	f.	0	0

Forty species of Crustacea were obtained in the gatherings collected by hand-net at the lower end of Loch Katrine. They comprised one species of the Amphipoda, fifteen species of Copepoda, seven species of Ostracoda, and seventeen species of Cladocera. There were also one or two species of Mollusca, *i.e.*, *Pisidium* and *Limnæa*, but they were very scarce. The Crustacea were also individually scarce, though a considerable variety of them were obtained. The total number of the species of Entomostraca observed in each gathering, and also the number belonging to each of the three groups represented, are shown in the annexed formula :—Co., Copepoda ; Os., Ostracoda ; Cl., Cladocera.

Date, - - - -	10th Sept. 1897.			27th Nov. 1897.			16th Mar. 1898.			28th June 1898.		
Groups represented, -	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.
Number of Species in each group, - -	9	0	11	10	6	5	7	5	3	6	0	12
Total Number in each gathering, - -	20			21			15			18		

The number of species of Cladocera is considerably larger in the gatherings collected in September and June than in those collected during the colder months ; but as regards the Copepoda the reverse of this is observed, though the difference is not so great. A somewhat similar difference is observed in the gatherings collected in Loch Arklet.

(4) Loch Achray.

The normal level of Loch Achray is stated to be two hundred and seventy-six feet above the sea, or eighty-eight feet lower than the level of Loch Katrine.* It appears to be nearly of the same size as Loch Arklet, but it differs considerably not only in its elevation, but also in its surroundings. It has been remarked that Loch Achray appears to be merely an expansion of the River Teith ; and it is also probable that, at a comparatively recent period, it was smaller in size and stood at a lower level than at present. If any good map of the district be examined, it will be observed that at a short distance from the east end of the loch the River Teith is joined by the Finglass—a stream which takes its rise ten or twelve miles to the northward, and which, flowing down Glen Finglass, drains a considerable portion of the neighbouring uplands. This stream debouches from Glen Finglass almost at right angles to the bed of the Teith, and where it enters that river it makes a slight bend to the west. Between this point and the east end of Loch Achray the Teith has very little of a fall ; and thus it happens that when the Finglass, swollen by heavy mountain rains, comes down in flood, the current of the Teith is sometimes overpowered and the water is forced back into Loch Achray, which, in consequence, rises at such times more or less above its normal level. Moreover, the Finglass will also, when in flood, carry down from the hills considerable quantities of *débris*—such as sand and gravel, branches, and roots of trees—which will no doubt have, within certain limits, tended to obstruct the bed of the River Teith, and thus gradually, and more or less permanently, to raise the level of the loch beyond.

* It may also be stated that, according to the reduced Ordnance Survey m p, present level of Loch Vennachar is only six feet below that of Loch Achray.

There are parts of the shores of Loch Achray that are fringed with a rich growth of vegetation which might be expected to afford shelter to a numerous Entomostracan fauna; but here, as in some other lochs where similar favourable conditions exist, it was found that the young trout and minnows were also cognisant of this fact, for shoals of these tiny marauders were observed busy at work trying to secure a share of the Entomostracan food sheltering amongst the aquatic vegetation. It is our experience, as it is the experience of others, that where these small fishes are plentiful the shore Entomostraca are not so numerous.

Loch Achray, like the other lochs, was examined on four different occasions. The method of examination was also similar, and the following is a record of the results obtained.

Temperature and other Physical Observations.

The annexed Table shows the temperature and other observations as recorded during the four different examinations of Loch Achray. The observations were taken well off shore, but not so far off as to be in the line of the river current.

TABLE SHOWING TEMPERATURE AND OTHER PHYSICAL OBSERVATIONS.

Date.	Hour.	Temperature.				Wind.		Weather.	Surface Movement of Water.
		Air.	Water.			Direction.	Force.		
			Surf.	5 Fms.	10Fms				
		Degs.	*Degs.*	*Degs.*	*Degs.*				
1897. Sept. 10	Noon.	..	57·0	55·0	55·0	Variable.	Light.	Mild; fine.	Slight ripple.
Nov. 27	Noon.	45·2	45·9	45·9	46·0	Westerly.	Squally.	Hvy show'rs of rain.	Rough.
1898. Mar. 17	11 a.m.	49·4	40·8	26ft. 40·9	..	S. Westerly.	Squally.	Showery.	Rough.
June 28	12.30 pm	78·5	64·1	52·6	48·8	Calm.	..	Fine; warm.	Smooth.

When the loch was tow-netted in November, the wind, though moderate at first, increased so much that our boat had to be run ashore half way down towards the east end of the loch; and on 17th March the weather was again so stormy that it was not considered advisable to proceed to the usual distance off shore, and on this occasion, therefore, a sounding of only twenty-six feet was obtained; on the other hand, soundings of ten fathoms were obtained in September and November, and when the loch was examined in June no bottom was found at sixty-four feet.

The temperature readings for this loch are in some respects different from the other lochs examined, but probably this is owing to the somewhat different physical conditions of Loch Achray. Comparison with other lochs can therefore only be made within certain limits. Loch Achray is comparatively small and narrow, and, except in dry seasons, there is a moderately large current of water continually passing through it. This current sets up movements in the water that tend not only to equalise the temperature, but also to reduce it. This is partly confirmed by the observations contained in the Table. Loch Achray is situated not only at a lower level than Loch Katrine, and is largely supplied with water from that loch, but it is also much smaller and more sheltered; its temperature might therefore be expected to be at least as high as that of the loch from which so large a proportion of its water comes. We find, however, that notwithstanding all this, its temperature for September, November, and March is really lower; but, on the other hand, when the loch was visited on the 28th of June, when the weather was, and had been for some time, warm and dry, and the stream flowing into it from Loch Katrine had consequently become much reduced, so that there was less movement in the water to equalise the temperature, the surface temperature was found to be considerably higher than that of any of the lochs previously examined. The surface and bottom temperature of Loch Achray exhibited in September a difference of only 2 degrees Fahrenheit, whereas the difference between surface and bottom temperature in June was over 15 degrees. In November and March the water appeared to be of a nearly uniform temperature. The difference between the highest and lowest surface readings is fully 23 degrees, but there is only a difference of 9 degrees between the highest and lowest readings at ten fathoms.

Pelagic Entomostraca captured by Tow-Net.

In the following list of Entomostraca captured with the tow-nets, it will be observed that *Holopedium*, though common in the gatherings collected in September and June, is not represented in those collected in September and March—which confirms what is said under Loch Arklet as to the influence on this species of seasonal changes—so far, at least, as regards its appearance in the smaller lochs. *Bythotrephes* also appears to be subject to somewhat similar seasonal variation. *Daphnia*, on the other hand, is apparently not so much affected by mere seasonal change. In Loch Achray, as in other lochs, *Daphnia* is one of the very few pelagic forms found in all the four gatherings that were collected.

TABLE CONTAINING THE NAMES OF THE ENTOMOSTRACA COLLECTED IN THE TOW-NETS.

Names of the Species.	Dates.			
	1897.		1898.	
	Sept. 10.	Nov. 27.	March 17.	June 28.
COPEPODA.				
Diaptomus gracilis, G. O. Sars, - -	r. (fr. in fine net).	r. (fr. in fine net).	f.	r. (fr. in fine net).
Cyclops strenuus, Fischer, - - -	f.	r. (fr. in fine net).	0	f.
,, *leuckarti*, Claus, - - -	0	0	0	f.
,, *viridis* (Jurine), - - -	r.	f.	0	0
,, *albidus* (Jurine), - - -	r.	fr.	0	0
CLADOCERA.				
Holopedium gibberum, Zaddach, - -	c.	0	0	c.
Daphnia galeata, G. O. Sars, - -	c.	fr.	f.	c.
Bosmina longispina, Leydig, - -	f.	f.	f.	f.
Eurycercus lamellatus (Müller), - -	0	fr.	0	0
Alonopsis elongatus, G. O. Sars, - -	0	0	0	r.
Bythotrephes longimanus, Leydig, -	f.	0	0	f.
Leptodora hyalina, Lilljeborg, - -	f.	0	0	0

Diaptomus gracilis, though scarce in the gatherings collected with the coarse net, were usually frequent in those collected with the fine net. *Diaptomus*, *Bosmina*, and *Daphnia* were the only species that occurred in all the four gatherings. *Cyclops viridis* and *albidus*, and *Eurycercus* and *Alonopsis*, were probably captured by the net passing over some shallow water or amongst aquatic plants. With the exception of *Diaptomus*, and on one occasion of *Cyclops strenuus*, all the species named in the list were more numerously represented in the gatherings collected with the coarser tow-net, and some were only captured with that net. A few male *Daphniæ* were observed in the gathering collected in September.

Shore and Bottom Invertebrates captured mostly by Hand-Net.

The following list contains the names of the species collected chiefly with the hand-net, and a few that were obtained by dragging the tow-net for a short distance over the bottom of the loch; those captured by the tow-net are indicated by an asterisk.

[Table,

TABLE CONTAINING THE NAMES OF INVERTEBRATES CAPTURED CHIEFLY BY HAND-NET.

Names of the Species.	Dates.			
	1897.		1898.	
	Sept. 10.	Nov. 27.	March 17.	June 28.
MOLLUSCA.				
Pisidium pusillum, Jenyns,	f.	c.	f.	0
**Planorbis contortus*, Linné,	0	fr.	0	0
* ,, *albus*, Müller,	0	f.	0	0
Limnæa peregra (Müller),	r.	fr.	r.	0
CRUSTACEA—COPEPODA.				
Diaptomus gracilis, G. O. Sars,	0	0	0	r.
,, *Wierzejskii*, Richard,	0	f.	0	0
Cyclops bicuspidatus, Claus,	0	0	r.	f.
,, *vernalis*, Fischer,	0	0	0	r.
,, *bisetosus*, Rehberg,	0	f.	f.	f.
,, *viridis* (Jurine),	r.	r.	f.	0
,, *fuscus* (Jurine),	f.	f.	0	f.
,, *albidus* (Jurine),	0	f.	0	r.
,, *serrulatus*, Fischer,	f.	f.	0	r.
,, *fimbriatus*, Fischer,	f.	f.	0	r.
Canthocamptus staphylinus (Jurine),	f.	f.	fr.	f.
,, *inornatus*, T. Scott,	0	r.	0	0
,, *minutus*, Claus,	f.	r.	f.	f.
Attheyella crassa (G. O. Sars),	f.	f.	f.	f.
,, *pygmæa* (G. O. Sars),	0	f.	fr.	f.
Moraria anderson-smithi, T. & A. Scott,	0	0	f.	0
* ,, *brevipes*, G. O. Sars,	0	f.	0	0
OSTRACODA.				
Cypria exsculpta (Fischer),	0	r.	r.	0
,, *ophthalmica* (Jurine),	0	0	r.	fr.
Cyclocypris lævis (Müller),	0	r.	f.	0
,, *serena* (Koch),	...	r.	0	f.
,, *globosa*, G. O. Sars,	...	r.	fr.	f.
Cypris obliqua, G. S. Brady,	0	r.	0	0
**Pionocypris vidua* (Müller),	0	f.	0	0
Candona candida (Müller),	r.	r.	0	f.
,, *kingsleii*, B. and R.,	r.	r.	0	0
CLADOCERA.				
Sida crystallina (Müller),	f.	0	0	0
Bosmina longirostris (Müller),	f.	0	f.	0
**Lathonura rectirostris* (Müller),	0	r.	0	0
Drepanothrix dentata (Euren),	f.	r.	0	r.
Ilyocryptus sordidus (Lievin),	0	f.	0	f.
Acroperus harpæ, Baird,	f.	f.	0	f.
Camptocercus rectirostris (Schœdler),	0	r.	0	0
Alonopsis elongatus, G. O. Sars,	f.	r.	0	f.
**Alona guttata*, G. O. Sars,	0	r.	0	0
,, *quadrangularis* (Müller),	0	f.	0	0
,, *affinis*, Leydig,	f.	0	0	r.
,, *rustica*, T. Scott,	0	f.	0	0
,, *intermedia*, G. O. Sars,	0	0	0	f.
Alonella exigua, G. O. Sars,	f.	0	0	f.
,, *nana* (Baird),	0	f.	0	f.
Pleuroxus trigonellus (Müller),	0	r.	0	0
Peracantha truncata (Müller),	f.	0	0	0
Harporhynchus falcatus, G. O. Sars,	f.	0	0	r.
**Chydorus globosus*, Baird,	0	r.	0	0
,, *sphæricus* (Müller),	f.	f.	f.	f.
,, *barbatus* (Brady),	fr.	f.	0	r.
,, *latus*, G. O. Sars,	0	0	fr.	0
,, *cælatus*, Schœdler,	0	0	0	r.
Monospilus dispar, G. O. Sars,	0	r.	0	0

Loch Achray is the only loch of the present series where *Diaptomus wierzejskii* was obtained. *Lathonura rectirostris* and the equally rare *Monospilus* were also obtained here. Fifty species of Entomostraca and four of Mollusca are recorded in this Table. The Entomostraca comprise seventeen species of Copepoda, nine species of Ostracoda, and twenty-four species of Cladocera. The formula shows the number of species belonging to each group that were observed in each of the four gatherings. Co., Copepoda ; Os., Ostracoda ; Cl., Cladocera.

Dates.	Sept. 10, 1897.	Nov. 27, 1897.	March 17, 1898.	June 28, 1898.
Names of the groups, - - - -	Co. Os. Cl.	Co. Os. Cl.	Co. Os. Cl.	Co. Os. Cl.
Number of Species in each group, -	7, 2, 12.	13, 8, 15.	8, 4, 3.	12, 4, 12.
Number of Species in each gathering,	21.	36.	15.	28.

The largest number of species was obtained in the November gathering, and the smallest in that collected in March. During my visit to the loch in June the boatman who was assisting me drew my attention to a green substance which he had observed growing in several places near the north shore where the water was shallow. This proved to be a fresh-water sponge (*Spongilla fluviatilis*). It appeared to be moderately common in some parts of the loch.

(5) Forfar Loch.

Forfar Loch, which belongs to the Earl of Glamis, is situated a little to the west of the town of Forfar. It extends in a S.W. and N.E. direction, and is, according to the reduced Ordnance Survey map of the district, a little over a mile in length by about three hundred and eighty or ninety yards broad at the widest part. The land on the north side and near the middle extends some distance out into the loch and forms a kind of peninsula, and the loch is here much narrower than it is to the east or the west of it. The elevation of the loch is about one hundred and seventy-one feet above the level of the sea. The overflow water finds an exit at the west end, and under the name of the "Dean Burn" makes its way in a winding course of some ten or twelve miles to the River Isla, which it joins a little to the north of the town of Meigle. The east end of Forfar Loch has become so much filled up as to be little better than a marsh; a considerable portion of the shore is also fringed with tall reeds. The loch for the most part is shallow, but there are one or two places where the water is of moderate depth. Near the middle of the loch I obtained a depth of twenty-one feet, while some distance to the west of the peninsula already referred to, and comparatively near to the north shore, a sounding of thirty-five and a-half feet—or almost six fathoms—was obtained, and this was at a time when the loch was below its normal level. Extensive beds of marl exist in certain parts of the loch. A small quantity of this marl which was brought up in the tow-net was found to consist to a large extent of dead molluscan shells, *Valvata piscinalis* and *Limnæa peregra* being specially numerous.

Forfar Loch was examined on five different occasions—viz., in July and November 1897, and in March, June, and September 1898. When visited in July 1897 our research was restricted to the shore, which was examined by means of the hand-net; but on the other four occasions when the loch was visited the usual tow-net examination was made, including temperature and other physical observations. I would here acknowledge my indebtedness to Andrew Ralston, Esq., factor to Lord Glamis, who not only allowed me the use of the boat for tow-netting the loch, but also kindly sent one of the gamekeepers to assist me with the work.

Temperature and other Physical Observations.

The annexed Table contains a record of temperature and other observations made at Forfar Loch on the different occasions when the loch was examined by means of the tow-nets.

TABLE SHOWING TEMPERATURE AND OTHER PHYSICAL OBSERVATIONS.

Date.	Hour.	Temperature.				Wind.		Weather.	Surface Movement of Water.
		Air.	Water.			Direction.	Force.		
			Surf.	Under Surf.	Under Surf.				
		Degs.	*Degs.*	*Degs.*	*Degs.*				
1897.				21ft.					
Nov. 3	Noon.	50·0	47·5	47·6	..	S. E.	Light.	Sky overcast	Slight ripple.
1898.				35ft.					
Mar. 4	,,	44·0	36·8	37·0	..	N. by E.	Mod'rate	Sky cloudy.	Not very rough.
				35½ft.					
June 16	,,	72·2	62·2	55·2	..	Easterly.	Light.	Sky overcast	Smooth.
				30ft.					
Sept. 15	11 a.m.	59·5	59·5	59·0	..	Calm.	..	Slight haze.	Smooth.

It will be observed that when the loch was examined in March the temperature of the water was only about 5 degrees above freezing point. It will also be noticed that the difference between the surface temperatures in March and June was 25·4 degrees, and in March and September 22·7 degrees; while the difference of the under-surface temperatures for the same periods was 18·2 degrees and 22·0 degrees respectively. In the one case there is a decrease, and in the other an increase, which is simply the result of the surface and under-surface water having in the latter month become of a more uniform temperature. It may be also further remarked that while the temperature of the water in March is considerably below what it was in November, it is on each of these occasions nearly uniform for surface and under-surface. All these results agree very closely with what was observed at Loch Lomond, and are probably to be explained in the same way in which I have tried to account for the differences observed in the temperature readings obtained in that loch.

Pelagic Entomostraca Captured by the Tow-Nets.

The free-swimming Entomostraca in Forfar Loch appear to consist chiefly of three species, viz.:—*Diaptomus gracilis*, G. O. Sars; *Cyclops strenuus*, Fischer; and *Daphnia lacustris*, G. O. Sars. A few other species were captured in the tow-nets, but they were all of rare occurrence.

Notwithstanding the great difference of 22 to 25 degrees Fahrenheit between the summer and winter temperature of the water referred to in previous remarks, the *Daphnia* were found to be abundant on all four occasions when the loch was tow-netted, though they were apparently more plentiful in June and September; a few of the males of *Daphnia* were observed in both of these latter gatherings. *Diaptomus* was much more common in the gathering collected in November—especially in that collected with the fine net—than in any of the others. *Cyclops strenuus* was more or less frequent in all the four gatherings. The annexed Table contains the names of all the species captured in the tow nets.

TABLE CONTAINING NAMES OF SPECIES AND DATES WHEN CAPTURED IN FORFAR LOCH.

(Ab., abundant ; c., common ; fr., frequent ; f., few ; r., rare ; 0, none.)

Names of the Species.	Dates.			
	1897.	1898.		
	Nov. 3.	March 4.	June 16.	Sept. 15.
COPEPODA.				
Diaptomus gracilis, G. O. Sars, - -	f. (ab. in fine net.)	r. (fr. in fine net.)	f. (fr. in fine net.)	fr.
Cyclops strenuus, Fischer, - - -	fr.	fr.	f. (fr. in fine net.)	fr.
,, *viridis* (Jurine), - - -	0	r.	0	0
,, *albidus* (Jurine), - - -	0	r.	0	0
CLADOCERA.				
Ceriodaphnia reticulata (Jurine), - -	0	0	0	r.
Simocephalus vetulus (Müller), - -	0	r.	0	0
Daphnia lacustris, G. O. Sars, - -	ab.	ab.	ab.	ab.
Chydorus sphæricus (Müller), - -	0	0	0	r.

The gathering collected with the fine net in September contained numerous *Ceratium*, Diatoms, Desmids, *Nostoc*, and others. So numerous were these minute forms of animal and vegetable life that they made the water obscure, so that it had the appearance as if fine dust were held in suspension. These minute forms may be reported on later.

The *Ceriodaphnia* were represented chiefly by females with *pseudova*, but there were also a few ephippial females and one or two males. The *Daphniæ* consisted chiefly of females with *pseudova;* and besides the males already referred to as having been observed in the June and September gatherings, there were also a few ephippial females present in these gatherings. Very few creatures other than the Entomostraca, and the Infusoria and Micro-algæ already mentioned, were observed in the tow-net collections.

The Shore and Bottom Fauna collected chiefly with the Hand-Net.

The Crustacea, Mollusca, etc., captured with the hand-net were fairly numerous and varied, and amongst them several rare forms were observed. These will be more particularly referred to in the sequel.

It has been remarked that, besides the four occasions on which the loch was tow-netted, the shores had on a previous visit—viz., in July 1897

—been examined by hand-net; and as several interesting species were then obtained which did not occur in any of the subsequent gatherings, I have included the results of this one in the same list with the others. A list of all the Mollusca and Crustacea observed during these five visits is therefore contained in the annexed Table, which also includes a few molluscan species that were captured by allowing the tow net to drag for a short distance over the mud at the bottom.

TABLE CONTAINING THE NAMES OF ALL THE SPECIES OF MOLLUSCA AND CRUSTACEA.

Names of the Species.	Dates.				
	1897.		1898.		
	July 27.	Nov. 3.	Mar. 4.	June 16.	Sept. 15.
MOLLUSCA.					
Sphærium corneum (Linné), - -	0	fr.	f.	fr.	f.
Pisidium pusillum (Gmelin), - -	f.	fr.	r.	f.	0
,, *nitidum*, Jenyns, - -	0	fr.	0	r.	0
**Anodonta cygnea*, Linné, - -	0	0	0	fr.	0
Valvata piscinalis, Müller, - -	f.	c.	f.	fr.	f.
,, *cristata*, Müller, - - -	f.	fr.	0	r.	fr.
Planorbis nitidus, Müller, - - -	f.	0	0	0	0
,, *nautileus* (Linné), - -	0	r.	0	f.	0
,, *albus*, Müller, - - -	0	0	0	f.	0
,, *contortus* (Linné), - -	f.	r.	f.	f.	f.
Physa fontinalis (Linné), - - -	0	r.	f.	r.	f.
Limnæa peregra (Müller), - -	f.	fr.	fr.	fr.	fr.
,, *palustris* (Müller), - -	f.	0	0	0	0
Succinea putris, Linné, - - -	0	0	0	r.	0
CRUSTACEA: AMPHIPODA.					
Gammarus pulex (Penn.), - - -	0	fr.	fr.	0	0
COPEPODA.					
Diaptomus gracilis, G. O. Sars, - -	f.	0	r.	0	0
Cyclops strenuus, Fischer, - - -	f.	f.	f.	fr.	f.
,, *biscuspidatus*, Claus, - -	f.	0	0	0	0
,, *vernalis*, Fischer, - - -	f.	0	f.	0	0
,, *viridis* (Jurine), - - -	f.	f.	r.	r.	f.
,, *albidus* (Jurine), . - -	f.	0	0	0	0
,, *serrulatus*, Fischer, - -	f.	f.	f.	f.	f.
,, *fimbriatus*, Fischer, - -	f.	0	f.	f.	f.
,, *phaleratus*, G. O. Sars, - -	f.	0	0	0	0
Canthocamptus staphylinus, Jurine, -	f.	fr.	fr.	r.	f.
,, *inornatus*, T. Scott, -	f.	0	0	0	f.
,, *minutus*, Claus, - -	f.	0	f.	r.	0
Attheyella duthiei, T. and A. Scott, -	f.	0	0	0	0
,, *crassa* (G. O. Sars), - -	f.	0	fr.	0	0
,, *pygmæa* (G. O. Sars), -	f.	0	f.	0	0
,, *zschokkei* (Schmeil), - -	f.	0	0	r.	0
Moraria anderson-smithi, T. & A. Scott,	f.	0	0	0	0
,, *brevipes*, G. O. Sars, - -	0	0	r.	0	0
OSTRACODA.					
Cypria exsculpta (Fischer), - -	f.	0	0	0	0
,, *ophthalmica* (Jurine), - -	f.	r.	f.	f.	?
Cyclocypris serena (Koch), - - -	f.	0	0	f.	?
Cypris incongruens, Ramdohr, - -	f.	0	0	0	?
,, *pubera*, Müller, - - -	f.	r.	r.	r.	?
Herpetocypris reptans (Baird), - -	f.	r.	r.	f.	?
,, *tumefacta*, B. and R., -	0	0	0	f.	?

* The *Anodonta* was not found in the loch, but in the bed of the Dean Burn a short distance from where it issues from the loch.

TABLE CONTAINING THE NAMES OF ALL THE SPECIES OF MOLLUSCA AND CRUSTACEA—*continued.*

Names of the Species.	Dates.				
	1897.		1898.		
	July 27.	Nov. 3.	Mar. 4.	June 16.	Sept. 15.
OSTRACODA—*continued.*					
Ilyodromus olivacea, B. and N.,	f.	0	0	0	...
Cypridopsis villosa (Jurine),	f.	0	r.	0	...
,, *newtoni*, B. and R.,	f.	0	0	0	...
Ilyocypris biplicata (Koch),	0	0	r.	0	...
Potamocypris fulva, G. S. Brady,	f.	0	0	0	...
Candona candida (Müller),	f.	r.	f.	f.	...
,, *lactea*, Baird,	f.	0	0	0	...
,, *kingsleii*, B. and R.,	f.	0	0	0	...
,, *rostrata*, B. and N.,	f.	0	0	0	...
,, *fabæformis* (Fischer),	0	0	f.	0	...
Limnicythere inopinata (Baird),	f.	0	f.	f.	...
CLADOCERA.					
Ceriodaphnia laticaudata, P. E. Müller,	f.	0	0	0	0
Scapholeberis mucronata (Müller),	f.	0	0	0	r.
Simocephalus vetulus (Müller),	f.	r.	0	0	r.
Daphnia lacustris, G. O. Sars,	f.	f.	fr.	c.	f.
Ilyocryptus sordidus (Lievin),	0	0	0	f.	f.
Eurycercus lamellatus (Müller),	f.	0	0	0	0
Leydigia quadrangularis (Leydig),	0	0	0	r.	0
Alona affinis (Leydig),	f.	0	0	0	r.
,, *quadrangularis* (Müller),	f.	f.	0	fr.	0
,, *guttata*, G. O. Sars,	f.	0	r.	r.	0
Pleuroxus uncinatus, Baird,	f.	0	0	0	fr.
,, *trigonellus* (Müller),	f.	f.	0	0	0
Chydorus sphæricus (Müller),	f.	r.	f.	0	f.

The accompanying formula shows the number of species belonging to each of the three entomostracan groups which were observed in the different shore gatherings. Co., Copepoda; Os., Ostracoda; Cl., Cladocera.

Date.	July 27, 1897.			Nov. 3, 1897.			March 4, 1898.			June 16, 1898.			Sept. 15, 1898.		
Names of the groups	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.
Number of Species in each group,	17	15	11	4	4	5	12	8	3	7	8	5	6	?	7
Number of Species in each gathering,	43			13			23			20			?		

When the loch was visited in July the weather was exceptionally favourable for shore-collecting, and by far the largest number of species in all the three groups was then obtained. The formula shows that the total number obtained in this gathering was forty-three, or nearly double the highest number observed in any of the other four gatherings. Fifty species of Crustacea and fourteen of Mollusca are the total number of the species belonging to the two groups of organisms observed in the various gatherings collected. The Crustacea comprised one Amphipod, eighteen species of Copepoda, eighteen of Ostracoda, but only thirteen of Cladocera. The number of Cladocera observed in the hand-net gatherings collected at Forfar Loch is smaller than that observed in any of the lochs previously described.

Amongst the rare species observed in this loch mention may be made of the following :—*Canthocamptus inornatus* was discovered for the first time in Rescobie Loch, near Forfar, a few years ago, and it is interesting to find it also in Forfar Loch. *Moraria brevipes* has been observed in very few of the Scottish lochs. *Cypris pubera* and *Ilyodromus violacea* are two Ostracods that are still considered as rare British species. *Leydigia quadrangularis* is a somewhat rare Cladoceran, which in Scotland has only been observed in a few places.

(6) Loch Leven.

Loch Leven, so well known for the excellence and beauty of its trout, and which is now more frequented by anglers than any other loch in Scotland, is one of the series of lochs that have recently been examined.

An investigation was also made of this loch in June 1890, and the results were fully described in a paper published in Part III. of the Ninth Annual Report of the Fishery Board for Scotland (1891). In this paper reference is made to some interesting statistics bearing on various matters connected with the Loch Leven fishery, to which the attention of the reader is directed. The present area of the loch, as stated in the previous paper, is about 3406 acres, or 1232 acres less than it was previous to 1845. The greatest length of the loch, measuring in a straight line from a point a little east of the Sluices to the head of the bay called Burleigh Sands, is slightly under three and three-quarter miles, while its greatest width appears to be nearly two and a quarter miles. It somewhat resembles a triangle in general outline, the eastern extremity, where the River Leven that drains the loch takes its rise, being the apex, and the end next Kinross the base. The height of Loch Leven above the sea is about three hundred and fifty-three feet; it is comparatively a shallow loch, but in the vicinity of St. Serf's Island—off the south and south-west shores—depths of seventy and eighty feet are met with. It is also moderately deep a little to the north and north-east of Scart Island. A considerable portion of the bottom of Loch Leven, especially towards the north side, is composed of sand, but in the deeper parts the bottom is muddy. At the west end of the loch the American weed, *Elodea canadensis*, is causing a great amount of trouble by its rapid and persistent growth. All the means hitherto tried for the purpose of destroying the weed are found to be only of temporary benefit, and it is very disheartening to those interested in the prosperity of the loch to find that in order to keep it clear of the weed the same laborious work has to be done over and over again.

I must express my great indebtedness to Mr. White, the manager of the Loch Leven Fishery, for the kindly and ungrudging way in which he placed a boat at my service on all the four occasions when I visited the loch.

Temperature and other Physical Observations.

Loch Leven was visited in September and December 1897, and in March and June 1898, and the following Table contains the temperatures recorded for these dates.

TABLE CONTAINING TEMPERATURE OBSERVATIONS.

Date.	Hour.	Temperature.				Wind.		Weather.	Surface Movement of Water.
		Air.	Water.			Direction.	Force.		
			Surf.	Under Surf.	Under Surf.				
		Degs.	*Degs.*	*Degs.*	*Degs.*				
1897. Sept. 3	Noon.	.	57·7	18 feet 57·6	.	W.N.W.	Light.	Sky cloudy.	Slight ripple.
Dec. 16	,,	46·5	36·8	18 feet 36·5	.	South.	Moderate.	Sky cloudy.	Moderate ripple.
1898. March 3	,,	42·0	36·0	50 feet 36·2	.	North.	Moderate.	Sky cloudy.	Moderate ripple.
June 13	,,	56·0	57·7	30 feet 55·3	60 feet 54·0	S.E.	Light.	Sky overcast.	Slight ripple.

The temperature in December and March is nearly uniform, not only as regards the surface and bottom temperatures for the same month, but also for both months. The surface and bottom temperatures are also nearly uniform in September, while in June the surface temperature, which is similar to that for September, is fully two degrees higher than the temperature at five fathoms. This variation, it may be remarked, agrees more or less with what has been observed in the examination of the other lochs, and shows that it is not till August or September that the summer heat is able to penetrate to any considerable depth. The highest and lowest surface temperatures obtained show a difference of 21·7 degrees Fahr.; the under-surface difference is nearly the same, viz.—21·4 degrees Fahr.

Pelagic Entomostraca Captured in the Tow-Nets.

Free-swimming Entomostraca, though very abundant in Loch Leven, consisted mainly of the one species, *Daphnia lacustris*, G. O. Sars. *Leptodora hyalina* was moderately common in the September gathering, but it was not observed in any of the other three. *Diaptomus gracilis* was frequent in the gathering collected in December, but was scarce in the others. *Bythotrephes longimanus*, though present in both the September and June gatherings, was not observed in those collected in December and March The names of the species and their distribution are shown in the Table annexed.

[TABLE.

Table containing the Names of the Entomostraca Captured in the Tow-Nets.

Names of the Species.	Dates. 1897. Sept. 3.	Dec. 16.	1898. March 3.	June 13.
Copepoda.				
Diaptomus gracilis, G. O. Sars, - -	f.	fr.	f.	f.
Cyclops strenuus, Fischer, - - -	f.	f.	f.	f.
Cladocera.				
Daphnia lacustris, G. O. Sars, - -	very ab.	ab.	ab.	very ab.
Bythotrephes longimanus, Leydig, -	f.	0	0	r.
Leptodora hyalina, Lilljeborg, - -	c.	0	0	0

A few male *Daphniæ* were observed in the December gathering, but in none of the others; females with *pseudova* were frequent in all the gatherings. When the loch was examined in June 1890 both *Daphnella brachyura* and *Polyphemus pediculus* were observed in the tow-net gatherings, but neither of these species was obtained in any of the gatherings recently collected. Infusoria and micro-algæ, which were moderately frequent on the first three occasions when the loch was examined, were quite abundant in the loch in June; but these minute forms did not appear to be generally diffused. They rather seemed to occur in shoals; they were particularly plentiful to the south of the little island called "Reed Bower." The appearance of the water was somewhat similar to that which was observed at Forfar Loch in September, and at Loch Doon in July.

The Shore and Bottom Fauna Collected by Hand-Net.

The examination of the shore yielded, as in the case of the other lochs examined, a much greater number of species than were captured by the tow-nets, but individuals were not nearly so numerous.

Fifty-five species of Crustacea were obtained in the shore gatherings collected during the recent experiments. The records of species obtained when the loch was examined in 1890 include some five or six that were not observed in the recent gatherings, and if these and the species captured with the tow-nets be added, they increase the number of crustacean species to sixty-five; and it is quite probable that even this number will yet be added to when the loch comes to be more thoroughly examined.

The species recently captured include one Amphipod (*Gammarus pulex*), and eighteen of each of the three following groups:—The Copepoda, the Ostracoda, and the Cladocera. The largest number of species of Crustacea obtained in any of the recent shore gatherings from Loch Leven was in that collected on 30th June. This gathering yielded thirty-eight species, or only four less than the total number observed in the tow-net and hand-net gatherings collected in June 1890. The names of all the species observed in the shore gatherings recently collected are contained in the following list; those collected in 1890 are also added for comparison with the more recent gatherings.

TABLE CONTAINING THE NAMES OF CRUSTACEA FROM LOCH LEVEN, COLLECTED CHIEFLY ROUND THE SHORES.

Names of the Species.	Dates.				
	1890.	1897.		1898.	
	June.	Sept. 3.	Dec. 16.	Mar. 3.	June 13.
AMPHIPODA.					
Gammarus pulex (Linné), - . -	fr.	0	0	0	f.
COPEPODA.					
Diaptomus gracilis, G. O. Sars, - -	fr.	0	r.	0	r.
Cyclops strenuus, Fischer, - - -	f.	0	f.	0	0
,, *bicuspidatus*, Claus, - -	0	f.	r.	0	r.
,, *vernalis*, Fischer, - - -	0	f.	0	f.	0
,, *bisetosus*, Rehberg. - -	0	0	r.	f.	0
,, *viridis* (Jurine), - - -	0	f.	r.	f.	f.
,, *albidus* (Jurine), - - -	0	f.	f.	0	f.
,, *serrulatus*, Fischer, - -	fr.	f.	f.	0	f.
,, *macrurus*, G. O. Sars, - -	0	0	0	0	r.
,, *fimbriatus*, Fischer, - -	f.	f.	0	0	f.
Canthocamptus staphylinus (Jurine), -	fr.	f.	fr.	f.	f.
,, *minutus*, Claus, - -	f.	f.	fr.	f.	f.
,, *schmeilii*, Mrázek, -	f.	f.	0	0	f.
Attheyella crassa (G. O. Sars), - -	fr.	f.	0	0	f.
,, *pygmæa* (G. O. Sars), - -	0	0	fr.	f.	f.
,, *duthiei*, T. and A. Scott, -	f.	f.	0	0	f.
,, *zschokkei* (Schmeil), - -	0	0	0	0	r.
Moraria anderson-smithi, T. & A. Scott,	0	0	fr.	f.	0
OSTRACODA.					
Cypria ophthalmica (Jurine), - -	c.	f.	fr.	r.	f.
,, *exsculpta* (Fischer), - -	f.	0	0	0	0
Cyclocypris lævis (Müller), - -	0	0	f.	r.	0
,, *serena* (Koch), - - -	c.	f.	fr.	0	fr.
Cypris fuscata (Jurine), - - -	0	0	r.	r.	r.
,, *virens* (Jurine), - - -	0	0	0	r.	0
Herpetocypris reptans (Baird), - -	fr.	0	r.	0	f.
,, *tumefacta*, B. and R., -	f.	0	0	r.	fr.
,, *strigata* (Müller), - -	r.	0	0	r.	0
Cypridopsis villosa (Jurine), - -	f.	f.	r.	r.	0
Pionocypris vidua (Müller), - -	fr.	f.	f.	0	r.
Potamocypris fulva (Brady), - -	fr.	0	0	0	r.
Candona candida (Müller), - -	fr.	f.	f.	f.	r.
,, *lactea*, Baird, - - -	fr.	0	0	0	0
,, (?) *compressa* (Koch), - -	fr.	0	f.	r.	r.
,, *kingsleii*, B. and R., - -	f.	0	0	f.	0
Ilyocypris biplicata (Koch), - -	r.	0	0	0	0
Limnicythere inopinata (Baird), -	f.	f.	0	0	f.
,, *sancti-patricii*, B. and R.,	f.	f.	0	0	0
Cytheridea lacustris, G. O. Sars, -	f.	0	0	r.	0
CLADOCERA.					
Sida crystallina (Müller), - - -	0	0	0	0	r.
Simocephalus vetulus (Müller), - -	0	0	f.	0	0
Daphnia lacustris, G. O. Sars, - -	c.	0	f.	0	fr.
Bosmina longirostris (Müller), - -	f.	0	0	0	0
,, (?) *longispina*, Leydig, -	c.	0	0	0	0
Ilyocryptus sordidus (Lievin), - -	r.	f.	0	0	0
Eurycercus lamellatus (Müller), - -	f.	0	r.	0	r.
Acroperus harpæ, Baird, - - -	fr.	f.	r.	0	f.
Alonopsis elongatus, G. O. Sars, -	f.	f.	0	0	f.
Alona guttata, G. O. Sars, - -	0	f.	r.	0	r.
,, *affinis*, Leydig, - - -	0	f.	0	0	fr.
,, *quadrangularis* (Müller), -	c.	f.	r.	0	f.
Alonella exigua (Lilljeborg), - -	fr.	f.	0	0	fr.
,, *nana* (Baird), - - -	f.	0	0	0	f.
Pleuroxus trigonellus (Müller), - -	c.	f.	0	0	0
,, *uncinatus*, Baird, - -	f.	f.	0	0	f.
Chydorus sphæricus (Müller), - -	c.	f.	r.	fr.	f.
,, *barbatus* (Brady), - -	0	f.	0	0	0
,, (?) *ovalis*, Kurz, - -	0	0	0	0	f.
Monospilus dispar, G. O. Sars, - -	f.	f.	r.	0	r.

The number of species belonging to each of the three groups of Entomostraca represented in the Table will be more clearly understood when arranged as in the annexed formula, where Co., = Copepoda, Os., = Ostracoda, and Cl., = Cladocera.

Dates.	June, 1890.			Sept. 3, 1897.			Dec. 16, 1897.			March 3, 1898.			June 13, 1898.		
Names of the Groups,	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.
Number of Species in each Group,	9	17	16	10	7	14	11	9	8	7	10	1	14	10	14
Total Number in each gathering,	42			31			28			18			38		

The Cladocera, as a whole, were scarcer in those gatherings collected in the colder months than in the others. It may also be stated that in March the level of the water was much higher than during any of the other visits, and this no doubt accounted, partly at least, for the great scarcity of Cladocera in the gathering collected at that time; the reduced temperature incidental to the season may also have had some influence in bringing about this result.

(7) Duddingston Loch.

Duddingston Loch, situated on the south side of Arthur's Seat and immediately south-west of the village of Duddingston, is of small dimensions, being a little over five hundred and fifty yards in length by about two hundred and forty yards in breadth at the widest part. Its elevation above the sea is about one hundred and fifty feet. The loch is shallow, and therefore its temperature is more readily influenced by the changes incidental to the different seasons; it is quite a common experience to find that in winter its surface has been transformed into a thick sheet of ice, while in summer the water may be so warm as to be almost tepid. Such extreme variations in the temperature of the water are here of yearly occurrence, and appear to be the rule rather than the exception, and it was thought that it would be of interest to ascertain what was the effect of such extreme variations of temperature on the invertebrate fauna of the loch, as well as upon the micro-algæ.

The loch was examined by tow-net on four different occasions—viz., on 15th December 1897, and on 2nd March, 15th June, and 16th September 1898. Two other attempts were made to tow-net the loch, but these failed. One of the failures was due to the surface of the water having become frozen over during the previous night; on the second occasion the observations could not be made owing to stormy weather.

In addition to the four visits which I have referred to, a portion of the shore of the loch was also examined on the 1st of September 1897, the results of which are incorporated with those obtained in connection with the other visits, so far as they relate to the shore fauna.

Temperature and other Physical Observations.

The following Table shows the temperature readings recorded on the four occasions when the loch was tow-netted :—

Date.	Hour.	Temperature.				Wind.		Weather.	Surface Movement of Water.
		Air.	Water.			Direction.	Force.		
			Surf.	5½ Ft.	— Ft.				
		Degs.	*Degs.*	*Degs.*	*Degs.*				
1897. Dec. 15	11 a.m.	48·2	35·7	36·0	..	Southerly.	Light.	Dull; showery.	Slight ripple.
1898. Mar. 2	Noon.	45·0	36·0	36·0	..	S. Westerly.	S'm'wh't squally.	Sky clear.	Moderate.
June 15	,,	62·1	62·0	62·0	..	Easterly.	Light.	Slight haze.	Slight ripple.
Sept. 16	,,	78·0	61·0	60·4	..	Westerly.	Light.	Sky clear.	Slight ripple.

The difference between the highest and lowest surface temperature is 26·3 degrees Fahrenheit. The surface and bottom temperatures were also nearly uniform on each of the four visits, and the readings for December and March were practically the same, while those for June and September differ at most only 1·6 degree. It will also be observed that it is the September readings that are the lowest of these two, and that notwithstanding the much higher temperature of the air.

Pelagic Entomostraca Captured by the Tow-Nets.

As might have been expected, the tow-net gatherings collected in Duddingston Loch yielded a somewhat greater number of Entomostracan species than was observed in some of the other lochs examined. This loch being shallow, plants growing on the bottom are able to send their leaves and stems well up towards and even above the surface of the water, and afford shelter and foothold to many species that do not usually adopt a free-swimming life—like *Daphnia* and one or two other forms. In towing the nets through the water it was scarcely possible to avoid at times coming in contact with those plants and capturing some of the organisms that might be clinging to them: hence the greater variety of forms observed in these gatherings. The following Table contains the names of the various species of Crustacea observed in the tow-net gatherings collected in Duddingston Loch.

[Table.

Names of the Species.	Dates.			
	1897.		1898.	
	Dec. 15.	March 2.	June 15.	Sept. 16.
ISOPODA.				
Asellus aquaticus, (Linn.)	r.	0	0	0
COPEPODA.				
Diaptomus gracilis, G. O. Sars,	f. (c. in fine net.)	f.	f. (c. in fine net.)	fr. (in both nets.)
Cyclops strenuus, Fischer,	fr.	fr.	f.	fr.
,, *viridis* (Jurine),	f.	0	r. (in fine net.)	0
,, *albidus* (Jurine),	f.	f.	r.	f.
,, *serrulatus*, Fischer,	r.	0	0	f. (in fine net.)
Attheyella pygmæa (G. O. Sars),	r.	0	0	0
OSTRACODA.				
Cyclocypris serena (Koch),	r.	0	f. (in fine net.)	0
Cypris pubera, Müller,	r.	0	0	0
Herpetocypris reptans (Baird),	0	0	0	f.
Pionocypris vidua (Müller),	0	0	0	f.
CLADOCERA.				
Ceriodaphnia quadrangula (Müller),	0	0	0	f. (males rare.)
Daphnia lacustris, G. O. Sars,	ab. (a few eph. f'mls.)	c.	ab. (a few males.)	c. (a few males.)
Eurycercus lamellatus (Müller),	r.	0	0	fr.
Chydorus sphæricus (Müller),	0	0	0	r. (in fine net.)

It will be observed that *Daphnia* is the most abundant of all the Crustacea captured in the tow-nets; *Diaptomus* and *Cyclops strenuus* are also moderately common. These, along with *Cyclops albidus*, occurred in all the four gatherings, and none of them appear to have been much affected in their distribution by the changes incidental to the different seasons of the year. A few male *Daphnia* were obtained in the gatherings collected in June and September, and they were also probably present in the December gathering, though they did not happen to be noticed; for in that gathering there were a number of ephippial females, and where such forms are observed I frequently also find that males are present. Moreover, here, as in the other lochs, *Diaptomus gracilis* was more plentiful in the gatherings collected with the fine net than in the others.

The Invertebrate Fauna obtained by Hand-Net chiefly around the Shore.

The following Table contains the names of all the species of Crustacea obtained by hand-net around the shores of Duddingston Loch during the different visits that have been made to it, inclusive of the one made in

September 1897, as well as the four referred to under "Tow-Net Observations."

Names of the Species.	Dates. 1897.		1898.		
	Sept. 1.	Dec. 15.	Mar. 2.	June 15.	Sept. 16.
AMPHIPODA.					
Gammarus pulex (Penn.),	f.	0	0	0	0
ISOPODA.					
Asellus aquaticus (Linn.),	f.	f.	0	0	0
COPEPODA.					
Diaptomus gracilis, G. O. Sars,	c.	0	r.	fr.	f.
Cyclops strenuus, Fischer,	f.	f.	f.	f.	f.
,, *bicuspidatus*, Claus,	f.	r.	0	0	0
,, *vernalis*, Fischer,	f.	f.	0	0	r.
,, *bisetosus*, G. O. Sars,	0	r.	0	0	0
,, *viridis* (Jurine),	r.	0	f.	0	r.
,, *albidus* (Jurine),	r.	0	0	0	f.
,, *serrulatus*, Fischer,	r.	f.	f.	f.	f.
,, *fimbriatus*, Fischer,	f.	0	f.	f.	0
,, *phaleratus*, G. O. Sars,	f.	0	0	0	0
Canthocamptus staphylinus (Jurine),	0	f.	r.	fr.	0
,, *inornatus*, T. Scott,	fr.	0	r.	f.	0
,, *minutus*, Claus,	fr.	fr.	r.	f.	0
Attheyella crassa (G. O. Sars),	f.	f.	r.	f.	r.
,, *pygmæa* (G. O. Sars),	f.	f.	0	0	r.
,, *zschokkei* (Schmeil),	f.	0	0	0	0
Moraria anderson-smithi, T. and A. Scott,	0	f.	0	0	0
OSTRACODA.					
Cypria ophthalmica (Jurine),	0	r.	f.	0	f.
Cyclocypris serena (Koch),	f.	fr.	f.	f.	f.
,, *lævis* (Müller),	0	f.	0	0	0
Cypris pubera (Müller),	0	0	r.	0	r.
Herpetocypris reptans (Baird),	f.	0	f.	f.	f.
,, *strigata* (Müller),	0	0	fr.	0	0
Ilyodromus olivaceus, B. and N.,	f.	0	f.	0	0
Ilyocypris biplicata (Koch),	0	0	r.	0	0
Candona candida (Müller),	0	f.	f.	f.	f.
,, *kingsleii*, B. and R.,	0	f.	0	0	0
,, *rostrata*, B. and N.,	f.	r.	f.	f.	f.
,, *fabæformis* (Fischer),	0	0	f.	0	0
Cyprois flava, Zaddach,	0	0	0	0	f.
Limnicythere inopinata (Baird),	0	f.	f.	f.	0
CLADOCERA.					
Bosmina longirostris, Müller,	0	0	r.	0	0
Ceriodaphnia quadrangula, Müller,	fr.	0	0	0	f.
,, *laticaudata*, Müller,	fr.	0	0	0	0
Simocephalus vetulus (Müller),	0	r.	0	0	0
Eurycercus lamellatus (Müller),	f.	0	0	0	fr.
Acroperus harpæ, Baird,	f.	f.	0	f.	0
Alona quadrangularis (Müller),	fr.	f.	r.	0	0
,, *tenuicaudis*, G. O. Sars,	fr.	f.	0	fr.	0
,, *guttata*, G. O. Sars,	fr.	f.	0	0	0
Pleuroxus trigonellus (Müller),	fr.	f.	f.	0	0
Chydorus sphæricus (Müller),	f.	f.	r.	0	0
,, *cælatus* Schœdler	0	r.	0	0	0

A few Mollusca were also obtained, *i.e.*, *Pisidium* sp., *Planorbis complanatus*, *Planorbis nautileus*, *Planorbis contortus*, *Physa fontinalis*, and *Limnæa peregra*.

The smallest number of Entomostraca observed in any of the gatherings was in the one collected in June; in this gathering the number observed amounted to sixteen; and the largest number, which was twenty-eight, was obtained in the gathering collected in September 1897.

The annexed formula shows the number of species belonging to each of the three groups of Entomostraca observed in the various shore gatherings; the following are the abbreviations used:—Co., Copepoda; Os., Ostracoda; Cl., Cladocera.

Dates,	Sept. 1, 1897.			Dec. 15, 1897.			March 2, 1898.			June 15, 1898.			Sept. 16, 1898.		
Names of the Groups,	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.
Number of Species in each Group,	14	4	10	10	7	9	9	11	4	8	5	3	8	7	3
Number of Species in each Gathering,	28			26			24			16			18		

(8) Loch Doon, Ayrshire.

Loch Doon, which is situated among the hills between Kirkcudbrightshire and Ayrshire, and close to the boundary line that divides these two counties, has an elevation of about six hundred and sixty feet above the sea. The north end of the loch is very nearly three miles in a direct line from Dalmellington—the place nearest to the loch to which the railway has yet penetrated; its overflow water finds an exit at this end and forms the River Doon. The river, immediately on issuing from the loch, flows with a rapid current down through Ness Glen—one of the finest glens in the West of Scotland. According to the reduced Ordnance Survey map of the district, Loch Doon extends for about two and a half miles from the north end in a nearly south-east by south direction, and then bends round to about south by west for other three miles. Its breadth varies from about a quarter to nearly half a mile, except at the "Ford of Moak"—a moderately large bay on the east side, near where the loch bends round to the westward; at this place the loch is nearly a mile wide. Most of the lower half of the loch is shallow, but the upper half (which I did not visit) is said to be deeper. The greatest depth I obtained was forty-one feet, which was in March, when the loch was rather above its usual summer level.

The loch was visited on 16th September and 10th December 1897, and on 31st March and 6th July 1898. On the occasion of the December visit the weather was somewhat stormy, and shortly after commencing the usual tow-net experiments the wind began to increase in force, and, as it was from the south-east, and therefore nearly straight down the loch, the water became so rough that the tow-net work had ere long to be given up, and more time was therefore devoted to shore examination, but this also did not give very satisfactory results. It has also to be noted that the loch at this time was in flood, the water being so much above its normal level that parts of the road that extends along its west side were submerged and rendered impassable for foot traffic. In July, on the other hand, the loch was so low that numbers of "islands," which in ordinary circumstances are under water, as well as a considerable part of the shore, were exposed; and these extreme conditions in the physical aspects of the loch would no doubt affect in a greater or less degree the distribution of the invertebrate fauna.

The following Table shows the temperature readings obtained on each of the four occasions when the loch was examined:—

Date.	Hour.	Temperature.				Wind.		Weather.	Surface Movement of Water.
		Air.	Water.			Direction.	Force.		
			Surf.	30 Ft.					
		Degs.	*Degs.*	*Degs.*					
1897. Sept. 16	11.30 a.m.	..	53·4	53·2	..	Westerly.	M'd'rate	Cloudy; showery.	Slight ripple under shelter of land.
Dec. 10	11.30 a.m.	38·8	39·0	39·0	..	S. E.	Squally.	Showers of sleet.	Rough.
1898. Mar. 31	11.30 a.m.	51·0	39·0	41 ft. 39·3	..	Westerly.	Light.	Cloudy, but fine.	Slight ripple.
July 6	1 p.m.	65·0	58·1	25 ft. 58·0	..	W. by W.	Squally.	Dull; inclining to rain.	Moderate.

In this loch the water at surface and bottom was of a nearly uniform temperature on each of the four occasions when I examined the loch, and the water was neither so cold in winter nor so warm in summer as that of Duddingston or Forfar Lochs. The difference between the surface reading on 31st March and 6th July is 19·1 degrees, while the difference between the bottom readings for the same periods is 18·7; the temperatures for December and March are practically the same; while the readings for September are fully 4½ degrees below those for July.

The Pelagic Fauna taken in the Tow-Nets.

The true pelagic Entomostraca of Loch Doon, as in the other lochs examined, comprised comparatively few species. The seasonal distribution of one or two of them exhibited more or less marked variation, while others appeared to be less subject to seasonal influences. Two of the Entomostraca obtained in the tow-net gatherings collected here—viz., *Diaptomus laciniatus* and *Daphnia nasuta*—have not been found in any of the other lochs; further reference is made to these under "Notes on the Species." The following is a full list of the Entomostraca captured in the tow-nets:—

[TABLE.

Names of the Species.	Dates.			
	1897.		1898.	
	Sept. 16.	Dec. 12.	March 31.	July 6.
COPEPODA.				
Diaptomus laciniatus, Lilljeborg,	f.	0	0	fr.
,, *gracilis*, G. O. Sars,	f.	0	f.	r.
Cyclops strenuus, Fischer,	f.	f.	fr.	f.
,, *viridis* (Jurine),	f.	f.	0	0
,, *albidus* (Jurine),	0	0	fr.	0
CLADOCERA.				
Sida crystallina (Müller),	f.	0	0	0
Holopedium gibberum, Zaddach,	...	...	...	...
Bosmina longispina, Leydig,	0	0	0	fr.
Daphnia nasuta, G. O. Sars,	fr.	fr.	r.	c.
Eurycercus lamellatus (Müller),	f.	0	r.	0
Camptocercus rectirostris (Schœdler),	f.	0	0	0
Bythotrephes longimana, Leydig,	f.	0	0	f.
Leptodora hyalina, Lilljeborg,	f.	0	0	fr.

Amongst the species named in this list the three following appear to show distinct seasonal variation, viz.:—*Diaptomus laciniatus*, *Holopedium gibberum*, and *Leptodora hyalina*. *Daphnia nasuta* also shows a certain amount of variation, but it is less marked than that of these three. *Cyclops strenuus* was more frequent in the gathering collected in March than in the others; while *Daphnia* was much scarcer in this than it was in the other gatherings. *Sida*, *Eurycercus*, and *Camptocercus* are forms which I do not, as a rule, find in tow-net gatherings collected in the open where the water is deep; when these species do occur in tow-net gatherings, the water they are collected in is usually shallow, and aquatic vegetation is more or less in evidence. *Holopedium* occurred only in the July gathering, in which it was moderately common, and *Diaptomus laciniatus* and *Leptodora* were frequent in the same gathering. These last two forms were also present in the gathering collected in September, but no trace of any of the three species was observed in either of the other two gatherings collected. The *Daphnia*, though obtained in all the four gatherings, was much more plentiful in that collected in July. It may also be noted that in the July gathering collected with the fine tow-net infusoria and micro-algæ were more or less abundant. An organism somewhat resembling *Nostoc* was very plentiful. It occurred in roundish masses of variable size, and in general appearance was very like the objects observed a short time before in Loch Leven. *Actinophrys sol* was also observed in the July gathering from Loch Doon, as well as *Ceratium*, Diatoms, Desmids, &c.; but a report on these may be prepared later.

The Invertebrate Fauna Collected by Hand-Net.

Amongst the Crustacea collected about the shores of Loch Doon by means of the hand-net, several rare species were observed—one of which, *Cyclops nanus,* appears to be new to Britain; *Cyclops languidus* and *Lathonura rectirostris* were also obtained here for the first time in Scotland. Other rare species obtained at Loch Doon were *Canthocamptus schmeilii* and *Maraenobiotus vejdovskei.* A full list of all the species of Crustacea observed in the hand-net gatherings from Loch Doon is contained in the following Table :—

[Table.

Names of the Species.	Dates.			
	1897.		1898.	
	Sept. 16.	Dec. 12.	March 31.	July 6.
AMPHIPODA.				
Gammarus pulex (Penn),	0	0	0	r.
COPEPODA.				
Cyclops strenuus, Fischer,	0	r.	0	0
,, *bicuspidatus*, Claus,	0	0	f.	0
,, *languidus*, G. O. Sars,	0	0	f.	f.
,, *vernalis*, Fischer,	f.	0	f.	0
,, *bisetosus*, G. O. Sars,	f.	f.	0	0
,, *viridis* (Jurine),	f.	r.	f.	r.
,, *fuscus* (Jurine),	0	0	fr.	0
,, *albidus* (Jurine),	f.	0	f.	f.
,, *serrulatus*, Fischer,	f.	0	f.	...
,, *fimbriatus*, Fischer,	f.	0	r.	f.
,, *nanus*, G. O. Sars,	0	0	f.	f.
Canthocamptus staphylinus (Jurine),	f.	0	f.	0
,, *minutus*, Claus,	f.	0	f.	f.
,, *schmeilii*, Mrázek,	f.	0	0	0
,, sp.,	f.	0	f.	f.
Attheyella crassa (G. O. Sars),	f.	0	f.	f.
,, *pygmæa* (G. O. Sars),	f.	0	f.	r.
,, *zschokkei* (Schmeil),	0	0	0	f.
Moraria anderson-smithi, T. & A. Scott,	f.	r.	f.	0
,, *brevipes* (G. O. Sars),	0	0	f.	0
Maraenobiotus vejdovskii, Mrázek,	0	f.	0	0
OSTRACODA.				
Cypria exsculpta (Fischer),	0	0	fr.	0
Cyclocypris serena (Koch),	r.	0	c.	f.
,, *globosa* (G. O. Sars),	r.	0	0	0
Cypris fuscata (Jurine),	0	0	0	r. (fine)
Ilydromus robertsoni, B. and N.,	f. (fine)	0	0	fr.
Cypridopsis villosa (Jurine),	r.	0	0	0
Candona candida (Müller),	f.	0	fr.	0
,, *kingsleii*, B. and R.,	fr.	0	f.	f.
,, *rostrata*, B. and N.,	f.	0	f.	0
,, *hyalina*, B. and R.,	0	0	0	r.
CLADOCERA.				
Sida crystallina (Müller),	f.	0	0	0
Lathonura rectirostris (Müller),	f.	0	0	0
Drepanothrix dentata, Eurin,	f.	0	f.	f.
Ilyocryptus sordidus (Lievin),	f.	0	f.	r.
Bosmina longirostris (Müller),	f.	r.	0	0
,, *longispina*, Leydig,	0	0	f.	0
Simocephalus vetulus (Müller),	0	0	f.	f.
Daphnia nasuta, G. O. Sars,	0	r.	f.	0
Eurycercus lamellatus (Müller),	f.	0	0	0
Acroperus harpæ, Baird,	f.	0	f.	f.
Camptocercus rectirostris, Schœdler,	f.	0	0	r.
Alonopsis elongatus, G. O. Sars,	f.	0	0	0
Graptoleberis testudinaria (Fischer),	f.	0	0	f.
Alona affinis, Leydig,	f.	0	f.	r.
,, *quadrangularis* (Müller),	f.	0	f.	r.
,, *rustica*, T. Scott,	0	0	f.	0
,, *intermedia*, G. O. Sars,	f.	0	fr.	0
,, *guttata*, G. O. Sars,	f.	f.	r.	0
Alonella nana (Baird),	f.	0	0	0
,, *exigua*, G. O. Sars,	f.	0	0	fr.
Pleuroxus trigonellus (Müller),	f.	0	0	0
Peracantha truncata (Müller),	f.	0	0	0
Harporhynchus falcatus, G. O. Sars,	f.	0	0	0
Chydorus sphæricus (Müller),	f.	0	f.	f.
,, *barbatus* (Brady),	0	0	0	f.
,, *cœlatus*, Schœdler.	f.	0	0	0

The total number of Crustacea obtained in, and around the shores of, Loch Doon amounts to sixty-three species, and comprises twenty-three species of Copepoda, ten of Ostracoda, and twenty-nine of Cladocera, to which has to be added *Gammarus pulex*.

The shore gatherings collected in September and March yielded the largest number of species, while the one collected in December gave very poor results; even the results of the tow-net gatherings collected at this time were disappointing, which was probably owing, in part at least, to the stormy weather then prevailing and to the flooding of the loch. But while this was the least successful of the various gatherings collected, it was the only one in which the rare *Maraenobiotus* was obtained.

The number of species of each of the three groups of Entomostraca observed in the various shore gatherings is shown in the formula. Co., Copepoda; Os., Ostracoda; Cl., Cladocera.

Dates,	Sept. 16, 1897.			Dec. 12, 1897.			March 31, 1898.			July 6, 1898.		
Names of the Groups,	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.	Co.	Os.	Cl.
Number of Species in each Group,	12	8	2	5	0	3	16	5	12	10	5	11
Total Number of Species in each Gathering,	41			8			33			26		

A number of minnows were obtained in the September gathering, and the contents of several of their stomachs were found to consist chiefly of Cladoceran remains; those remains that were perfect enough for identification represented at least eight different species. Trout are fairly plentiful in Loch Doon, and fine specimens are occasionally captured. One of the largest has been preserved, and is in the possession of Mr. James Macdonald of the Eglinton Hotel, Dalmellington.

It appears that extensive deposits of marl exist in Loch Doon; and, about the time of my visit to the loch in July, advantage had been taken of the water being so low to have some of it excavated. Some of the marl was so pure that when it was dried it closely resembled a piece of chalk both in colour and weight. A sample which I collected, measuring nearly nine cubic inches, weighed scarcely four ounces when dry. It was solid throughout, and exhibited indistinct traces of lamination. It was nearly white in colour, but variegated with light brownish bands. When dissolved in water and carefully examined no remains of molluscan shells were observed; it seemed to consist largely of a fine whitish mud, in which were numerous *Diatomacea* and seeds of *Chara* or *Nitella*. But the marl varied in purity to a considerable extent; though of moderate thickness in some places, in others it consisted only of thin layers interbedded with dark vegetable matter; but whether in thin or thick layers, it seemed to be characterised by the absence of Molluscan shells, and thus differed very markedly from the marl observed in Forfar Loch. It may, in the absence of Molluscan remains, be somewhat difficult to determine from what source this marl is derived. A chemical examination of the water at different seasons of the year might probably throw some light on this question.

I found Mollusca rather scarce in Loch Doon; Coleoptera were also scarce; but *Corixa* appeared to be locally frequent.

It is not pretended that the various lists contained in the preceding pages represent all the species of Crustacea likely to be found in the various lochs described—more especially around their shores; it is more likely that further research will add considerably to the number of those recorded. All that may be said about these lists in the meantime is that they contain a record of the species observed by the writer in the gatherings collected in the various lochs that have been made the subject of this special investigation.

II. SECOND SERIES OF LOCHS EXAMINED.

The second series of lochs to be noticed here comprise Loch Ness, Loch Oich, and Loch Lochy, all of them situated in the Great Glen and in the line of the Caledonian Canal. Tow-net gatherings have at various times been collected in each of these lochs, when the s.s. *Garland* was on her way from the East to the West Coasts or *vice versa*. Observations on the temperature of the water, both at the surface and at different depths from surface to bottom, have also been made. The number of observations and experiments made in these lochs is therefore very considerable. Only those of them, however, that coincide more or less approximately with the investigations carried out in the first series of lochs will be referred to here. The examination of these three lochs has been carried out under the supervision of Mr. F. G. Pearcey, to whom I am indebted for most of the gatherings of Entomostraca to be described, and for the records of temperature.

(1) Loch Ness.

This, which is the largest and deepest of the three lochs now under consideration, has been examined at three different places, viz., off Castle Urquhart, off Foyers, and off Port Clair, and the tow-net gatherings that are to be described were collected in August, October, and December 1897, and in January, August, and October 1898; they were collected at the surface and at various depths down to sixty fathoms. Usually the gatherings that were collected at the same place and on the same date contained the same kinds of organisms, and only differed more or less in the quantity collected; it is not necessary, therefore, to describe in detail the results of each separate gathering. I propose rather to give a general description of the gatherings collected on the different dates at the three places mentioned, referring where necessary to any point of interest that presents itself concerning any of the gatherings collected or of the species observed.

Temperature and other Physical Observations.

The following Table contains the temperature and other observations that correspond more or less closely with the dates on which the tow-net gatherings were collected. Only the temperature at the surface and at five and ten fathoms is given, and for the following dates—7th August, 28th October, and 6th December 1897, and 3rd August and 7th October 1898.

Table showing Records of Temperature.

The following abbreviations are used:—U., off Castle Urquhart; F. off Foyers; C., off Port Clair.

Date.		Hour.	Temperature.				Wind.		Weather.	Surface Movement of Water.
			Air.	Water.			Direction.	Force.		
				Surf.	5 fms.	10 fms				
1897.			*Degs.*	*Degs.*	*Degs.*	*Degs.*				
Aug. 7,	U.	6.35 a.m.	59.1	60·9	•	•	N.E.	Light.	Fine rain.	Water smooth.
,,	F.	3.35 p.m.	61·1	60·3	55·4	53·0	,,	,,	Passing showers.	,,
,,	C.	4.28 p.m.	62·6	59·2	•	•	,,	,,	,,	,,
Oct. 2	U	1.45 p.m.	60·4	50·0	49·4	49·8	S.W.	,,	Hazy.	,,
,,	F.	12.15 p.m.	60·9	49·7	49·2	49·5	,,	M'drate.	,,	Moderate ripple.
,,	C.	9.20 a.m.	56·8	49·2	49·0	49·0	,,	Light.	,,	Smooth.
Dec. 6,	U.	9.55 a.m.	41·3	46·2	46·8	47·0	W.	,,	Overcast.	,,
,,	F.	1.15 p.m.	44·0	46·0	46·3	46·5	S.W.	M'drate.	Cloudy.	Moderate ripple.
,,	C.	9 a.m.	43·1	46·0	46·0	45·8	W.S.W.	Squally.	Rain.	Rough.
1898.										
Aug. 3,	U.	9.55 a.m.	56·3	55·0	55·0	55·0	S.W.	Strong.	Showery.	,,
,,	F.	12.35 p.m.	56·8	54·0	54·0	53·0	,,	Squally.	,,	,,
,,	C.	2.38 p.m.	57·2	50·2	51·8	51·4	,,	,,	,,	Moderate ripple.
Oct. 7,	U.	2 13 p.m.	56·3	55·2	55·4	55·0	N.E. by E.	M'drate.	Cloudy.	Strong ripple.
,,	F.	10 a.m.	51·4	54·1	54·8	54·1	,,	,,	,,	Slight ripple.
,,	C.	8.50 a.m.	51·4	54·6	53.5	54·0	E.	,,	Fog.	Strong ripple.

The Pelagic Entomostraca Collected by the Tow-Nets.

The Entomostraca observed in the various tow-net gatherings comprise altogether about twelve species, but a few of them are exceedingly rare. The most numerous forms were two species of *Diaptomus*—(*D. hircus*, G. S. Brady,* and *D. gracilis*, G. O. Sars); and *Bosmina longispina*, Leydig. The next in order of frequency were *Daphnia galeata*, G. O. Sars; *Bythotrephes longimanus*, Leydig; and *Leptodora hyalina*, Lilljeborg. *Cyclops strenuus*, Fischer, was also occasionally more or less frequent. The following Table will show approximately the relative frequency of the different species and their seasonal distribution. The gatherings represented in this Table were collected on six different dates, viz., on 6th August, 28th October, and 6th and 7th December 1897, and on 25th January, 3rd August, and 7th October 1898. The following abbreviations are used in the Table:—ab—abundant; c—common; fr—frequent; and r—rare. "0" also signifies the absence of any species.

* See Notes on this and other species at p. 188.

[Table.

TABLE CONTAINING THE NAMES OF ENTOMOSTRACA OBSERVED IN TOW-NET GATHERINGS FROM LOCH NESS.

Names of the Species.	Dates. 1897. Aug. 6.	1897. Oct. 28.	1897. Dec. 6, 7.	1898. Jan. 25.	1898. Aug. 3.	1898. Oct. 7.
COPEPODA.						
Diaptomus gracilis, G. O. Sars, -	f.	fr.	fr.	f.	ab.	ab.
,, *hircus*, Brady, - - -	0	f.	r.	f.	ab.	ab.
Cyclops strenuus, Fischer, - - -	0	f.	r.	f.	f.	fr.
,, *viridis* (Jurine), - - -	0	0	r.	0	0	0
CLADOCERA.						
Sida crystallina (Müller), - - -	r.	0	0	0	0	0
Diaphanosoma brachyurum (Lievin), -	0	0	0	0	r.	0
Daphnia galeata, G. O. Sars, - -	f.	fr.	fr.	c.	c.	c.*
Bosmina longispina, Leydig, - -	c.	f.	f.	f.	ab.	fr.
Alonopsis elongata, G. O. Sars, - -	0	r.	r.	0	0	0
Polyphemus pediculus (Linn.), - -	f.	0	0	0	fr.	r.
Bythotrephes longimanus, Leydig, -	f.	r.	0	0	c.	fr.
Leptodora hyalina, Lilljeborg, - -	r.	r.	r.	0	c.	fr.

* A few males were observed in a gathering from 60 fathoms off Castle Urquha and from 50 fathoms off Port Clair.

Diaptomus gracilis occurred in gatherings collected at the surface and at various depths down to 110 fathoms, or, in other words, as deep as the tow-nets were worked.

Diaptomus hircus, Brady, did not appear to be so generally distributed as the last; it was usually more frequent in the mid-water gatherings than in those collected at the surface or in very deep water. In the series of gatherings collected on 3rd August 1898, no specimens were observed in those from the surface down to 10 fathoms, but the species was abundant in a gathering from 30 fathoms, and rare in one from 60 fathoms.

Cyclops strenuus, though generally distributed, was seldom very common. *Cyclops viridis*.—This Copepod was observed in only one of the gatherings, collected in about 10 fathoms at the north-east end of the loch. Among the Cladocera, the first two species in the list only occurred once—the *Sida* in a surface gathering collected on 6th August 1897, and the *Diaphanosoma* in a gathering from 20 fathoms collected off Port Clair on August 3rd, 1898.

Daphnia galeata was more or less generally distributed from the surface down to 110 fathoms, but it was usually more common in gatherings from the surface down to about 20 fathoms than in those from deep water. It also seemed to be more common in the gatherings collected in 1898 than in those collected in 1897.

Bosmina longispina.—The *Bosmina* from Loch Ness exhibited some variation in size and in the length of the antennules and posterior spines, but appeared to belong to the same species. They also appeared to show a certain amount of seasonal variation, for it will be observed that while they were "common" or "abundant" in gatherings collected in August 1897 and 1898, they were decidedly scarcer in those collected during the late autumn and winter months.

Alonopsis occurred on two of the dates mentioned, and on both occasions in gatherings collected with a fine silk tow-net off Castle Urquhart, and both were surface gatherings. Only one specimen of *Alonopsis* was observed in each of the gatherings.

Polyphemus pediculus.—It would seem, from an examination of the Table, that seasonal changes affect to some extent the distribution of this Cladoceran; it was not observed in the gatherings collected in December and January, nor in those collected in October 1897; it was rare in those collected in October 1898, while in those collected in August 1897 and 1898 it was more or less frequent. It occurred in gatherings collected at 60 fathoms, and from that depth to the surface, but was more frequent in those from the lesser depths.

Bythotrephes longimanus.—This had a distribution somewhat similar to *Polyphemus.*

Leptodora hyalina.—The distribution of *Leptodora*, like that of some of the others, appeared to be affected to some extent by the changes of the seasons; it occurred all over the loch, and in almost all of the gatherings, but it was most common in those collected in August 1898.

(2) Loch Oich.

Loch Oich is situated along the watershed of the Great Glen, and is the highest of the three lochs under discussion. It is much shallower than Loch Ness or Loch Lochy, and its bottom is very irregular; its surface is also broken up by several islands. Its present level is about 100 feet above the sea at ordinary high water. Being smaller and more sheltered than either of the other two lochs, its range of temperature is greater, the water in summer being warmer and in winter colder, and probably this may have a tendency to react on the more susceptible of the invertebrate inhabitants of the loch. The examination of the tow-net gatherings has not, however, brought out any very marked differences; but further reference will be made to this point under "Notes on the Species" at p. 186. A series of temperature records will be found in the following Table.

TABLE SHOWING RECORDS OF TEMPERATURE OBSERVATIONS TAKEN AT LOCH OICH.

Date.	Hour.	Temperature.				Wind.		Weather.	Surface Movement of Water.
		Air.	Water.			Direction.	Force.		
			Surf.	5 Fms.	15Fms				
		Degs.	*Degs.*	*Degs.*	*Degs.*				
1897. Aug. 6	Noon.	64·0	65·0	62·0	49·0	S. W.	M'drate.	Hazy; rain.	Moderateiy rough.
Dec. 7	2.15p.m.	48·2	43·1	42·9	10 fms 42·9	,,	Squally.	Heavy rain.	Rough.
1898. Aug. 4	9.30a.m.	55·7	59·5	59·0	59·0	W. S. W.	M'drate.	Cloudy; showery.	Slight ripple.
Oct. 6	3.7 p.m.	66·2	55·5	52·3	52·3	E.	,,	Fair; clear.	Strong ripple.

The highest surface temperature is 65·0 degrees, and the lowest 43·1 degrees—showing a difference of 21·9 degrees; whereas the difference between the highest and lowest surface temperature readings for Loch Ness is 14·9 degrees, or only about two-thirds of the difference observed in Loch Oich. There is a marked difference in the temperature of the water on 6th August 1897 and 4th August 1898. On the latter date the temperature of the water is practically uniform—down, at least, to ten fathoms; while on 6th August 1897 there is a difference between the temperature at the surface and at 15 fathoms of 16 degrees Fahrenheit.

The Pelagic Entomostraca Collected by the Tow-Nets.

The names of the various species observed in the tow-net gatherings from Loch Oich will be found in the annexed Table:—

Names of the Species.	Dates. 1897. Aug. 6.	Dates. 1897. Dec. 7.	Dates. 1898. Jan. 24.	Dates. 1898. Aug. 4.	Dates. 1898. Oct. 6.
COPEPODA.					
Diaptomus gracilis, G. O. Sars,	r.	f.	f.	c.	fr.
,, *hircus*, Brady,	0	0	0	r.	0
Cyclops strenuus, Fischer,	r.	0	0	f.	fr.
,, *viridis* (Jurine),	r.	r.	r.	0	0
,, *albidus* (Jurine),	0	0	0	r.	0
CLADOCERA.					
Sida crystallina (Müller),	f.	0	0	f.	r.
Diaphanosoma brachyurum (Lievin),	0	0	0	f.	0
Daphnia galeata, G. O. Sars,	ab.	f.	f.	fr.	ab.*
Bosmina longispina, Leydig,	r.	f.	f.	c.	r.
Holopedium gibberum, Zaddach,	r.	0	0	r.	r.
Camptocercus rectirostris, Schœdler,	0	0	0	0	r.
Alona affinis, Leydig,	0	0	0	r.	0
Polyphemus pediculus (Linn.),	r.	0	0	r.	r.
Bythotrephes longimanus, Leydig,	fr.	0	0	fr.	f.
Leptodora hyalina, Lilljeborg,	r.	0	0	fr.	fr.

* Male *Daphnia* were frequent in the gatherings collected at this date.

Among the Copepoda observed in Loch Oich, *Diaptomus gracilis* was the most common. It was also one of the few species that occurred in all the gatherings examined.

Diaptomus hircus, Brady, appeared to be rare in Loch Oich. The three species of *Cyclops* were also apparently scarce.

Sida and *Diaphanosoma* were also somewhat rare, but *Sida* was less so than the other. In the gatherings collected in August 1897 *Sida* occurred, but very sparingly, from the surface down to ten fathoms. In the gatherings collected in August and October 1898 its distribution was somewhat similar.

Daphnia galeata was more or less plentiful, except in the gatherings collected during the winter months. Large specimens of the *Daphnia* with strongly crested heads were obtained in Loch Oich; a considerable variation in the form of the head was also observed.

Bosmina also exhibited a considerable amount of variation.

Holopedium gibberum occurred very sparingly in Loch Oich. It was not observed during the winter months. The seasonal changes appear to affect very much the distribution of *Holopedium*.

Camptocercus was observed in only one gathering, collected at five fathoms on 6th October 1898. The post-abdomen of this *Camptocercus* is more characteristic of *C. rectirostris* than of *C. macrurus*—the species to which British specimens have usually been ascribed.

Alona affinis. A single specimen of this Cladoceran was obtained in a gathering from ten fathoms.

Polyphemus was apparently absent from the gatherings collected in December and January, and this tends to confirm what has been said as to its susceptibility to seasonal changes.

Bythotrephes and *Leptodora* show a distribution very similar to the distribution of the same species in Loch Ness.

(3) Loch Lochy.

The distance between the north-east end of Loch Lochy and the south-west end of Loch Oich is slightly over one and a half miles, and there is a difference of only a few feet between the levels of the two lochs. From the frequent passage of vessels to and from the East and West Coasts, a considerable quantity of water makes its way from Loch Oich through the canal into Loch Lochy, and probably conveys some of the Loch Oich Entomostraca into the neighbouring loch, and thus gradually tends to bring about a more or less marked uniformity in their pelagic faunas. Littoral species—that is, species whose habitat is about the roots or amongst the foliage of the aquatic vegetation of the shore and shallows of lochs—are less likely to be affected by these movements of the water than those are that live in the open; and therefore a greater dissimilarity may exist between the shore and bottom faunas than between the free-swimming species of lochs which are so situated that the overflow water from the one passes into the other. The study of the dispersion of species is of wide interest and has an important bearing on the question of what are, or should be, considered distinct species or varieties.

Temperature Observations.

So far as the records are comparable, the temperature of Loch Lochy shows rather less seasonal variation than Loch Oich, which is no doubt owing to the greater body of water in Loch Lochy.

The annexed Table contains a number of temperature observations taken in this loch :—

[TABLE.

Date.	Hour.	Temperature.				Wind.		Weather.	Surface Movement of Water.
		Air.	Water.			Direction.	Force.		
			Surf.	5 Fms.	10Fms.				
		Degs.	*Degs.*	*Degs.*	*Degs.*				
1897. Oct. 27	10.15a.m	59·1	50·1	50·0	50·0	S.	Squally.	Bright sunshine.	Rough.
Dec. 8	9.20a.m.	37·2	46·1	46·4	46·2	S. W.	,,	Snow showers.	Rough.
1898. Aug. 4	1 p.m.	57·3	57·0	56·0	56·0	W. S. W.	,,	Showery.	Strong ripple.
Oct. 6	3.7 p.m.	66·2	56·0	55·3	53·4	S.	Light.	Fine.	Slight ripple.

The surface temperatures for December 1897 and August 1898 show a difference of 10·9 degrees Fahrenheit for Loch Lochy; whereas the difference for the same months for Loch Oich is 16·4 degrees Fahrenheit.

The Pelagic Entomostraca Collected by the Tow-Nets.

The Entomostraca contained in the tow-net gatherings from Loch Lochy are very similar in number and kind to those from the Loch Ness gatherings. The only difference worth noting is the presence in Loch Lochy of *Holopedium gibberum*; and curiously, though this species occurred in all the four gatherings collected on 4th August 1898 at the surface and at ten fathoms, twenty fathoms, and fifty fathoms, it was not observed in any gathering on the other dates mentioned in the following Table of Species.

TABLE CONTAINING THE NAMES OF ENTOMOSTRACA OBSERVED IN TOW-NET GATHERINGS FROM LOCH LOCHY.

Names of the Species.	Dates.					
	1897.			1898.		
	Aug. 6.	Oct. 27.	Dec. 8.	Jan. 24.	Aug. 4.	Oct. 6.
COPEPODA.						
Diaptomus gracilis, G. O. Sars,	c.	ab.	f.	c.	ab.	c.
,, *hircus*, Brady, .	0	fr.	r.	fr.	f.	fr.
Cyclops strenuus, Fischer, .	c.	fr.	r.	f.	fr.	fr.
,, *viridis* (Jurine), . .	0	0	r.	0	0	0
CLADOCERA.						
Holopedium gibberum, Zaddach,	0	0	0	0	fr.	0
Daphnia galeata, G. O. Sars, .	f.	c.	c.	c.	ab.	c.
Bosmina longispina, Leydig .	fr.	fr.	f.	f.	fr.	f.
Polyphemus pediculus (Linn.),	f.	0	0	0	f.	0
Bythotrephes longimanus, Leydig,	r.	fr.	r.	0	c.	c.
Leptodora hyalina, Lilljeborg,	r.	fr.	0	0	c.	fr.

Diaptomus gracilis was more plentiful in the gatherings from this loch than in those from the other two. It was, however, less common in the December gatherings than in those for the other months.

Diaptomus hircus, Brady, was also moderately frequent, except in the gatherings for August 1897.

Cyclops strenuus was one of the more common species in this loch; while *Cyclops viridis* only occurred once.

Holopedium gibberum has already been referred to.

Daphnia galeata was quite common in the gatherings from Loch Lochy, with the exception of those collected in August 1897. The *Daphniæ* in the gatherings from this loch were similar to those observed in Loch Ness; but those with the head strongly helmeted were less in evidence here than in Loch Oich.

Bosmina longispina. The *Bosminæ* of Loch Lochy, like those of Loch Oich and Loch Ness, exhibited a certain amount of variation in size and in the length of the antennules and of the posterior spines, and it may be that they include one, or perhaps two, other species besides *B. longispina*. That, however, appears to be the typical form, and I prefer meantime to consider the others as "varieties."

Polyphemus was one of the less common Entomostracans in Loch Lochy, and here, as elsewhere, appeared to be susceptible to seasonal changes.

Bythotrephes was more plentiful in the gatherings collected in August and October 1898 than in those collected previously, and, though it occurred in all of them from the surface down to seventy fathoms, it was scarcer in those collected in deep water.

Leptodora differed little in its distribution from *Bythotrephes*, except that it was not observed in the gatherings collected either in December or January, nor in those collected below fifty fathoms. It was common in one or two of the surface gatherings.

General List of all the Species of Crustacea and Mollusca that are recorded from the various Lochs referred to in the Preceding Pages, together with Names of the Lochs in which they were observed.

An x under the name of a Loch indicates that the species was obtained in it.

Names of the Species.	Loch Lomond.	Loch Arklet.	Loch Katrine.	Loch Achray.	Forfar Loch.	Loch Leven.	Duddingston Loch.	Loch Doon.	Loch Ness.	Loch Oich.	Loch Lochy.
CRUSTACEA.											
AMPHIPODA.											
Gammarus pulex (Penn.), -	-	-	x	-	x	x	x	x	-	-	-
ISOPODA.											
Asellus aquaticus (Linn.), -	-	-	-	-	-	-	x	-	-	-	-

General List of all the Species of Crustacea, &c.—*Continued.*

Names of the Species.	Loch Lomond.	Loch Arklet.	Loch Katrine.	Loch Achray.	Forfar Loch.	Loch Leven.	Duddingston Loch.	Loch Doon.	Loch Ness.	Loch Oich.	Loch Lochy,
Copepoda.											
Diaptomus gracilis, G. O. Sars,	x	x	x	x	x	x	x	x	x	x	x
,, *laciniatus*, Lilljeborg,	-	-	-	-	-	-	-	x	-	-	-
,, *hircus*, Brady, -	-	-	x	-	-	-	-	-	x	x	x
,, *wierzejskii*, Richard,	-	-	-	x	-	-	-	-	-	-	-
Cyclops strenuus, Fischer, -	x	x	x	x	x	x	x	x	x	x	x
,, *leuckarti*, Claus, - -	x	-	-	x	-	-	-	-	-	-	-
,, *dybowskyii*, Lande, -	x	-	-	-	-	-	-	-	-	-	-
,, *bicuspidatus*, Claus, -	x	-	x	x	x	x	x	x	-	-	-
,, *languidus*, G. O. Sars, -	-	-	-	-	-	-	-	x	-	-	-
,, *vernalis*, Fischer, - -	x	-	x	x	x	x	x	x	-	-	-
,, *bisetosus*, G. O. Sars, -	x	x	-	x	-	x	x	x	-	-	-
,, *viridis* (Jurine), - -	x	x	x	x	x	x	x	x	x	x	x
,, *fuscus* (Jurine), - -	-	x	x	x	-	-	-	x	-	-	-
,, *albidus* (Jurine), - -	x	x	x	x	x	x	x	x	-	x	-
, *serrulatus*, Fischer, -	x	x	x	x	x	x	x	x	-	-	-
,, *macrurus*, G. O. Sars, -	-	x	-	-	-	x	-	-	-	-	-
,, *affinis*, G. O. Sars, -	*x	-	-	-	-	-	-	-	-	-	-
,, *nanus*, G. O. Sars, -	*x	-	-	-	-	-	-	x	-	-	-
,, *fimbriatus*, Fischer, -	x	x	x	x	x	x	x	x	-	-	-
,, *phaleratus*, G. O. Sars,	-	-	-	-	x	-	x	-	-	-	-
Canthocamptus staphylinus, (Jurine),	x	x	x	x	x	x	x	x	-	-	-
,, *minutus*, Claus, -	x	x	x	x	x	x	x	x	-	-	-
,, *inornatus*, T. Scott,	-	x	x	x	x	-	x	-	-	-	-
,, *schmeilii*, Mrázek,	x	-	-	-	-	x	-	x	-	-	-
,, *hirticornis*, T. Scott,	x	-	-	-	-	-	-	-	-	-	-
Attheyella crassa (G. O. Sars), -	x	x	x	x	x	x	x	x	-	-	-
,, *pygmæa* (G. O. Sars),	x	x	x	x	x	x	x	x	-	-	-
,, *zschokkii* (Schmeil), -	x	x	-	-	x	x	x	x	-	-	-
,, *duthiei*, T. & A. Scott,	-	-	-	-	x	x	-	-	-	-	-
Moraria anderson-smithi, T. & A. Scott,	x	x	x	x	x	x	x	x	-	-	-
,, *brevipes*, G. O. Sars, -	-	-	-	x	x	-	-	x	-	-	-
Maraenobiotus vejdovskii, Mrázek,	-	-	-	-	-	-	-	x	-	-	-
Ostracoda.											
Cypria exsculpta, Fischer, -	-	-	-	x	x	x	-	x	-	-	-
,, *ophthalmica* (Jurine), -	x	x	x	x	x	x	x	-	-	-	-
Cyclocypris serena (Koch), -	x	x	x	x	x	x	x	x	-	-	-
,, *lævis*, (Müller), -	x	x	x	x	-	x	x	-	-	-	-
,, *globosa* (G. O. Sars),	x	x	x	x	-	-	-	x	-	-	-
Cypris fuscata (Jurine), - -	-	-	-	-	-	x	-	x	-	-	-
,, *incongruens*, Ramdohr, -	-	-	-	-	x	-	-	-	-	-	-
,, *pubera*, Müller, - -	-	-	-	-	x	-	x	-	-	-	-
,, *virens* (Jurine), - -	-	-	-	-	-	x	-	-	-	-	-
,, *obliqua*, Brady, - -	x	-	-	x	-	-	-	-	-	-	-
Herpetocypris reptans (Baird), -	x	-	-	-	x	x	x	-	-	-	-
,, *strigata*, Müller, -	-	-	-	-	-	x	x	-	-	-	-
,, *tumefacta*, B. & R.,	-	-	-	-	x	x	-	-	-	-	-
Ilyodromus robertsoni, B. & N.,	-	-	-	-	-	-	-	x	-	-	-
,, *olivaceus*, B. & N., -	-	-	-	-	x	-	x	-	-	-	-
Cypridopsis villosa (Jurine), -	x	-	-	-	x	x	-	x	-	-	-
,, *newtoni*, B. & R., -	-	-	-	-	x	-	-	-	-	-	-
Pionocypris vidua (Müller), -	x	-	-	x	-	x	x	-	-	-	-
Potamocypris fulva, Brady, -	-	-	-	-	x	x	-	-	-	-	-
Cyprois flava, Zaddach, - -	-	-	-	-	-	-	x	-		-	-

* These are not from Loch Lomond itself, but from the "Dhu Loch" alongside.

GENERAL LIST OF ALL THE SPECIES OF CRUSTACEA, &c.—*continued.*

Names of the Species.	Loch Lomond.	Loch Arklet.	Loch Katrine.	Loch Achray.	Forfar Loch.	Loch Leven.	Duddingston Loch.	Loch Doon.	Loch Ness.	Loch Oich.	Loch Lochy.
OSTRACODA—*Continued.*											
Candona candida (Müller), -	x	x	x	x	x	x	x	x	-	-	-
,, *lactea*, Baird, - -	-	-	-	-	x	x	-	-	-	-	-
,, *rostrata*, B. & N., -	-	-	-	-	x	-	x	x	-	-	-
,, *kingsleii*, B. & R., -	-	x	x	x	x	x	x	x	-	-	-
,, *fabaeformis* (Fischer),	x	-	-	-	x	-	x	-	-	-	-
,, *acuminata* (Fischer),	x	-	-	-	-	-	-	-	-	-	-
,, *compressa* (Koch), -	x	-	-	-	-	x	-	-	-	-	-
,, *hyalina*, B. & R., -	x	x	x	-	-	-	-	x	-	-	-
Ilyocypris biplicata (Koch), -	-	-	-	-	x	x	x	-	-	-	-
Darwinula stevensoni, B. & R.,	x	-	-	-	-	-	-	-	-	-	-
Limnicythere inopinata, Baird, -	x	-	-	-	x	x	x	-	-	-	-
,, *sancti-patricii*, B. & R.,	-	-	-	-	-	x	-	-	-	-	-
Cytheridea lacustris, G. O. Sars,	x	-	-	-	-	x	-	-	-	-	-
CLADOCERA.											
Sida crystallina (Müller), -	x	x	x	x	-	x	-	x	x	x	-
Diaphanosoma brachyurum (Lievin),	-	-	-	-	-	-	-	-	x	x	-
Holopedium gibberum, Zaddach,	-	x	-	x	-	-	-	x	-	x	x
Ceriodaphnia reticulata (Jurine),	-	-	-	-	x	-	-	-	-	-	-
,, *laticaudata*, Müller,	-	-	-	-	x	-	x	-	-	-	-
,, *quadrangula*, Müller,	-	-	-	-	-	-	x	-	-	-	-
Scapholeberis mucronata, Müller,	*x	-	-	-	x	-	-	-	-	-	-
Simocephalus vetulus (Müller), -	x	-	-	-	x	x	x	x	-	-	-
Daphnia longispina, var. *aquilina*, Leydig,	-	x	-	-	-	-	-	-	-	-	-
,, *lacustris*, G. O. Sars, -	x	-	-	-	x	x	x	-	-	-	-
,, *galeata*, G. O. Sars, -	-	-	x	x	-	-	-	-	x	x	x
,, *longispina*, var. *nasuta*, G. O. Sars,	-	-	-	-	-	-	-	x	-	-	-
Bosmina longirostris (Müller), -	x	x	x	x	-	x	x	x	-	-	-
,. *longispina*, Leydig, -	x	-	x	x	-	x	-	x	x	x	x
Lathonura rectirostris (Müller),	-	-	-	x	-	-	-	x	-	-	-
Streblocercus minutus, G. O. Sars,	*x	-	-	-	-	-	-	-	-	-	-
Drepanothrix dentata (Euren), -	*x	x	-	x	-	-	-	x	-	-	-
Acantholeberis curvirostris (Müller),	*x	x	-	-	-	-	-	-	-	-	-
Ilyocryptus sordidus (Lievin), -	*x	x	-	x	x	x	-	x	-	-	-
Eurycercus lamellatus (Müller),	x	x	x	x	x	x	x	x	-	-	-
Acroperus harpæ, Baird, - -	x	x	x	x	-	x	x	x	-	-	-
Camptocercus rectirostris, Schœdler,	x	-	-	x	-	-	-	x	-	x	-
Alonopsis elongatus, G. O. Sars,	x	x	x	x	-	x	-	x	x	-	-
Leydigia quadrangularis (Leydig),	-	-	-	-	x	-	-	-	-	-	-
Graptoleberis testudinaria (Fischer),	-	x	-	-	-	-	-	x	-	-	-
Alona guttata, G. O. Sars, -	x	x	x	x	x	x	-	x	-	-	-
,, *tenuicaudis*, G. O. Sars, -	-	-	-	-	-	-	x	-	-	-	-
,, *costata*, G. O. Sars, -	x	-	-	-	-	-	-	-	-	-	-
,, *quadrangularis* (Müller),	x	-	x	x	x	x	x	x	-	-	-
,, *affinis* (Leydig), - -	x	-	x	x	x	x	-	x	-	x	-
,, *intermedia*, G. O. Sars, -	-	x	x	x	-	-	-	x	-	-	-
,, *rustica*, T. Scott, - -	x	x	-	x	-	-	-	x	-	-	-
Alonella exigua (Lilljeborg), -	x	x	x	x	-	x	-	x	-	-	-
,, *nana* (Baird), - -	*x	x	x	x	-	x	-	x	-	-	-

* These are not from Loch Lomond itself, but from the "Dhu Loch" alongside,

GENERAL LIST OF ALL THE SPECIES OF CRUSTACEA, &c.—*continued.*

Names of the Species.	Loch Lomond.	Loch Arklet.	Loch Katrine.	Loch Achray.	Forfar Loch.	Loch Leven.	Duddingston Loch.	Loch Doon.	Loch Ness.	Loch Oich.	Loch Lochy.
CLADOCERA—*Continued.*											
Pleuroxus trigonellus (Müller),	x	-	x	x	x	x	x	x	-	-	-
,, *uncinatus*, Baird, -	x	-	-	-	x	x	-	-	-	-	-
Harporhynchus falcatus, G. O. Sars,	x	x	x	x	-	-	-	x	-	-	-
Peracantha truncata (Müller), -	*x	x	x	x	-	-	-	x	-	-	-
Chydorus sphæricus (Müller), -	x	x	x	x	x	x	x	x	-	-	-
,, *globosus*, Baird, -	x	-	-	x	-	-	-	-	-	-	-
,, *cœlatus*, Schoedler, -	-	x	x	x	-	-	x	x	-	-	-
,, (?) *latus*, G. O. Sars, -	-	x	-	x	-	-	-	-	-	-	-
,, *barbatus* (Brady), -	x	x	x	x	-	x	-	x	-	-	-
,, (?) *ovalis*, Kurz, -	-	-	-	-	-	x	-	-	-	-	-
Monospilus tenuirostris (Fischer),	x	-	-	x	-	x	-	-	-	-	-
Polyphemus pediculus (Linn), -	x	x	x	-	-	-	-	-	x	x	x
Bythotrephes longimanus, Leydig,	x	x	x	x	-	x	-	x	x	x	x
Leptodora hyalina, Lilljeborg, -	x	x	x	x	-	x	-	x	x	x	x
MOLLUSCA.											
Sphærium corneum (Linné), -	-	-	-	-	x	-	-	-	-	-	-
Pisidium fontinale (Drap.) -	x	-	-	-	-	-	-	-	-	-	-
,, *pusillum*, Gmelin, -	-	-	-	x	x	-	-	-	-	-	-
,, *nitidum*, Jenyns, -	x	-	-	-	x	-	-	-	-	-	-
Anodonta cygnea, Linné, - -	-	-	-	-	x	-	-	-	-	-	-
Valvata piscinalis (Müller), -	x	-	-	-	x	-	-	-	-	-	-
,, *cristata*, Müller, - -	-	-	-	-	x	-	-	-	-	-	-
Planorbis nitidus, Müller, -	x	-	-	-	x	-	-	-	-	-	-
,, *nautileus* (Linné), -	-	-	-	-	x	-	-	-	-	-	-
,, *albus*, Müller, - -	x	-	-	x	x	-	-	-	-	-	-
,, *glaber*, Jeffreys, -	x	-	-	-	-	-	-	-	-	-	-
,, *contortus*, Linné, -	-	-	-	x	x	-	-	-	-	-	
Physa fontinalis (Linné), - -	x	-	-	-	x	-	-	-	-	-	
Limnæa peregra (Müller), -	x	-	-	x	x	-	-	-	-	-	
,, *palustris* (Müller), -	x	-	-	-	x	-	-	-	-	-	
,, *truncatula* (Müller), -	x	-	-	-	-	-	-	-	-	-	
Succinea putris (Linné), - -	-	-	-	-	x	-	-	-	-	-	

* These are not from Loch Lomond itself, but from the "Dhu Loch" alongside.

[TABLE

TABLE SHOWING THE TOTAL NUMBER OF SPECIES BELONGING TO THE THREE GROUPS OF THE ENTOMOSTRACA THAT HAVE BEEN OBSERVED IN THE DIFFERENT LOCHS.

Names of the Three Groups of the Entomostraca.	Names of the Lochs. Loch Lomond.	Loch Arklet.	Loch Katrine.	Loch Achray.	Forfar Loch.	Loch Leven.	Duddingston Loch.	Loch Doon.	Loch Ness.	Loch Oich.	Loch Lochy.
Copepoda, - - - - -	21	16	16	19	18	18	17	22	4	5	4
Ostracoda, - - - - -	16	7	7	9	18	20	15	10	-	-	-
Cladocera, - - - - -	32	25	22	30	14	23	11	29	8	10	6
Total number of Entomostraca from each Loch, - -	69	48	45	58	50	61	43	61	12	15	10

NOTES ON SOME OF THE SPECIES MENTIONED IN THE PREVIOUS LIST.

In these notes I propose to limit my remarks chiefly to the local distribution of the rarer species and to a few questions bearing on variation of form, but some of the more common species may also be referred to.

THE AMPHIPODA.—The Amphipoda represented in the gatherings from the lochs referred to in the preceding pages included only the common *Gammarus pulex*. *Gammarus duebeni* was not observed in any of them.

THE ISOPODA.—*Asellus aquaticus* was the only Isopod observed.

THE COPEPODA.—Thirty-one species of Copepoda have been identified in the various gatherings, and several of them—as *Diaptomus gracilis*, *Cyclops strenuus*, *Cyclops serrulatus*, and *Canthocamptus staphylinus*—appear to be more or less common and generally distributed. *Diaptomus gracilis* and *Cyclops strenuus* occurred in nearly all the lochs examined, as well as on each of the dates that the lochs were visited. The following are a few of the rarer species noticed :—

Cyclops leuckarti.—The only loch of the present series in which *C. leuckarti* was observed was Loch Lomond. It has, however, been obtained in a few other lochs in Scotland, and has already been referred to in a recent Report.

Cyclops dybowskii, Lande.—This *Cyclops* has only been observed in Loch Lomond, and it was observed in only one of the gatherings, but in that one it was moderately frequent. *C. dybowskii* comes very near *C. oithonoides*, G. O. Sars, and may only be a form of that species.

Cyclops bicuspidatus.—This distinct species was observed in several of the lochs examined. Two of its more obvious characters seem to be the elongate secondary branches of the fifth pair of thoracic feet, and the elongate caudal furca, in which the exterior marginal seta has a position nearly midway between the base and apex of each furcal segment.

Cyclops vernalis and *Cyclops bisetosus* were also observed in a few of the lochs examined. *C. bisetosus* is a distinctly smaller *Cyclops* than the other; in structure *C. bisetosus* seems to occupy an intermediate position between *C. bicuspidatus* and *C. vernalis*.

Cyclops languidus and *Cyclops nanus*.—The first of these two Copepods was only observed in Loch Doon, but the other has been obtained both in Loch Doon and Loch Lomond, thus indicating by the difference in the altitude and position of these two lochs that it may have a moderately extensive distribution in Scotland. Dr. Schmeil is inclined to regard both these *Cyclops* as forms of *Cyclops vernalis*. *Cyclops nanus* is a very small species with eleven-jointed antennules; several specimens carrying ova were observed amongst the representatives of this species in Loch Doon. With regard to *C. languidus*, the character that first attracted attention was the structure of the antennules, which were found to be sixteen-jointed.

Cyclops macrurus.—This appears to be a moderately scarce species. It was observed in only two of the series of lochs under consideration—viz., Loch Arklet and Loch Leven.

Cyclops affinis was observed only in the Dhu Loch (close to Loch Lomond). It appears to be rare in the lochs of Scotland.

Cyclops phaleratus.—This species is recorded from only two of the present series of lochs—Forfar Loch and Duddingston Loch. Ova-bearing specimens of all these species have been observed and examined. In the preparation of lists such as these it is often preferable to defer recording a species till ova-bearing specimens can be obtained, as there is always more or less risk of error in the discrimination of immature forms.

Diaptomus gracilis has already been referred to as one of the more generally diffused and common of the fresh-water Copepoda, but two other species of *Diaptomus* have been observed which are less common, and these may now be referred to:—

Diaptomus laciniatus.—Loch Doon is the only loch in which this species has been obtained. If it be safe to judge of its distribution by what has been observed in regard to its occurrence in that loch, *D. laciniatus* seems to be more affected by seasonal changes than some other of the fresh-water species. A number of specimens were obtained in a gathering collected in September 1897, but in those collected in December 1897 and March 1898 not a single specimen was observed. When subsequently in the month of July following the loch was again tow-netted, *Diaptomus laciniatus* was found to be moderately common. Professor G. S. Brady has recorded a *Diaptomus* from Ireland which may probably belong to the same species, and, curiously enough, the loch in which this Irish *Diaptomus* was discovered is also called Loch Doon. This species is quite distinct from any other British *Diaptomus* by having the last two segments of the thorax curiously produced at the sides.

On Plate XIII., figure 1 represents an adult female; figure 2 shows one of the fifth pair of thoracic feet of the same specimen; figure 3 represents one of the fifth pair in the male; and figure 4 shows the last three joints of the right antennule of the male.

Diaptomus hircus, Brady, var.—A *Diaptomus*, frequent in Loch Ness, Loch Oich, and Loch Lochy, which appears to represent one of several forms which agree in having a more or less close relationship with *Diaptomus salinus*, Daday. There is a certain uniformity of structure in the fifth thoracic feet of the males of this group which indicates their relationship, but there is also a certain diversity between the different forms composing it, which, if it were constant, might constitute a satisfactory basis for the separation of the various forms and for distinguishing the one from the other. It appears, however, that this diversity is not constant. Specimens are met with in which the characters of different forms seem to blend; so that it is sometimes difficult to decide as to the species to which they should be ascribed. It also lends support to the opinion that after all these various forms, as in the case of certain *Daphniæ* to be referred to later on, may be but modifications of one variable type. For the present I am inclined to ascribe the *Diaptomi* from the three lochs mentioned to *Diaptomus hircus*, Brady, as being the species to which they are most closely related, though differing in one or two points. For example, the appendage at the end of the third-last joint of the right male antennule is not fimbriated; the protopodite of the left foot of the fifth pair in the male wants the finger-like hyaline appendage on the inner margin; and the last joint of the outer branches of the same pair of feet in the female is furnished with two sub-equal setæ: these characters appear, however, to be more or less variable. A somewhat similar form of *Diaptomus* was obtained sparingly in Loch Katrine. Figure 5 on Plate XIII. represents one of the Loch Oich specimens. It measured fully one and a half millimetres in length. Figures 6 and 7 represent one of the fifth pair of feet of the female and the male fifth pair; and figure 8 shows the last three joints of the male right antennule.

Diaptomus wierzejskii, Richard.—One or two specimens, apparently belonging to this form, were obtained in Loch Achray, but the species appears to be very rare. One of the more obvious characters of this *Diaptomus* is the moderately large and serrated appendage at the end of the third-last joint of the right antennule of the male. *D. wierzejskii* is considered to be identical with *D. serricornis*, Lilljeborg, but there seems to be some difference of opinion as to which of the two names should take precedence. Professor G. S. Brady has given the preference to Lilljeborg's name,* but Dr. O. Schmeil † has shown that though the two names were published within a very short time of one another, Richard's was really the first in the field. Both names were published in the same year and in the same volume, Richard's at page 53 and Lilljeborg's at page 157. *D. wierzejskii* is one of the *Diaptomus salinus* group.

The Harpacticidæ.—Among the Harpacticidæ observed in the different lochs there are a few that may be specially referred to here:—

Canthocamptus minutus, Claus, though only recorded within recent years as a member of the British fresh-water fauna, is apparently a widely-distributed species in Britain. It was observed in each of the eight lochs composing the first series of those now under discussion.

Canthocamptus inornatus, a species described in one of the recent reports of the Fishery Board, has had its distribution still further extended by these researches. It was observed in four of the present series of lochs.

Canthocamptus schmeilii, Mrázek.—This interesting species, which was observed for the first time in Britain in Loch Leven, and some time

* Revision of the British Fresh-water Cyclopidæ and Calanidæ, p. 36 (1891).
† Deutschlands freilebende Süsswasser—Copepoden, Part III., p. 55 (1896).

afterwards was obtained in Park Loch, near Campbeltown (Cantyre), has now also been obtained in Loch Lomond. It occurred in the shore gathering collected between Balmaha and the mouth of the Endrick Water. In this gathering it was somewhat rare.

Canthocamptus hirticornis.—This also was obtained in Loch Lomond in nearly the same locality as the last, but at a somewhat later date. *C. hirticornis* is sometimes observed in water that is more or less brackish.

Attheyella duthiei.—This Harpactid was described from Shetland specimens, but was subsequently discovered in a shore gathering of Entomostraca from Loch Leven, Kinross. This somewhat rare species was again observed in two of the shore gatherings from Loch Leven collected during the recent investigations.

Moraria brevipes (G. O. Sars), which is a somewhat rare species in the lochs of Scotland, was observed in Loch Achray and Loch Doon, but appeared to be scarce in both lochs.

Maraenobiotus vejdovskii, Mrázek.—This small *Moraria*-like species was a few years ago added to the British fauna from specimens obtained in Loch Vennachar. I have now to record its occurrence in another Scottish loch—viz., in Loch Doon. It was observed in a shore gathering from that loch collected in December 1897. In *Maraenobiotus* the mandible-palp is almost obsolete, and in this respect it differs both from *Mesochra* and *Moraria*, which possess a moderately developed one-branched mandible-palp.

The species that compose the genus *Canthocamptus* appear to be a rather heterogeneous lot, and there seems to be good reason for not only removing some of them to Dr. Brady's genus *Attheyella*, but for a still further subdivision of the group.

THE OSTRACODA.—A few of the Ostracods obtained during the recent investigations may now be referred to:—

Cypria exsculpta, Fischer.—This, which is one of a small group of laterally compressed Ostracods, differs from the more common *Cypria compressa* by having its shell ornamented with fine, close-set striæ. Though observed in four of the lochs it is less common than some of the other species.

Cypris obliqua, Brady.—This fine and distinct species has a moderately wide distribution, but is not very common. It has been obtained in only two of the lochs examined.

Cypris incongruens, Ramd.—This Ostracod appears to be local and erratic in its distribution, occurring in some places in the greatest abundance, while in localities that appear to be equally favourable not a trace of it is to be found. On one occasion the species was observed in great plenty on the surface of some mud that had collected in the bottom of a large tank situated on the top of a sugar refinery in Greenock. How they got there is a mystery, as the only water that the tank contained was supplied by the clouds.

Cypris pubera, Müller.—This is one of the largest, if not the largest, of the British Ostracods. It occurred in only two of the lochs under consideration—viz., Forfar Loch and Duddingston Loch. An interesting point in the distribution is that it does not appear to have yet been observed in any of the lochs on the west side of Scotland, though it has been observed in a few on the east side.

Herpetocypris strigata, Müller.—This, which is also a fine and large species, appears to be somewhat restricted in its distribution. It was during the present investigations observed only in Loch Leven and Duddingston Loch.

Ilyodromus olivaceus, B. and N.—The distribution of this species appears to be also very restricted, though it may not be rare where it does occur. Like *Cypris pubera*, it was obtained in Forfar Loch and in Duddingston Loch. It may be of interest to refer to a somewhat curious feature in the distribution of the two Ostracods *Herpetocypris strigata* and *Ilyodromus olivaceus* as regards their occurrence at Duddingston Loch. On the north-west shore of that loch—the part of the shore which is accessible to the public—there are several large boulders, and at the foot of one of them which is situated two or three yards back from the edge of the water, the soil has been excavated to a small depth along the front side, either by the feet of people who are wont to use the boulder as a seat, or by children digging about it. This hollow and the ground all round the boulder is dry and hard for two or three months during summer; but from late autumn to spring the hollow is full of water which percolates into it from the rising ground behind. Yet in this hollow, which in summer is baked by the sun and trampled hard by the feet of people who use the boulder as a resting-place, and where it is difficult to conceive how anything could retain its vitality, I have found, year after year, in the early winter and spring, a considerable abundance of *Herpetocypris strigata*, together with a certain admixture of *Ilyodromus olivaceus*. These are the only two species which I can remember having observed at this place; and it often puzzled me to find out how they were able to survive the heat and drought of summer. Probably all the adults perish, but the ova will be better able to resist the extreme conditions to which they are exposed during the summer months. The two Ostracods referred to, though more or less common here, are seldom obtained in the loch itself.

Ilyodromus robertsoni, B. and N.—A number of specimens of this comparatively rare species were obtained in Loch Doon. Its distribution, so far as known, appears to be restricted to a few lochs in Scotland. *Herpetocypris strigata*, *Ilyodromus robertsoni*, and *Ilyodromus olivaceus* show a certain gradation of form which is somewhat difficult to describe clearly; but when actual specimens are compared, the one with the other, there is not much trouble in discriminating the different species.

Cyprois flava, Zadd.—Duddingston Loch appears still to be the only loch in Britain in which this species certainly exists, and it is interesting to find that the *Cyprois* is restricted to a comparatively small portion of the west end of the loch. Moreover, the species is not found, except, perhaps, rarely, in the loch itself, but in little pools in the marshy ground outside the extensive mass of tall reeds that fringe the shore at this part. At my last visit to Duddingston Loch I obtained specimens of the *Cyprois* at the same part at which it was found a good many years ago.

Candona acuminata, Fischer.—Specimens of this somewhat rare Ostracod were obtained in Loch Lomond, along with *Candona falcæformis* and one or two other species.

Candona hyalina, B. and R.—This *Candona* has been known for a considerable number of years, but there was for a time some uncertainty as to whether it were really distinct, or simply a form of some other species. Now, however, there seems to be little doubt as to its being a "good" species. *Candona hyalina* was obtained in four of the lochs recently examined—Loch Lomond, Loch Arklet, Loch Katrine, and Loch Doon.

Darwinula stevensoni, B. and R.—This curious and somewhat rate Ostracod was observed in only one loch—viz., Loch Lomond—and was scarce in the only gathering in which it occurred.

Cytheridea lacustris, G. O. Sars.—Loch Lomond was one of the two lochs in which this species was observed. *C. lacustris* has already been recorded for Loch Lomond by Professor G. S. Brady and the late Dr. Robertson, but it is a species that is not very generally distributed. Its occurrence in Loch Leven has also been previously recorded.

The Cladocera.—A number of species of Cladocera that are more or less interesting because of their rarity, their restricted distribution, or their remarkable tendency to variation, will now be referred to:—

Sida crystallina, Müller.—This fine species was obtained in eight of the lochs examined.

Diaphanosoma brachyurum, Lievin.—*Daphnella*—the name by which this Cladoceran was known from Dr. Baird's time on till recent years, is now replaced by the somewhat clumsy appellation of *Diaphanosoma.* The representatives of this genus, which occurred in two of the lochs examined, appear all to belong to the form previously known as *Daphnella brachyura.*

Holopedidæ.

Holopedium gibberum, Zaddach.—This curious species was observed in five of the lochs, and in all of them it appeared to be more susceptible to seasonal changes than any of the other Entomostracan species. Though common or plentiful in the summer or autumn months, it seemed to disappear entirely during winter.

Daphnidæ.

Ceriodaphnia laticaudata, P. E. Müller.—This somewhat rare species was obtained in Forfar Loch in a shore gathering, and *C. reticulata* occurred in the same loch, but in gatherings collected by tow-net.

Ceriodaphnia quadrangula (O. F. Müller) was observed in tow-net gatherings from Duddingston Loch. Figure 55 on Plate VII. represents one of the Duddingston Loch specimens, and figure 23, Plate XIII., represents the post-abdomen of the same specimen.

Scapholeberis mucronata, O. F. Müller.—This somewhat rare Cladoceran occurred in two of the lochs examined—the Dhu Loch (close by Loch Lomond) and in Forfar Loch, but it appeared to be somewhat scarce in both of them.

Daphniæ sp. (Plate VII., figures 1-54.)

The *Daphniæ* obtained during the recent investigations have shown in some instances a considerable diversity of form, which it may be of interest to refer to somewhat in detail; and, in order to avoid as far as possible confusing one thing with another, I will consider separately the *Daphniæ* observed in each of the lochs, with remarks, where necessary, on the relationship of the various forms observed.

The study of these organisms has been more difficult than that of some of the other groups owing to the diversity of opinion that exists as to what forms should be considered "species" and what "varieties." In some instances the tendency to variation is so great that though extreme forms when compared directly with each other seem to be "good" species, yet gradations between them may be met with, which prove more or less clearly that the two extreme forms are merely "forms" of one species; this tendency to variation, which is specially evident in *Daphniæ* from some of the lochs recently examined, makes their study both interesting and perplexing. In my notes of the *Daphniæ* of the different lochs, I will be guided to some extent by Professor G. S. Brady's "Revision of the British Species of *Daphnia* and other Allied Genera," and the same order will be observed here in dealing with the lochs as is observed in the former part of this paper.

It may be remarked further that the *Daphniæ* with crested heads (so common in some of the lochs of the middle and north of Scotland, and which have been recognised as identical with Professor G. O. Sars' *Daphnia galeata*) have, in several of my previous papers on the invertebrate fauna of the inland waters of Scotland, been ascribed to *Daphnia jardinii* of Baird, because it seemed to me that Dr. Baird's short definition of his species (published in the *Edinburgh New Philosophical Journal*, 1857) was quite applicable to some of the forms of this variable species. Dr. Brady and also Professor G. O. Sars appear, however, to regard *Daphnia galeata* and *Daphnia jardinii* as distinct; yet, as *Daphnia galeata* shows so great a tendency to variation, it will not be very surprising if the form to which Dr. Baird's name has been restricted should, after all, prove to be but another variety of Sars' species, the product of some peculiarity in the environment, *i.e.*, a slight difference in the chemical properties of the water, or in the general temperature, or in the food supply. But questions such as these can only be satisfactorily solved by a careful and systematic study of the life-history of the organisms concerned, and that can scarcely be done except in a properly-equipped laboratory.

It might be useful if names were given to even a greater number of the remarkable forms of such a protean species as *Daphnia galeata* than has yet been done. A number of the prominent varieties of this form will be referred to when we come to discuss the *Daphniæ* of Loch Ness, Loch Oich, and Loch Lochy. Meantime, I go on to consider briefly one or two points concerning the *Daphniæ* observed in Loch Lomond. The *Daphniæ* of the other lochs will be referred to in their order.

The Loch Lomond *Daphniæ*. (Plate VII., figures 34, 35, 51.)

All the *Daphniæ* contained in the various gatherings from this loch appear to belong to the one species—*Daphnia lacustris*, G. O. Sars. Professor G. S. Brady, who kindly examined some of the specimens from this loch, considered them to belong to that species. A few of the Loch Lomond specimens present what appears to be an interesting departure from the normal form of *D. lacustris.* The adult female, according to the description of the species, has no tooth on the top of the head or even on the dorsal aspect near the top. "The presence of a vertex tooth is a character of the young only, but disappears altogether in the adult."* Among the Loch Lomond specimens collected near Balmaha there are a few adult females—or, at any rate, females carrying *pseudova*—which are furnished with a distinct tooth near the top of the head and a little towards the dorsal aspect; one of the specimens is represented by figure 34, Plate VII.† This specimen is, with the exception of the tooth, similar to the more common form without a tooth, of which figure 35 is an example. It is not uncommon to find young *Daphniæ* provided with a tooth; but the present specimen is of more interest seeing that it is apparently an adult female. Another female with *pseudova* has the tooth bidentate (figure 34A). The toothed form appears to be rare in Loch Lomond, the other with the evenly-rounded head being the more common one. No male *Daphniæ* were observed in this loch.

The *Daphniæ* of Loch Arklet. (Plate VII., figures 40, 45, 45A.)

The Loch Arklet *Daphniæ* has been identified by Professor Brady as *Daphnia longispina*, O. F. Müller, and as probably belonging to the variety *aquilina*, G. O. Sars. Professor Sars, however, describes his variety as a variety of *D. lacustris*, and it would almost seem as if that were the more probable relationship. I have already stated that the Loch Lomond *Daphnia* has been identified as *D. lacustris*; and if, in connection with that, it is remembered that the overflow water from Loch Arklet falls into Loch Lomond, it is not unreasonable to suppose that the *Daphniæ* of the two lochs should be more or less closely related. There is, no doubt, a certain amount of difference between the typical Loch Arklet female *Daphnia* and the typical Loch Lomond female; but it is a difference which might be produced by the difference in the habitat of the two forms. The most obvious difference between the *Daphniæ* of the two lochs is in the contour of the heads of the females. In the Loch Arklet female the dorsal curve of the head is not so bold as in that of the female from Loch Lomond, and the head is also proportionally somewhat shorter when compared with the entire length of the body, as shown by the figures (figures 35 and 40). In the specimen figured (figure 40) the number of preanal spines is fourteen, and the post-abdominal processes are small (figure 45). In another and slightly larger specimen the preanal spines number sixteen, and the processes are moderately elongate (figure 45A). It may also be remarked that an adult female *Daphnia* from Loch Lomond carried fourteen preanal spines and possessed long post-abdominal processes—both of which characters are by no means uncommon among the Loch Lomond *Daphniæ*—thus indicating still more clearly the relationship of the *Daphniæ* of the two lochs.

The *Daphniæ* of Loch Katrine.

The *Daphniæ* observed in Loch Katrine belong to *D. galeata*, G. O. Sars. They did not exhibit such a variety of form as those of the same species from some of the other lochs which will be referred to, but resembled generally the form represented by figure 10, Plate VII. No male *Daphnia* were observed in this loch.

* "Revision of the British Species of Daphnia" (p. 232).

† This is probably the form described by Dr. Richard in his Revision des Cladocères (Ann. d. sc. Nat. Zool., 1896, p. 307, pl. xxiv., fig. 4) as *Daphnia lacustris*, var. *vicina*. Dr. Richard's specimens of this variety, which were obtained in Loch Leven Kinross are considered by Dr. Brady to be merely the young of the species named; whether that be so or not, there can be no doubt that the form referred to here as possessing a vertex tooth is to all intents and purposes "adult"

The *Daphniæ* of Loch Achray. (Plate VII., figures 22, 53.)

Loch Achray, as already stated, receives most of its supply of water from Loch Katrine, and probably the *Daphniæ* found in it have been introduced with the water from that loch. They belong to the same species, but exhibit, perhaps, somewhat greater variation. It is interesting to note that the *Daphniæ* of Loch Vennachar—which receives the overflow water from Loch Achray—appear to belong to *Daphnia galeata.* Though hundreds of specimens from each of the three lochs—Loch Katrine, Loch Achray, and Loch Vennachar—have been examined, none were observed that could satisfactorily be ascribed to any other species than the one named. This circumstance seems to favour the opinion that the Loch Arklet and Loch Lomond *Daphniæ* are but forms of the one species—viz., of *Daphnia lacustris.*

A few male *Daphniæ* were observed in the Loch Achray gatherings, and one of them is represented by figure 22.

The *Daphniæ* of Forfar Loch. (Plate VII., figures 23-28, 49.)

In this loch the *Daphniæ*, which were very plentiful, appeared all to belong to the one species—*D. lacustris.* A considerable proportion of the young were furnished with a tooth on or near the top of the head, as shown by figure 24; while the usual form of the adult females contained in the different gatherings is that represented by figure 23. A certain amount of variation was observed. This variation included a slight difference in the form of the head and in the length of the posterior spine; figures 25, 26, and 27 represent a few of these differences. The specimen represented by figure 26 has a very short posterior spine; while in that represented by figure 27 the spine is obsolete. It will also be observed that figures 25 and 26 are ephippial females which possess a distinct bulge at the base of the posterior spine—a feature which is said to be characteristic of *Daphnia longispina.* Moreover, the usual number of preanal spines in the adult females is thirteen, but the number varies in some specimens to twelve and fourteen; the abdominal processes in many of the specimens are also comparatively short (figure 49). In fact, the Forfar Loch *Daphniæ* possess characters which seem to indicate a relationship with *D. longispina*, whilst others show as distinct an affinity to *D. lacustris.* Figure 28 represents one of the male *Daphniæ* observed in Forfar Loch. It has in many cases been noticed that the young *Daphnia*, when about to leave the protection of the parent, has no tooth on the head. A tooth appears, however, to be developed at a very early stage in the growth of the specimens, and to be lost before maturity is reached. No adults furnished with a tooth have been observed among the Forfar Loch *Daphniæ*; the tooth observed on the young was usually bidentate.

The Loch Leven *Daphniæ.* (Plate VII., figures 29–33.)

Loch Leven is another of the lochs recently examined in which *Daphniæ* are very abundant. In my paper on the invertebrates of this loch (published in the Ninth Annual Report of the Fishery Board), I ascribed the Loch Leven *Daphnia* to *D. longispina*, but they are now referred to *D. lacustris;* it is really doubtful, however, if there is a single character that can be laid hold of that is not, under varying conditions, common to both. After the examination of many hundreds of specimens there is only one mark which may be considered as belonging to *D. lacustris*—viz., the presence in the young of a tooth on or near the top of the head. Yet even this is a doubtful character; for specimens may be obtained in this loch both with and without the tooth which are otherwise identical (figures 32, 33). Figure 29 represents a very common form among the Loch Leven *Daphniæ*; while figures 30 and 31 represent specimens in which the posterior spine is almost or altogether obsolete. A few males were observed in the gatherings from this loch collected in December.

The *Daphniæ* of Duddingston Loch. (Plate VII., figures 41–44, 44A, 46, 54.)

Daphnia hyalina, var. *pellucida*, P. E. Müller, is recorded by Dr. Brady from Duddingston Loch, which appears to be the only loch in Britain where this variety has been observed. As the distribution of this form appears to be so restricted, the following description of the female, transcribed from Dr. Brady's *Revision* already referred to, may be of interest:—

"*Female.*—Outline as seen from the side subovate, with a very long, slender, and slightly curved spine. Head occupying about one-third of the length of the body, well-rounded in front, ventral margin straight or very slightly sinuated, and terminating in a slightly produced beak; dorsal border of the shell forming a continuous very gentle curve, somewhat flattened in the middle; ventral margin rather boldly convex. The post-abdominal spines are slender and simple, except for a fringe of excessively delicate setæ, progressively increasing in size from behind backwards; dorsal abdominal processes obsolete. Eye rather large, placed near the centre of the head; between it and the rostrum is generally visible a minute eye-spot. Shell often very distinctly chequered; in other cases nothing but a granulated structure is visible. Length, 1·8mm.; height, ·9mm."

During the four occasions on which Duddingston Loch was examined no satisfactory examples of the variety described above were observed. The *Daphniæ* that were collected showed a certain amount of variation in the general outline, in the length of the posterior spine, in the number of preanal teeth on the post-abdomen, and in the development of the post-abdominal processes. Some of the more or less immature specimens resembled somewhat the variety described by P. E. Müller, but the most common appearance assumed by the adult female is that represented by figure 41. The post-abdomen of this specimen is shown by figure 46. The length of this specimen, exclusive of the posterior spine, is about 1·9mm.; but it measures, including the spine, 2·5mm. The head is a very little more than a fourth of the total length of the body. The preanal spines are ten, but in some specimens they amount to fourteen. The abdominal processes are moderately developed, and the post-abdominal claws are similar to those of *D. lacustris* or *D. longispina.* I have not, so far, observed any of the young with a vertex tooth. Male specimens were not very rare in the gathering collected in September last, and one of them is represented by figure 43. Had the young been furnished with a vertex tooth, I would have been inclined to ascribe the Duddingston Loch *Daphnia* captured in our tow-nets to *D. lacustris*; but as no young possessing such a tooth have been observed, the species with which they most closely agree is *D. longispina.* Figure 44 represents the head of a not very mature specimen, and figure 44A its abdominal processes.

The Loch Doon *Daphniæ.* (Plate VII., figures 36, 39, 50.)

The *Daphniæ* of this loch are of a somewhat peculiar form that appears to be identical with *Daphnia longispina*, var. *nasuta*, G. O. Sars. Loch Doon appears to be the only British loch in which this variety has been observed. It is the only *Daphnia* that I have noticed in the Loch Doon gatherings, and in one or two of them it was moderately common. A slight variation is observable in some of the specimens, especially in the contour of the head, but otherwise the form is a very constant one. Figure 36 represents one of the more common forms. The head, seen from the side, is narrowed anteriorly, and the ventral margin is slightly convex, but more distinctly so immediately anterior to the beak. The dorsal margin is boldly curved anteriorly; it then extends in a nearly-straight line to a little beyond the middle of the body, and thence curves gently to the base of the posterior spine. The ventral margin from the beak to the base of the posterior spine is prominently arcuate. The head is equal to about a fourth part of the entire length of the body. The posterior spine is of moderate length, but the length varies somewhat in different specimens. The specimen represented by figure 37 is somewhat larger than the one just referred to, and has the front and dorsal margins of the head slightly concave. A male specimen which has the head more evenly rounded, and possesses a longer posterior spine, is represented by figure 38. The preanal spines of the post-abdomen figured (fig. 50), which is that of a female, number thirteen; but the number varies to a small extent in different specimens. The terminal claws are slender and of moderate length; and the abdominal processes, which in the specimen figured (fig. 50) are moderately developed, have also a slight tendency to variation. Figure 39 shows a front view of a male specimen.

The *Daphniæ* of Loch Ness, Loch Oich, and Loch Lochy.
(Plate VII., figures 1–21, 47, 48, 52.)

The *Daphniæ* observed in these three lochs, though exceedingly variable in form, appear all to be referable to the one species—*D. galeata.* Figure 1, which represents one of the largest and finest of the forms observed in Loch Oich, measured about 3·4mm. (fully $\frac{1}{8}$th of an inch) in length. This is a common form in Loch Oich, but there are quite a number of variations. Figures 2 and 3 represent two of these variations in which the crest, though pointing forward as in figure 1, is scarcely so much produced; while in figure 3 the beak is more produced than it is in figures 1 and 2. In figures 5 to 8, which represent other variations, the crest assumes a more or less upright position. In figure 6 the head has the form of an equilateral triangle. In figure 4, on the other hand, the beak is somewhat prominent, but the head has lost its pointed form and becomes somewhat rounded. Figures 18 to 20 represent another set of variations in which, though the head be somewhat similar to that shown by figures 1 to 3, the posterior spine is either very short or obsolete. All the figures just referred to were prepared from Loch Oich specimens and represent adult females, *i.e.*, females with pseudova or embryos, or in which an ephippium was in process of development. Figure 17 represents a Loch Oich male. Many of these were examined; but while variation among the females was almost unlimited, there was very little variety of form observed among the males; and in no case was a male specimen observed with a rounded head. Every one of the specimens noticed was furnished with a pointed crest; even the immature specimens possessed it. Where any difference was observed among these male specimens, it was limited very much to the prominence in front of the eye being more arcuate in some than in others.

In figures 11 to 16 a somewhat different group of variations is represented; these figures were prepared from Loch Ness and Loch Lochy specimens. In the Loch Oich *Daphniæ* the predominant type of head, whether it be acutely or bluntly crested, and whether the crest be upright or inclined, is in its general outline more or less triangular; whereas the usual form of head met with among the Loch Ness and Loch Lochy *Daphniæ* is more or less flat and rounded, and where a crest is developed it usually starts more or less abruptly from the broadly rounded head; figures 11 and 12 may be cited as examples. There is, of course, some overlapping of the variations in the several lochs; still it seems to be the case that while in Loch Oich the triangular and gradually tapering form of head is the more general form, the broadly rounded and abruptly apiculate head is more typical of the *Daphniæ* of Loch Ness and Loch Lochy. These differences, however, have only been observed amongst the females. The males that have been observed in Loch Ness and Loch Lochy are identical in form with those observed in Loch Oich; and the remarks on the variations noticed in the males of that loch are equally applicable to those of the other two. It may be added that figures 15 and 16 represent forms closely resembling that on Plate IX. of Dr. Brady's "Revision" already referred to, and described by him as *D. galeata* var. *obtusifrons*, G. O. Sars; but Dr. Brady, referring to this variety, says: "I can scarcely think that this form is a permanent one, or that it represents more than a transitory condition." Still the distinguishing by name of the different gradations observed should be useful for reference. It is by no means singular that there should be some difference between the forms of individuals from Loch Ness and Loch Lochy and those from Loch Oich, when the physical conditions of Loch Oich are taken into account, and when they are compared with those of the other two lochs. Loch Oich is comparatively a small loch; its average depth is considerably less than that of the other two; and it is also more sheltered. Moreover, its surface is broken up by several small islands and headlands, and its range of temperature is greater. All these differences will doubtless react to some extent on the fauna—at least, on the pelagic fauna—of the loch; and those organisms that are more readily affected by such differences will exhibit variations more or less obvious. And if, taking into account the physical contrasts referred to, the occurrence of certain modifications in the form of those organisms more readily affected by such differences should not be considered remarkable, neither need it be considered strange that the *Daphniæ* of these lochs, and especially of Loch Oich and Loch Ness, should belong to the same species; for the direct overflow of Loch Oich by the River Oich is into Loch Ness, and therefore a more or less close identity of species may reasonably be expected to exist between them. Another point that should be remembered is that a considerable amount of Loch Oich water finds its way into Loch Lochy by means of the canal; but how far this may have an influence in equalising the fauna of these two lochs may be a somewhat more difficult question to solve. It is very probable, however, that the continual daily movement of Loch Oich water south-westward into Loch Lochy *via* the canal will have a tendency to transport some, at least, of the free-swimming forms from the one loch to the other, and thus extend the distribution of such species.

There is still another point that may be noticed before passing on from the consideration of the *Daphniæ* of these lochs. Glen Garry, which extends in a nearly east and west direction, terminates at Loch Oich, and the River Garry, which flows through the glen, empties itself into that loch. This river passes in its course through two small lochs—Loch Quoich, near the west end of the glen, and Loch Garry, near the east end. Indeed, one would not be far wrong in considering these lochs as being merely expansions of the river. Now, reasoning by analogy, one would be inclined to presume that the *Daphniæ* of these Glen Garry lochs would very likely belong to the same species as those of Loch Oich and Loch Ness—and we have no reason to suppose that they are not the same species. I am aware that some specimens of *Daphnia* which the Rev. A. M. Norman collected in Loch Garry have been ascribed to a different genus and species (*Hyalodaphnia kahlbergensis*, Schœdler); but Dr. Brady, while so far recognising this identification, refers to the characters relied upon for the discrimination of this form as being "very doubtful," and adds: "Some of the helmeted forms—as, for instance, *D. galeata*—have always a small, though distinct, eye-spot, but are in other respects so closely similar to *D. kahlbergensis* as to be with difficulty distinguished. Under these circumstances Schœdler's generic name seems of questionable value, and it may even be doubted whether all the members of the helmeted group should not be looked upon as mere varieties of one very protean species." Had Loch Garry been entirely separated from Loch Oich (as Lough Erne is from Melvin Lough in Ireland, whence some helmeted specimens have been sent to Professor Brady), there would have been more reasonableness in the supposition that the *Daphniæ* of the two lochs were more or less distinct. However, seeing that a considerable stream of water passes through Loch Garry, and after a course of a few miles falls into Loch Oich, and also that *Daphniæ* are decidedly pelagic in their habits, and therefore liable to be transported from one loch to another—especially when lochs and rivers are in flood—it will be of considerable interest if it can be satisfactorily proved that a species of *Daphnia* exists in this small Glen Garry loch distinctly different from that observed in Loch Oich. I am rather inclined to think that if a large series of the Loch Garry specimens were examined, as has been done in the case of Loch Oich, they would be found to be specifically identical with those of that loch.

But the more interesting points in any discussion on the *Daphniæ* of these lochs are not so much questions as to whether certain modifications should be regarded as being of specific or non-specific value, for the great tendency to variation exhibited by this particular group of organisms is so great, scarcely any of the several characters that have at one time or another been selected as affording a means for discriminating between the different forms can be relied upon as satisfactory; hence what may be regarded as a species or a variety is, in not a few cases, simply a matter of opinion. A more interesting point is the striking evidence which these variations furnish of the apparent susceptibility of *Daphniæ* to the influence of the changes that may occur in their environment. Another point, and one which has already been touched upon, is whether the various forms of *Daphnia* living in the same loch, or in a series of lochs of limited extent and communicating directly the one with the other—as Loch Katrine, Loch Achray, and Loch Vennachar—should all be considered forms of one species; or whether there is satisfactory proof that two or more species of *Daphnia* may be, or have been, obtained under such conditions. It is possible that in the large fresh-water lakes of Continental Europe—lakes which, when compared with the lochs of Scotland, might almost be denominated inland seas—more than one species of *Daphnia* is to be found; but in the examination of the Scottish fresh-water lochs, which has now been carried on for several years, I have so far obtained no satisfactory evidence to show that more than the one species is to be found in the one loch, or in a series of lochs directly connected with each other as in the example cited above.

The figures of *Daphnia* on Plate IV. represent female specimens carrying *pseudova* or embryos, or which are developing ephippia, except where otherwise stated. It is not pretended, however, that the specimens are all equally mature. *Daphniæ* begin to bear *pseudova* at a comparatively early stage of development, and may, in the course of subsequent stages, become altered in form; they may develop larger abdominal processes, and the number of preanal spines may be increased. All this emphasises the need for extra carefulness, in dealing with such forms, not to place undue value on characters so unstable as these are.

As regards seasonal distribution, *Daphnia* seems to be less affected by the changes incidental to the different seasons than some of the other entomostracan species appear to be. In the larger lochs the variation of these organisms in regard to number was found to be usually very little for the different seasons; and even in lochs of less dimensions—as Forfar Loch, Loch Leven, and Duddingston Loch—the *Daphniæ*, though somewhat less numerous in winter than in summer, were still comparatively common. But while the distribution of *Daphnia* is fairly constant in large sheets of water and even in lochs of moderate size, it is sometimes different in the case of small bodies of water. In ponds, tarns, etc., *Daphniæ* occasionally exhibit some curious vagaries in regard to their distribution. Prolonged dry or wet weather causes greater extremes in the quantity of water present in such ponds and tarns than it does in the larger lochs, and to this probably is due the erratic distribution referred to.* The following is a brief narration of an example of this erratic distribution of *Daphnia* which last year came under my own observation. Some time during the summer of last year I was informed by a friend that Entomostraca were common in an artificial pond in the vicinity of Edinburgh. I visited the pond on 3rd July and found *Daphnia pulex* abundant. Many of them were carrying *pseudova*, and males and ephippial females were plentiful, but few other species were observed. On the 25th of August following I made another visit to the same pond. The weather during the interval had been dry and warm; little or no rain had fallen, and the quantity of water in the pond had become greatly reduced. It might have been thought that in these circumstances the Entomostraca would have become more crowded together and that a larger catch would be obtainable than on the previous visit. The actual result was, however, very different. It was found that Entomostraca were few, and that *Daphnia* had entirely disappeared; not a single specimen was obtained though a more careful examination was made than on the former visit. The interval between the two visits was seven weeks and three days. This, however, can hardly be called an example of seasonal distribution. It simply shows that in limited areas certain forms of Entomostraca may be so affected by temporary physical changes as to cause, for a time at least, their entire disappearance.

LYNCODAPHNIDÆ

Lathonura rectirostris, O. F. Müller.—This rare species was obtained in two of the lochs examined—viz., Loch Doon and Loch Achray—but it occurred in only one of the gatherings from each of these lochs.

Streblocercus minutus, G. O. Sars.—The Dhu Loch (at the side of Loch Lomond) was the only place where this rare Cladoceran was observed. Only a few specimens have been obtained; but it is a very small species and may readily be overlooked.

* Such variations in the weather as described will occasion considerable changes in the temperature of small bodies of water, and this also will have a certain influence bearing on the distribution of the fauna and flora.

Drepanothrix dentata (Euren) was also obtained in the Dhu Loch, as well as in Loch Arklet, Loch Achray, and Loch Doon. This species appears to have a wide distribution in Scotland.

Acantholeberis curvirostris, O. F. Müller.—This also was observed in the Dhu Loch and in Loch Arklet; but these are the only two of the present series of lochs in which it occurred.

LYNCEIDÆ.

Camptocercus rectirostris, Schoedler.—The *Camptocercus* that has been observed in four of the lochs under consideration appears to be the form that has been described by Schoedler under the name of *Camptocercus rectirostris*, and which is referred to under that name by Herrick in his "Crustacea of Minnesota." Figure 56, Plate VII., represents one of the specimens from Loch Doon, the post-abdomen of which is represented by figure 57. The figure of the post-abdomen of the *Camptocercus* in Dr. Baird's classical work agrees very closely with that of the form described by Schoedler. In this form the spiniferous margin of the post-abdomen slopes away gradually from the base of the claw; but in the form which seems to be generally considered as the *Lynceus macrurus* of O. F. Müller (now *Camptocercus macrurus*), the post-abdomen is of moderate depth throughout, the margins towards the claw are nearly parallel with each other, and the slope at the base of the claw is abrupt or nearly subtruncate.

Leydigia quadrangularis, Leydig.—This is a rare Cladoceran in Scotland, though it appears to have a fairly wide distribution. Forfar Loch is the only loch of the present series in which it was obtained. A few years ago I had the privilege of submitting specimens of this form to Professor G. O. Sars, who confirmed the identification of the species. In this form the terminal claw of the post-abdomen is furnished near the base with a distinct, though small, spinule. Figures of the species are published in Part III. of the Ninth Annual Report of the Fishery Board for Scotland.

Alona tenuicaudis, G. O. Sars.—This also is comparatively a rare or local species. It was observed only in Duddingston Loch, but it occurred in three out of the five gatherings from that loch, and was frequent in two of them. The post-abdomen in this species somewhat resembles that of *Alonopsis*, but its armature is very different.

Alona intermedia, G. O. Sars.—The Lynceid, which I have described under the name of *Alona neglecta*,* appears to be the *Alona intermedia* of G. O. Sars; while the Lynceid recorded as *Alona intermedia* from various parts of Scotland † and England ‡ is the *Alona rectangula* of G. O. Sars. *Alona intermedia* (*A. neglecta*, mihi) occurred in four of the lochs of the present series, but was scarce in all of them. It is a small species and readily overlooked, and may therefore appear rarer than it really is.

Alona rustica, T. Scott.—It appears from recent investigations that this is a widely distributed species in Britain. It has been obtained in Shetland,

* *Thirteenth Annual Report of the Fishery Board for Scotland*, Part III., p. 189, Plate V., figures 4, 18.

† *Annual Reports of the Fishery Board for Scotland*, Part III., 1895, p. 188; 1896, p. 237; 1897, p. 333; and 1898, p. 252.

‡ "The Entomostraca of Epping Forest," by D. J. Scourfield, in *The Essex Naturalist*, Vol. X., p. 319, 1898.

in various parts of the mainland of Scotland, and Mr. Scourfield (*loc. cit.*) reports its occurrence as far south as Epping Forest. *A. rustica* has been obtained in Loch Lomond, Loch Arklet, Loch Achray, and Loch Doon, but was somewhat rare in each of them.

Alonella exigua, Lilljeborg.—The *Alonella* which I have here, and in previous papers on the fresh-water Entomostraca of Scotland, recorded under the name of *Alonella exigua* belongs to the form known as *Alonella excisa*, G. O. Sars. The shell of this Lynceid has the interspaces formed by the reticulations ornamented with numerous very delicate striæ. In recording this Lynceid under Lilljeborg's rather than under Sars' name, I follow the authors of the "Monograph of the British Entomostraca belonging to the Bosminidæ, Macrothricidæ, and Lynceidæ," who regarded both as forms of the one species, and accordingly gave the preference to the older name. It may be that both forms are distinct, and if they are so these Scottish *Alonellas* ought to be called *Alonella excisa*. This *Alonella* was moderately frequent in some of the gathetings.

Harporhynchus falcatus, G. O. Sars.—This curious Lynceid was observed in five of the lochs examined—Loch Lomond, Loch Arklet, Loch Katrine, Loch Achray, and Loch Doon. It is perhaps a more widely distributed species than it was at first thought to be.

Chydorus globosus, Baird.—This fine species occurred in only two lochs —Loch Lomond and Loch Achray. Though its distribntion extends to the Shetland Islands, it does not appear to be very common.

Chydorus cœlatus, Schoedler.—This very small form was observed in five of the lochs examined.

Chydorus (?) *latus* and *Chydorus* (?) *ovalis* are two doubtful forms which may probably be only the young of *Chydorus globosus*.

Monospilus tenuirostris, Fischer.—This curious and rare Cladoceran was observed in Loch Lomond, Loch Achray, and Loch Leven. It has been known as a member of the Loch Leven entomostracan fauna for a good many years—at least since 1890.

POLYPHEMIDÆ.

Bythotrephes longimanus, Leydig.—*Bythotrephes* has occurred in all but two of the eleven Scottish lochs recently examined. It seems to have a wide distribution among the lochs of the mainland, but it has not been observed in any of the lochs of the Outer Hebrides that I have examined, nor in those of Orkney or Shetland.

Leptodora hyalina, Lilljeborg.—This entomostracan occurred in each of the lochs in which *Bythotrephes* was obtained, and it was moderately common in several of them. *Leptodora*, like that species, has not been observed in the Outer Hebrides or in the Orkney or Shetland Islands; but its distribution on the mainland extends from the South of Scotland northward as far at least as Loch Ness. A careful examination of specimens from various lochs and of various sizes and stages of development has been made in order to ascertain if more than the one species existed in Scotland, but it has failed so far to bring to light any other form than the well-known *Leptodora hyalina*.

DESCRIPTION OF THE PLATE.

PLATE VII.

Daphnia galeata. G. O. Sars.

Fig. 1. Female, side view, Loch Oich . . . . × 20.

Fig. 2. ,, head, side view, to show variation in form of head, Loch Oich × 20.

Fig. 3. ,, ,, ,, ,, ,, ,, × 20

Fig. 4. ,, ,, ,, ,, ,, ,, × 20.

Fig. 5. ,, ,, ,, ,, ,, ,, × 20.

Fig. 6. Female, side view, Loch Oich . . . . × 20.

Fig. 7. ,, head, side view, to show variation in form of head, Loch Oich × 20.

Fig. 8. ,, ,, ,, ,, ,, ,, × 20.

Fig. 9. ,, side view, Loch Oich . . . . . . × 20.

Fig. 10. ,, ,, common form, Loch Oich . . . × 20.

Fig. 11. ,, head, side view, a common form, Loch Ness . . × 20.

Fig. 12. ,, ,, ,, another common form, Loch Ness . × 20.

Fig. 13. ,, side view, another specimen, with large eye, Loch Ness . × 20.

Fig. 14. ,, ,, to show slightly different beak, Loch Ness . × 20.

Fig. 15.* ,, head, side, view, with head rounded, eye sub-central, Loch Ness . . . . × 40.

Fig. 16.* ,, head, side view, with head rounded, eye near the top of the head, Loch Ness . . . . . . × 40.

Fig. 17. Male, side view, Loch Oich . . . . × 20.

Fig. 18. Female ,, with posterior spine nearly obsolete, and showing slight bulge at base . . . . × 20.

Fig. 19. ,, ,, another specimen with still shorter spine, Loch Oich . . . . . . × 20.

Fig. 20. ,, ,, another specimen, without posterior spine, Loch Oich . . . . . . × 20.

Fig. 21. ,, ,, another specimen, without crest, posterior spine nearly obsolete, Loch Oich . . . × 20.

Fig. 22. Male, side view, Loch Achray . . . . × 20.

Fig. 47. Post-abdomen, female, Loch Oich . . . . . × 60.

Fig. 48. ,, ,, ,, Loch Ness . . . . . . ×160.

Fig. 52. Antennule, male, Loch Oich . . . . ×160.

Fig. 53. ,, ,, Loch Achray . . . . . ×160.

* Figs 15 and 16 agree with var. *obtusifrons*, G. O. Sars.

Fig. 24. Female (juv.), with vertex tooth, Forfar Loch . . . . × 53.

Fig. 25. ,, side view, with bulge at base of posterior spine, Forfar Loch . . . . × 20.

Fig. 26. ,, side view, also with bulge, but posterior spine very short, Forfar Loch . . . . × 20.

Fig. 27. Female, side view, with posterior spine obsolete, Forfar Loch . × 20.

Fig. 28. Male ,, Forfar Loch . . . . . × 40.

Fig. 29. Female ,, a common form, Loch Leven . . . × 20.

Fig. 30. ,, ,, posterior spine nearly obsolete, Loch Leven . × 20.

Fig. 31. ,, ,, ,, ,, ,, . . × 20.

Fig. 32. , (juv.), with vertex tooth, Loch Leven . . . × 40.

Fig. 33. ,, ,, without vertex tooth, Loch Leven . . . × 32.

Fig. 34. ,, side view, adult, with vertex tooth, Loch Lomond . × 26.

Fig. 34A. Bidentate vertex tooth of another specimen, Loch Lomond . × 26.

Fig. 35. Female, side view, a normal form, Loch Lomond . . . × 26.

Fig. 49. Post abdomen of female, Forfar Loch . . . . . × 60.

Fig. 51. , ,, ,, Loch Lomond . . . . × 80.

Daphnia longispina, var. *nasuta*, G. O. Sars.

Fig. 36. Female, side view, Loch Doon . . . . × 26.

Fig. 37. ,, ,, (another form), Loch Doon . . . × 26.

Fig. 38. Male ,, Loch Doon . . . . × 26.

Fig. 39. ,, front view, Loch Doon, enlarged . . . . .

Fig. 50. Post-abdomen of female, Loch Doon . . . . . × 60.

Daphnia (?) *longispina*, var. *aquilina*, G. O. Sars.

Fig. 40. Female, side view, Loch Arklet . . . . . × 19.

Fig. 45. Post-abdomen of female, Loch Arklet . . . . × 60.

Fig. 45A. Post abdominal processes of another specimen, Loch Arklet, enlarged.

Daphnia (?) *longispina*, var. (?).

Fig. 41. Female, side view of a common form, Duddingston Loch . . × 20.

Fig. 42. ,, ,, without posterior spine, Duddingston Loch . × 20.

Fig. 43. Male ,, Duddingston Loch . . . . . × 34.

Fig. 44. Head of a scarcely mature female, Duddingston Loch . . × 64.

Daphnia lacustris, G. O. Sars.

Fig. 23. Female, side view, a common form, Forfar Loch . . . × 20.

Fig. 44A. Post-abdominal processes of the same specimen . . . × 96.

Fig. 46. Post-abdomen of female (fig. 41), Duddingston Loch . . × 96.

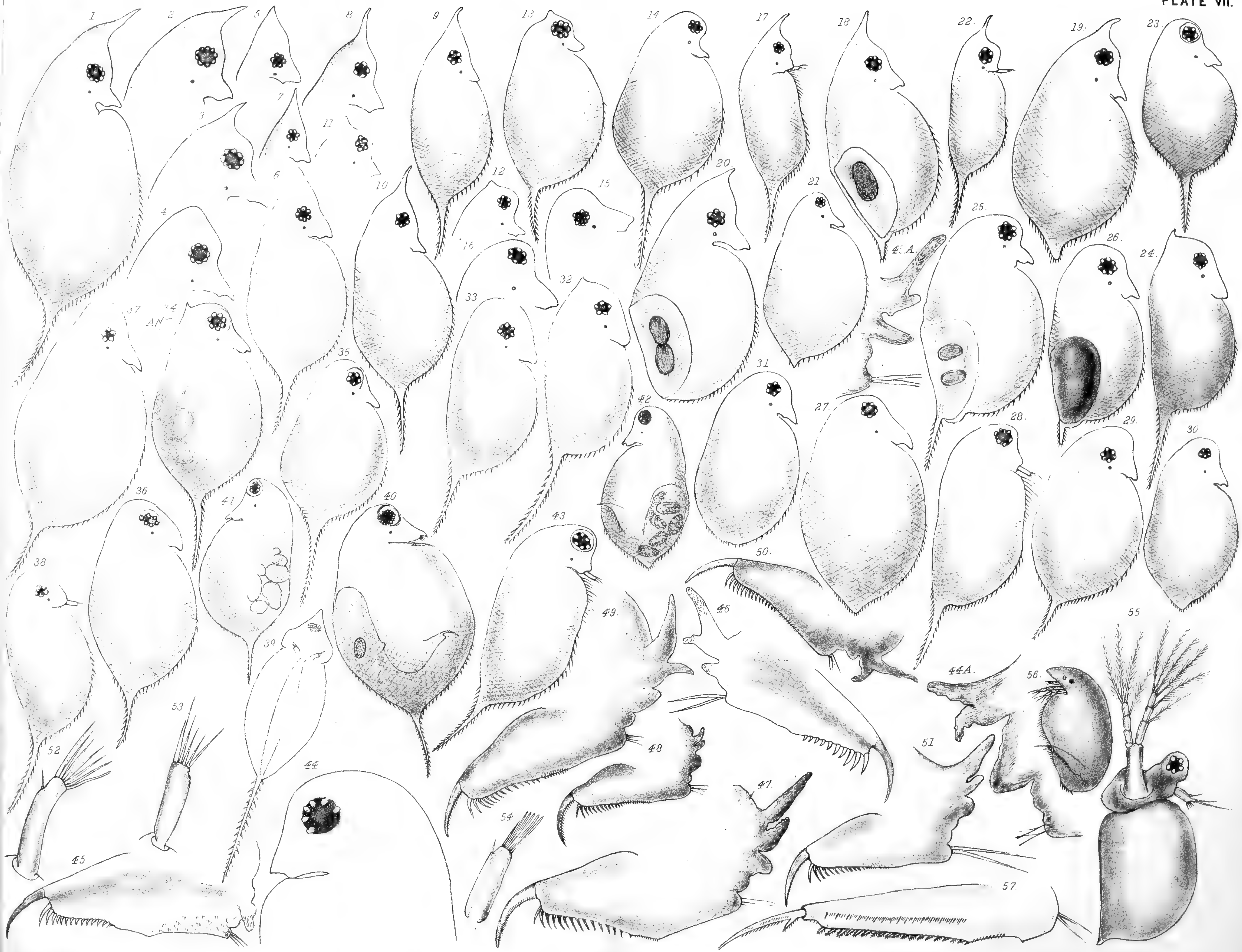
Fig. 54. Antennule of the male, Duddingston Loch, enlarged . .

Fig. 55. *Ceriodaphnia quadrangula*, side view, Forfar Loch . . × 53.

Fig. 56. *Camptocercus rectirostris*, side view, Loch Doon . . . × 20.

Fig. 57. Post-abdomen of *C. rectirostris*, Loch Doon. . . . × 95.

PLATE VII.



A. SCOTT, *del.*

CLADOCERA OF SCOTTISH LAKES.

IV. REPORT ON THE OPERATIONS AT DUNBAR MARINE HATCHERY DURING THE SPRING SEASON 1898. By Harald C. Dannevig. Plate VIII.

During the spring season of 1898 the hatching of plaice was carried out on the same lines as in the previous years, and under much the same conditions. The collection of the spawning fishes was begun on February 8th and continued till the middle of March, when 725 adult male and female plaice had been received. Having been procured from steam trawlers, the bulk of the fishes exhibited the same characteristic features as have been described in previous reports, and they were not all equally well suited for spawning purposes. While some succumbed to the injuries received during their capture and transport, others that were in a healthier condition soon began to produce eggs.

The collection of impregnated eggs was carried out in the spawning pond from the middle of February to May 7th, when altogether 21,510,000 had been collected and transferred to the hatching boxes. Of this number 19,200,000 were successfully hatched, while the rest, or 10·7 per cent., died during the process. The daily progress of the hatching work, and the records of the temperature of the air and of the water in the pond and in the harbour, will be seen from Table I.

Table I.—Showing the Daily Progress of the Hatching Work and the Temperature of the Air and the Water in the Harbour and in the Spawning Pond.

Date.		Number of Eggs collected	Number of Eggs dead in boxes.	Number of Fry put out.	Number of Eggs and Fry in the boxes.	Temperature of the Harbour at Noon.		Temperature of the Pond at Noon.		Temperature of the Air at Noon.	
						C.	F.	C.	F.	C.	F.
Feb.	15th.	50,000	...	...	50,000	6·7	44·0	6·6	43·9	12·7	54·8
,,	16th.	...	...	...	50,000	5·9	42·6	6·3	43·3	5·4	41·7
,,	17th.	70,000	...	...	120,000	5·2	41·4	5·4	41·7	5·2	41·4
,,	18th.	...	...	...	120,000	5·2	41·4	5·2	41·4	3·1	37·5
,,	19th.	80,000	...	...	200,000	5·1	41·2	5·2	41·4	5·0	41·0
,,	20th.	...	...	...	200,000	5·1	41·2	5·1	41·2	0·0	32·0
,,	21st.	80,000	...	...	280,000	5·0	41·0	5·1	41·2	2·4	36·3
,,	22nd.	...	...	...	280,000	5·1	41·2	5·0	41·0	4·5	40·1
,,	23rd.	50,000	...	...	330,000	4·8	40·6	4·9	40·8	2·7	36·9
,,	24th.	90,000	20,000	...	400,000	5·0	41·0	4·8	40·6	3·6	39·4
,,	25th.	80,000	...	...	480,000	5·3	41·5	4·9	40·8	5·4	41·7
,,	26th.	110,000	...	...	590,000	5·1	41·2	5·1	41·2	4·1	39·4
,,	27th.	100,000	...	...	690,000	5·4	41·7	5·3	41·5	6·3	43·3
March	1st.	130,000	40,000	...	780,000	5·1	41·2	5·2	41·4	6·8	44·2
,,	2nd.	140,000	...	...	920,000	4·9	40·8	4·8	40·6	3·0	37·4
,,	3rd.	100,000	...	...	1,020,000	4·8	40·6	4·8	40·6	5·3	41·5
,,	4th.	160,000	...	...	1,180,000	4·5	40·1	4·6	40·3	4·7	40·5
,,	5th.	200,000	...	...	1,380,000	4·6	40·3	4·6	40·3	4·5	40·1
,,	6th.	150,000	80,000	...	1,450,000	4·5	40·1	4·4	39·9	5·2	41·4
,,	7th.	180,000	...	...	1,630,000	4·8	40·6	4·5	40·1	4·7	40·5
,,	8th.	200,000	...	...	1,830,000	4·7	40·5	4·7	40·5	4·5	40·1
,,	9th.	140,000	...	...	1,970,000	4·8	40·6	4·7	40·5	3·3	37·9
,,	10th.	160,000	70,000	...	2,060,000	5·0	41·0	4·8	40·6	7·7	45·9
,,	11th.	210,000	...	...	2,270,000	5·0	41·0	5·2	41·4	8·9	48·0
,,	12th.	240,000	...	...	2,510,000	5·6	42·0	5·4	41·7	11·3	52·3
,,	13th.	220,000	90,000	...	2,640,000	5·7	42·0	5·6	42·0	7·2	45·0
,,	14th.	260,000	...	...	2,900,000	5·7	42·0	5·6	42·0	9·7	49·5
,,	15th.	280,000	...	...	3,180,000	5·3	41·5	5·4	41·7	5·3	42·2
,,	16th.	270,000	75,000	...	3,375,000	5·4	41·7	5·5	41·9	8·7	47·7
,,	17th.	290,000	...	...	3,665,000	5·6	42·0	5·6	42·0	10·0	50·0

TABLE I.—*Continued.*

Date.	Number of Eggs collected	Number of Eggs dead in boxes.	Number of Fry put out.	Number of Eggs and Fry in the boxes.	Temperature of the Harbour at Noon.		Temperature of the Pond at Noon.		Temperature of the Air at Noon.	
					C.	F.	C.	F.	C.	F.
March 18th.	330,000	...	...	3,995,000	6·3	43·3	6·2	43·2	13·9	57·0
,, 19th.	320,000	50,000	...	4,265,000	6·7	44·0	6·7	44·0	12·8	55·0
,, 20th	340,000	...	...	4,605,000	6·3	43·3	6·6	43·9	5·8	42·4
,, 21st.	400,000	...	...	5,005,000	6·1	43·0	6·2	43·2	6·7	44·0
,, 22nd.	500,000	...	...	5,505,000	6·1	43·0	6·0	42·8	7·0	44·6
,, 23rd.	600,000	120,000	...	5,985,000	6·3	43·3	6·2	43·2	9·6	49·3
,, 24th.	860,000	...	...	6,845,000	6·3	43·3	6·3	43·3	5·4	41·7
,, 25th.	700,000	...	...	7,545,000	6·1	43·1	5·8	42·4	3·8	38·8
,, 26th.	600,000	60,000	...	8,085,000	5·5	41·9	5·8	42·4	3·8	38·8
,, 27th.	680,000	...	...	8,765,000	5·1	42·2	5·5	41·9	3·6	38·5
,, 28th.	800,000	170,000	...	9,395,000	5·0	41·0	5·4	41·7	3·6	38·5
,, 29th.	800,000	...	...	10,195,000	5·4	41·7	5·2	41·4	4·4	39·9
,, 30th.	700,000	...	...	10,895,000	5·9	42·6	5·5	41·9	5·4	41·7
,, 31st.	760,000	220,000	...	11,435,000	6·6	43·9	6·6	43·9	7·2	45·0
April 1st.	880,000	...	800,000	11,515,000	6·6	43·9	6·5	43·7	8·0	46·4
,, 2nd.	700,000	...	...	12,215,000	5·7	42·2	5·6	42·0	9·2	48·6
,, 3rd.	600,000	240,000	...	12,575,000	5·8	42·4	5·7	42·2	8·1	46·6
,, 4th.	630,000	...	...	13,205,000	5·5	41·9	5·7	42·2	6·1	43·0
,, 5th.	500,000	...	...	13,705,000	5·6	42·0	5·5	41·9	8·0	46·4
,, 6th.	600,000	180,000	...	14,125,000	5·9	42·6	5·5	41·9	11·9	53·4
,, 7th.	440,000	90,000	...	14,475,000	6·3	43·3	6·3	43·3	12·9	55·2
,, 8th.	450,000	...	...	14,925,000	6·3	43·3	6·3	43·3	13·7	56·7
,, 9th.	460,000	...	...	15,385,000	6·5	43·7	6·6	43·9	13·1	55·6
,, 10th.	400,000	200,000	...	15,585,000	7·4	45·3	6·8	44·2	14·1	57·4
,, 11th.	320,000	...	...	15,905,000	7·2	45·0	6·8	44·2	12·1	53·8
,, 12th.	280,000	60,000	1,400,000	14,725,000	7·1	44·8	6·9	44·4	10·7	51·2
,, 13th.	300,000	...	...	15,025,000	6·7	44·0	6·9	44·4	10·7	51·2
,, 14th.	350,000	90,000	...	15,285,000	6·6	43·9	6·9	44·4	8·2	46·8
,, 15th.	300,000	...	2,900,000	12,685,000	6·5	43·7	6·7	44·0	8·2	46·8
,, 16th.	250,000	...	...	12,935,000	6·8	44·2	6·8	44·2	10·0	50·0
,, 17th.	...	80,000	...	12,855,000	6·9	44·4	7·0	44·6	11·9	53·4
,, 18th.	230,000	...	...	13,085,000	7·1	44·8	7·0	44·6	8·2	46·8
,, 19th.	...	120,000	...	12,965,000	6·4	43·5	6·1	43·0	9·4	48·9
,, 20th.	310,000	...	...	13,275,000	6·4	43 5	6·9	44·4	7·9	46·2
,, 21st.	...	...	...	13,275,000	6·7	44·0	6·6	43·9	9·9	49·8
,, 22nd.	...	80,000	2,700,000	10,495,000	7·1	44·8	7·0	44·6	7·9	46·2
,, 23rd.	330,000	...	...	10,825,000	7·1	44·8	7·0	44·6	7·4	45·3
,, 24th.	...	...	...	10,825,000	7·4	45·3	7·1	44·8	8·1	46·6
,, 25th.	180,000	50,000	...	10,955,000	7·5	45·5	7·7	45·9	7·9	46·2
,, 26th.	...	...	2,200,000	8,755,000	7·1	44·8	7·4	45·3	7·6	45·7
,, 27th.	170,000	...	...	8,925,000	7·3	45·1	7·1	44·8	8·3	46·9
,, 28th.	...	...	...	8,925,000	7·0	44·6	7·1	44·8	7·7	45·9
,, 29th.	...	30,000	3,400,000	5,495,000	7·0	44·6	7·0	44·6	7·8	46·0
,, 30th.	200,000	...	...	5,695,000	7·2	45·8	7·1	44·8	9·3	48·7
May 1st.	...	...	...	5,695,000	7·1	44·8	7·2	45·8	12·7	54·9
,, 2nd.	...	...	...	5,695,000	7·5	45·5	7·4	45·3	8·8	47·8
,, 3rd.	...	40,000	...	5,655,000	7·6	45·7	7·6	45·7	10·0	50·0
,, 4th.	...	...	2,200,000	3,455,000	7·8	46·0	7·7	45·9	10·4	50·7
,, 5th.	...	...	...	3,455,000	7·8	46·0	7·8	46·0	9·8	49·8
,, 6th.	...	...	...	3,455,000	7·8	46·0	7·7	45·9	9·3	48·7
,, 7th.	200,000	25,000	...	3,630,000	8·3	46·9	8·1	46·6	11·8	53·2
,, 8th.	...	...	...	3,630,000	8·3	46·9	8·2	46·8	14·7	58·5
,, 9th.	...	...	...	3,630,000	8·9	48·0	8·7	47·7	10·1	50·2
,, 10th.	...	...	1,300,000	2,330,000	...	...	...	...	...	...
,, 11th.	...	...	...	2,330,000	...	...	...	...	...	...
,, 12th.	...	...	...	2,330,000	...	...	...	...	...	...
,, 13th.	...	...	700,000	1,630,000	...	...	...	...	...	...
,, 14th.	...	...	...	1,630,000	...	...	...	...	...	...
,, 15th.	...	...	...	1,630,000	...	...	...	...	...	...
,, 16th.	...	30,000	...	1,600,000	...	...	...	...	...	...
,, 17th.	...	...	900,000	700,000	...	...	...	...	...	...
,, 18th.	...	...	...	700,000	...	...	...	...	...	...
,, 19th.	...	...	...	700,000	...	...	...	...	...	...
,, 20th.	...	...	700,000	...	...	...	...	...	...	...

In last year's Report it was stated that an experiment had been begun in Loch Fyne in order to find out what practical results may be obtained in a confined area by the planting of a limited number of artificially-hatched fry of plaice. During 1898 the experiment was continued, and all the fry produced in the hatchery were placed in the loch, on this occasion in the upper part, to the north-east of Strachur. While it may be considered to some extent an open question what particular locality of a tidal loch, such as Loch Fyne, is the most suitable for the distribution of fry at the different stages of the tide, some cases are less difficult to decide than others. When the tide is full there seems little doubt that the fry should be planted as far up in the loch as possible, in order that they may not tend to be carried out by the ebb. But there appear to be strong reasons why the fry should always be planted near the head of the loch. The tidal currents are of course strongest at the entrance, through which all the water passes and repasses which causes the rise and fall of the level of the whole loch; and from the same reason these horizontal currents are of least strength at the head of the loch, where the tidal movement of the water is more a simple rise and fall. It was principally for this reason that the fry in 1898 were distributed near the head of Loch Fyne, which was also the most convenient locality, as the transport was effected by means of the ordinary mail service to Inveraray. The salinity of the water in that part of the loch is often much reduced, especially during heavy rainfalls; but this fresh water, which accumulates in a layer on the surface, is drifted to and fro by the wind in the loch, and it does not as a rule remain stationary for any long time in the upper loch. The depth of this fresh-water layer is usually not very great, so that in 1898 water of sufficient salinity always existed some feet below the surface. The fry were sometimes distributed through an indiarubber tube at various depths, once or twice at as much as twenty feet down, where a sufficient salinity was found, while the surface water was quite brackish.

TABLE II.—SHOWING THE LOCALITY AND THE PHYSICAL CONDITIONS WHERE THE FRY WERE DISTRIBUTED.

Date.	Locality.	Temperature of the Water into which the Fry were planted.		Sp. gravity of the Water into which the Fry were planted.	State of the Tide.	Number of Fry Planted.
		C.	F.			
April 1st,	Off Inveraray, in the middle of the loch,	7·8	46	1026·8	4h. ebb	800,000
,, 12th,	,, ,,	5·6	42	1022·0	1h. ebb	1,400,000
,, 15th,	,, ,,	9·5	49	1024·5	3h. flood	2,900,000
,, 22nd,	,, ,,	...	...	...	5h. ebb	2,700,000
,, 26th,	,, ,,	...	...	...	1h. flood	2,200,000
,, 29th,	Two miles above St. Catherine's,	9·5	49	1025·8	5h. flood	3,400,000
May 4th,	Off Inveraray, in the middle of the loch,	9·9	49·8	1023·8	1h. flood	2,200,000
,, 10th,	,, ,,	10·3	50·5	1023·0	2h. ebb	1,300,000
,, 13th,	,, ,,	9·8	49·6	1025·0	H.W.	700,000
,, 17th,	,, ,,	10·7	51·2	1024·6	5h. ebb	900,000
,, 20th,	,, ,,	11·5	52·7	1023·0	1h. flood	700,000

During the five years in which the hatchery has been in operation, a total of 119,595,000 of plaice fry have been produced, together with 16,895,000 of various other species. The plaice, as will be seen, has principally been dealt with, and although the number turned out is a fair one for the size and capacity of the present establishment, it would undoubtedly have been greatly increased if the anticipated local conveniences could have been utilised in due course. As was explained in the Board's Report for last year, the Dunbar authorities withdrew their grant for the use of some important sea-creeks adjoining the hatchery, and the work has therefore had to be carried out under somewhat difficult conditions. But, as the Board has lately selected a site, and partly already erected a new station, at the Bay of Nigg, near Aberdeen, the desired facilities may soon be obtained, and the hatching operations carried on on a larger scale than hitherto.

Sufficient time has not yet elapsed to allow of any conclusions being drawn from the Loch Fyne experiments.

The utility of sea-fish hatching, or the possibility of doing anything artificially to increase the stock of food fishes within limited areas, has in certain quarters been recently called in question on general grounds. It is a problem, however, which can only be solved by systematic experiment and trial, and it requires time, and also that the operations should be conducted on a sufficiently extensive scale.

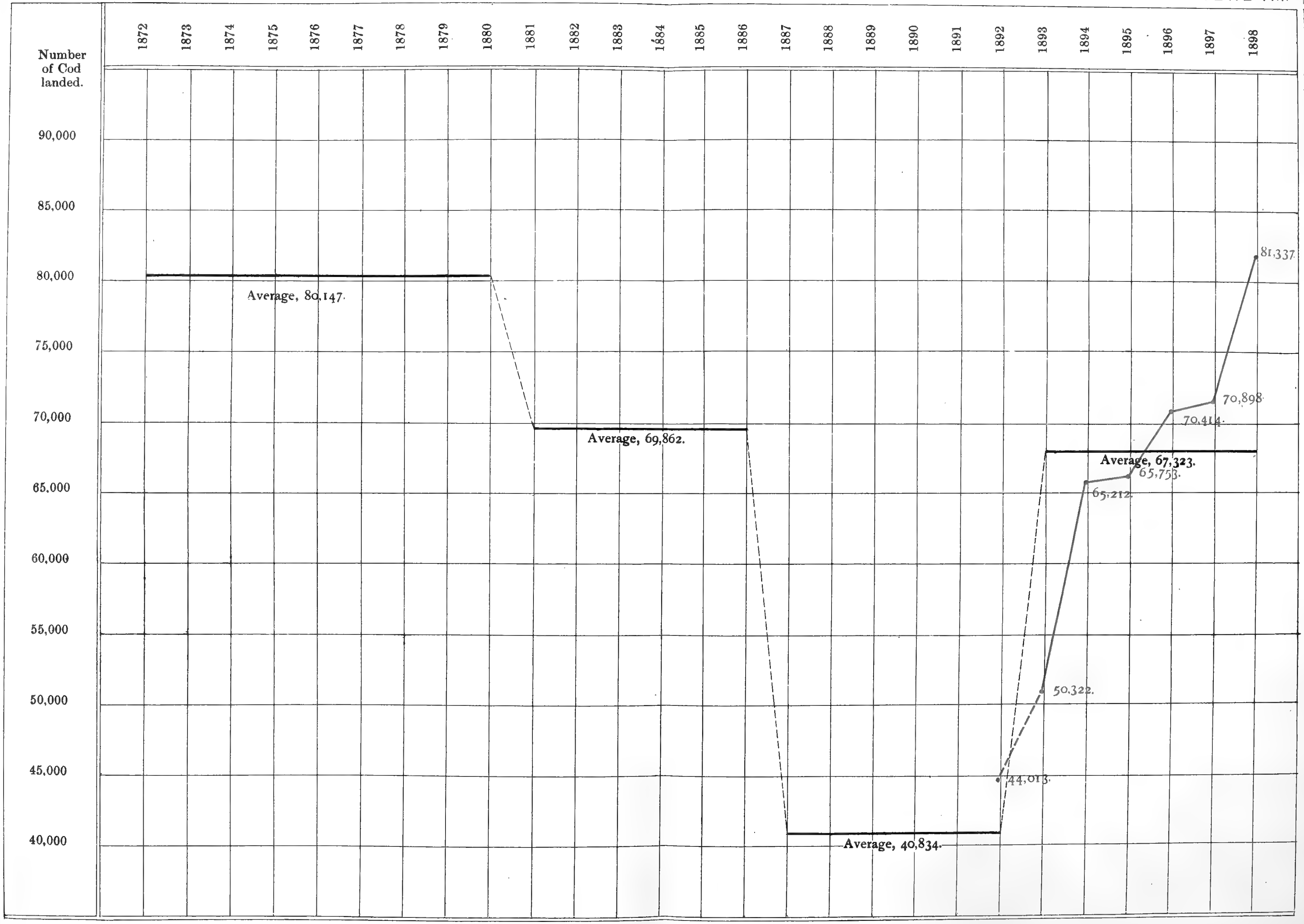
The results of the hatching of cod in Norway are very encouraging. The hatchery at Flödevig was established with the view of improving the inshore fishery in the south of Norway, and its operations have hitherto been confined to that area—to the fjords east of the Naze. It is therefore wrong to suppose, as has been done, that its work would have effect along the whole Norwegian coast, and a considerable part of which, in fact, is further away from the hatchery than the Scottish East Coast is. But there is distinct evidence of its influence in raising the stock of cod in the waters in which, or near which, the fry have been distributed. This is shown by the statistics of the Society for the Promotion of the Fisheries in the Christiania Fjord, within Dröbak, which have been published in their Reports. *

The records extend over a period of twenty-seven years—from 1872 to 1898 inclusive—and the figures referring to the quantity of cod brought to the market from this district in the various years are given below. Fry of cod from the hatchery were distributed in the fjord for the first time in 1892, and the operation has been continued since. The returns for 1893, when results could first be looked for, have been grouped together with those for the following years, thus forming one group of six years. For comparison the returns for the previous years have also been combined into similar groups, but the three years 1872-1874 have been added to the first group, which thus represents nine years.

The average catch of cod	for the period	1872–1880	was	80,147.
Do.	do.	1881–1886	-	69,862.
Do.	do.	1887–1892	-	40,834.
Do.	do.	1893–1898	-	67,323.

The decline in the fishery from 1872 to 1892 was very great—in fact, it was reduced to about one-half of what it was. But the increase in the following period, when fry were being distributed in the fjord, is also remarkable, and it is reasonable to assume that this increase was due in large measure to the distribution of the fry.

* *Beretning fra Selskabet til Fremme af Fiskerierne i Christiania=fjorden indenfor Dröbak, Christiania.*



Number of Cod landed.
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
Average, 80,147.
Average, 69,862.
Average, 40,834.
Average, 67,323.
81,337.
70,898.
70,414.
65,753.
65,212.
50,322.
44,013.

A closer examination of the records for the last period is of interest in comparison with the number of fry yearly planted :—

	1892.	1893.	1894.	1895.	1896.	1897.	1898.
Number of cod landed,	44,013	50,322	65,212	65,753	70,414	70,898	81,337
Number of fry distributed, . .	10 millions	20 millions	Nil.	12 millions	18 millions	20 millions	Not known.
Yearly increase, .		6,309	14,819	514	4,461	484	10,439

Thus the decline in the annual catch during the period 1872-1892 amounted to 39,313 cod ; the total number of fry planted from which results might be looked for during the period 1893-1890 was 80,000,000, and the total increase in the fishery during the same six years was 37,324 cod. The increase during the last six years is not far short of the decline during the previous twenty-one years.

It is stated in the Reports of the Society that the increase was principally among the young fishes—not yet matured ; and as two of these are often counted for one owing to their smaller size, the actual increase was greater than shown by the figures of the statistics. In Plate I. is given a graphic illustration of the progress of the cod-fishery in the Christiania Fjord during the past twenty-seven years, as shown in the Table, and I think the Tables as well as this illustration can best be left to speak for themselves. The red line extending between the years 1892 to 1898 represents the progress of the fishery during that period. Its average is 67,323, while it rises gradually from 44,013 in 1892 to 81,337 cod in 1898.

V.—ON THE MIGRATORY MOVEMENTS AND RATE OF GROWTH OF THE GREY OR COMMON GURNARD. By T. Wemyss Fulton, M.D., F.R.S.E., Scientific Superintendent.

CONTENTS.

Introduction.

Among the fishes caught by the "Garland" there appears to be none whose migratory movements are more marked and definite than the common gurnard; nor is there any in which this migratory movement can be more distinctly correlated with the seasonal changes in the temperature of the sea water, and with the instinct of propagation, than in this fish. The circumstance that the common gurnard approaches the inshore grounds at the spawning time and leaves them in great numbers late in autumn was pointed out in 1892;* and subsequent investigation has shown that this movement is one of great regularity, and is associated with other phenomena of interest. The facts set forth in the following pages are based on a study of the catches of gurnards made by the "Garland" during the past ten years; but the more detailed and systematic part deals principally with the garnards caught in what may be termed the Firth of Forth area, which includes not only the Firth itself and the estuary, but also the open sea to a distance of twelve or fourteen miles east of the Isle of May. Some hauls were also taken at a bank † twenty-two miles east by south of the Isle of May. In this area the occurrence of gurnards at each station has been studied in relation to (1) their appearance and numbers in the various months of the year; (2) their sizes in relation to maturity and age; (3) the temperature of the sea water in the various months at the different stations; (4) the spawning period. The number of gurnards dealt with in this area is over 10,000, and the period comprises ten years. The gurnards caught in the other areas where the "Garland" has carried on trawling work—viz., the Moray Firth, the Firth of Clyde and Loch Fyne, St. Andrews Bay, Aberdeen Bay, Montrose Bay, and Lunan Bay—over 14,500 in number, have also been dealt with; and some of these areas, and especially the Clyde and the Moray Firth, have furnished important data in connection with the conclusions reached for the Firth of Forth.

The Migratory Movements.

In considering the migratory movement, we shall first of all deal with the gurnards as a whole, irrespective of their grouping into sizes or of the slight variations that occur in different years. For this purpose the collective data referring to each particular month in all the years have

* Fulton: "Observations on the Reproduction, Maturity, and Sexual Relations of the Food Fishes." *Tenth Annual Report Fishery Board for Scotland*, Part III., p. 235.

† Liston Bank, so named from the experienced trawler who has had charge of the actual trawling operations on the "Garland" from the first.

been combined, so as to give the mean for each month in the period. In the Forth area gurnards are almost entirely absent from November to April. In January of the various years only one was captured in the Firth of Forth, viz., a specimen of four inches taken at Station V. (west of the Isle of May), in a depth of between 20 and 30 fathoms, on 21st January 1891. It was, as we shall see, no doubt an individual which had for some reason or other remained behind when the shoals left the Forth in the previous autumn. One other specimen was taken on 19th January 1893 in the open sea at "Liston Bank" in twenty-four fathoms of water (see Fig. 1). It was five inches in length; and we shall find that in the winter months small gurnards are to be found in the deep offshore waters in the Clyde and Moray Firths. The number of hauls made in the Januaries of the various years in the Forth area, including "Liston Bank," was 55. In February only three gurnards were taken in 71 hauls, and all of them were caught outside the limits of the Firth of Forth, viz., at Stations VIII. and IX., where the water varies from 20 to 32 fathoms in depth (Fig. 1). One at Station IX., on 19th February 1891, was 10 inches in length; the other two, taken at Station VIII. on 18th February 1896, were each twelve inches in length. In March, in which month 52 hauls were made, the number of gurnards captured was 15; with one exception they were all taken at stations either outside the Firth or just at its mouth. Thus, on 19th and 21st March 1891, one 12 inches and one 13 inches were caught at Stations V. and VI. respectively; on 14th March 1894 one 14 inches long was taken at Station VIII.; and on 29th and 30th March in the same year other eleven were caught at Stations V., VI., and VII. at the mouth of the Forth, of which three were 14 inches in length, one 12 inches, three 10 inches, one 9 inches, and the others 6 and 7 inches. The exception referred to was a small specimen, four inches long, which was captured on 13th March 1891 at Station II. (far up the Forth), and had probably remained in the Firth from the autumn.

Thus there is at the end of March an indication of the movement of the gurnards into the Firth. In April this movement is found to be in full progress. The number captured in this month in 63 hauls amounted to 700, or an average of 11 gurnards per haul of the net. They are now found at every station in the Firth of Forth, throughout the waters of which they have become well distributed. At Station II. (off West Wemyss, Fife) they are more abundant than at any other station, except Station VII. (which runs parallel to the coast from the Bass Rock westwards). At the innermost stations, near Inchkeith (I.-III) and in Aberlady Bay, they are rather more numerous than at the stations outside the Firth (VIII. and IX.). The average number caught in each haul in April at the inner group of stations (I.-IV.) was 9·9; at the outer group (VIII.-IX.) it was 7·8; and at the three stations at the mouth of the Firth (V., VI., VII.) it was 15·5. They were thus most abundant at the mouth of the Forth in this month. How much further they extend up the Forth is not shown, since no gurnards were ever caught at the special station above the Forth Bridge (Station X.). The sizes of the April gurnards will be dealt with later; here it is sufficient to say that the great majority were adults. The migratory movement of the gurnard from the open sea into the inshore waters goes on actively during April, and reaches its height in May. In this month the number of gurnards captured in the area was 2789, in 63 hauls of the net, or an average of 44·2 gurnards per haul. They were most numerous at the three Stations at the mouth of the Firth (V., VI., VII.), where 1189 were caught, the average per haul being 51·7. At the inner group of Stations (I.-IV.) they were also abundant, the average per haul being 46·7. The total

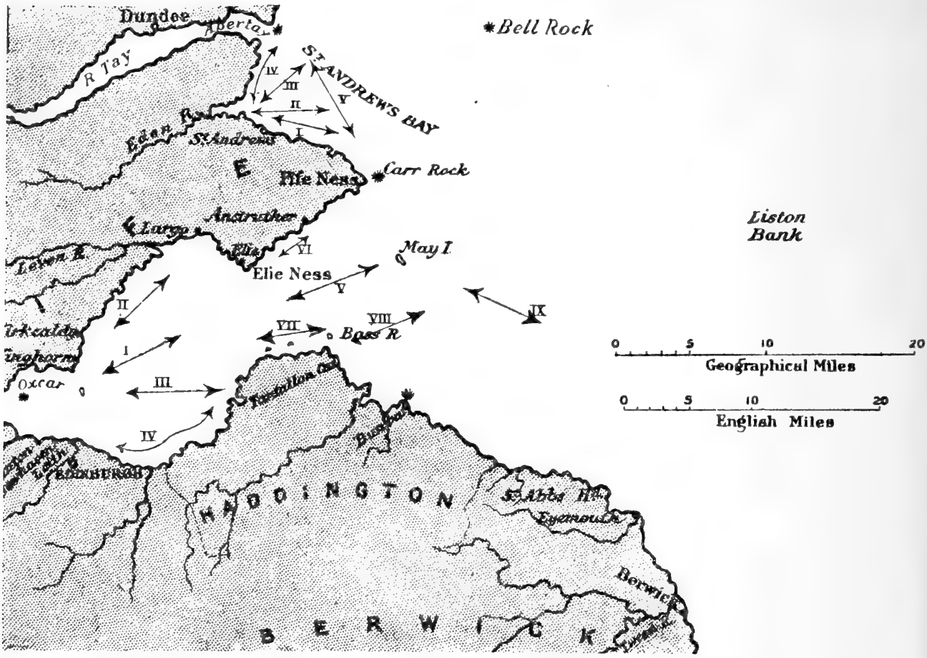


FIG. 1, Showing the various Trawling Stations in the Firth of Forth area.

number caught was 1260. At the outer stations the average was only 26·1, much higher than in the previous month, but much less than within the limits of the Firth in the same month. At Station VII., on the south side, near the Bass Rock, the average in May is 100 gurnards per haul, compared with 22·4 at Station V., west of the Isle of May, and 29·9 at Station VI., on the north side, off the coast of Fife. At Station III., east of Inchkeith, the average is 59·9; at Station II., in the north bay, it is 49·3; at Station I. it is 41·7; and at Station IV., in the south bay, it is 33·4. The lowest average of all is at Station IX., in the open sea, furthest from the Firth, where it is only 14·5. These data show that the shoals of gurnards begin to move into the Firth from the deeper waters of the open sea in March; this movement is continued and is much more marked in April, and is intensified in May, when they are found in great numbers all over the Firth, but are most numerous just within its mouth.

In June we find the numbers of the gurnards have considerably diminished. With 71 hauls of the net 2142 were captured, or an average of 30·2 gurnards per haul. In this month they are most abundant at the inner stations, the average for Stations I.-IV. being 35·1, compared with 29·1 at Stations V.-VI., and 22·9 at the outer stations, VIII.-IX. They are most numerous at Station II., in the north bay, where the average is 43; at Station I. it is also high, viz. 41. They are least abundant at Station V. (18·6) and at Station IX. (11·4). In July the diminution in the abundance of the gurnards continues. The number caught in 51 hauls of the net was 1225, an average of 24 per haul for the whole area. They are now least numerous at the inner stations, where the average per haul is 17·1, or less than half of what it was in the previous month. They are more abundant at the three stations at the mouth of the Firth (V., VI., VII.), where the average is 28·5, or only a little under the previous month; and they are most abundant at the outer stations, VIII. and IX., in the open sea, where the average has risen to 34·1, which is the maximum for this part of the area for the year. The highest average is at Station VIII. (45·6), and the lowest at Station III. (13·7). The average at Station VI. is also high, viz. 40·5. In August and September the decrease in the abundance of gurnards in the area continues, but the rate of diminution is not so marked as in June and July. Thus, while there was a drop in the average from May to June of 12, and a drop of 6·2 from June to July, the drop from July to August was only 2·4, and from August to September almost the same, viz. 2·7. In August 1534 gurnards were caught in 71 hauls, or an average of 21·6 per haul. The same relative abundance at different parts of the area is exhibited as in July. The average number taken in each haul of the net at the four inner stations is 18·4; at the three stations at the mouth of the Firth the average is 23·2, and at the outer stations in the open sea it is 26·7. In September 1306 gurnards were caught in 69 hauls, the average being 18·9. In this month the average at the four inner and the two outer stations is nearly the same—namely, 20·6 at the former and 21·5 at the latter; at the intermediate three stations the average sank to 14·8. Thus at the inner stations a rise took place in August and September, the reason for which we shall see when we come to deal with the gurnards according to their sizes. The highest average for the month is at Station II. (25·2), the next highest are at Station IV. (24·9) and at Station IX., in the open sea, where it is 24·5.

In October a very marked change occurs. The number of gurnards captured in 66 hauls of the net was 552, the average per haul being 8·4. The averages at the inner stations in this month are higher than at the intermediate or outer station—viz., 10·6, compared with 7·9 at the three stations at the mouth of the Firth and 4·9 at the two stations in the open sea. The highest average was at Station II. (18·1), and the lowest at the shallow-water Station IV. (4·6), which is first affected by the falling temperature. The average at Station IX. was practically the same, 4·7. In November the gurnards have almost disappeared from the area. Only 65 were captured in 58 hauls, or an average of 1·1 per haul. They were very scarce in the inner parts of the Firth and at the mouth, the averages being 0·7 and 0·6 respectively; at the outer stations they were more numerous, the average per haul being 3·2; the average at the outermost Station (IX.) was 3·8. In December only 11 gurnards were taken in 59 hauls, an average of less than 0·2 per haul; four of them were captured at the four inner stations, three at the three intermediate stations, and four at the two outer stations. The averages at each station for each month throughout the ten years are given in the following Table:—

[TABLE.

TABLE I.

Months.	Stations.									Totals.	
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	Number Caught.	Av'ge.
January, .	...	...	...	...	0·2	...	...	...	...	1	0·02
February,	...	...	...	...	...	...	...	0·25	0·12	3	0·04
March, .	...	0·2	...	...	0·6	0·6	0·7	0·2	0·2	15	0·29
April, .	7·5	14·9	9·1	7·7	10·5	6·7	30·7	10·0	5·6	700	11·1
May, .	41·7	49·3	59·9	33·4	22·4	29·9	100·1	36·1	14·5	2,789	44·2
June, .	41·0	43·0	33·5	22·7	18·6	32·9	35·9	34·4	11·4	2,142	30·2
July, .	15·8	14·7	13·7	26·6	21·0	40·5	21·8	45·6	22·6	1,225	24·0
August, .	14·1	16·0	28·1	18·9	28·7	23·2	18·3	27·4	25·8	1,534	21·6
September,	13·4	25·2	19·5	24·9	13·1	11·7	19·4	19·2	24·5	1,306	18·9
October, .	8·3	18·1	11·6	4·6	6·0	11·3	6·7	5·0	4·7	552	8·4
November,	0·5	1·8	0·5	0·4	0·2	1·1	0·5	2·6	3·8	65	1·1
December,	0·1	...	0·5	...	0·2	0·4	...	0·3	0·3	11	0·2

The averages for the three groups of stations, inner, outer, and intermediate, for each month of the ten years are represented in Table II.

TABLE II.

Months.	Inner Stations, I.—IV.	Intermediate Stations. V.—VII.	Outer Stations. VIII.—IX.
January, . .	—	0·07	—
February, . .	—	—	0·19
March, . .	0·05	0·6	0·2
April, . .	9·9	15·5	7·8
May, . .	46·7	51·7	26·1
June, . .	35·1	29·1	22·9
July, . .	17·1	28·5	34·1
August, . .	18·4	23·2	26·7
September, .	20·6	14·8	21·5
October, . .	10·6	7.9	4·9
November, .	0·7	0·6	3·2
December, .	0·15	0·19	0·3

Before proceeding to consider the migratory movements of the gurnard, as revealed by these data, in connection with the changes in the temperature of the sea and the period of spawning, it may be desirable to compare the general results with those in other areas, and especially in the Firth of Clyde and the Moray Firth. In St. Andrews Bay, where more than 6500 gurnards were caught during the ten years, the changes in the relative abundance in the various months are of the same general character as in the Forth area, but there are some differences of interest. The averages for each month are as follows :—

January.	February.	March.	April.	May.	June.
0·0	0·05	0·5	10·4	86·7	83·6

July.	August.	September.	October.	November.	December.
18·1	35·7	24·4	10·3	8·8	1·2

We see here that the averages are comparable with those in the Forth. The rise in May is relatively and absolutely far greater, and the average for June is also very high, and not much under that for May. There is also a rise in August and September, as at the inner group of stations of the Firth of Forth. Moreover, the averages in November and December are somewhat higher. Those procured in March—fifteen in number—were, with one exception, all obtained in 1890 in the hauls made at the end of the month, when the temperature at most of the stations was very slightly higher; and they were got at the south and eastern parts of the bay (nearest the open sea), none being procured at the innermost Station IV., which runs round the bay in from $5\frac{1}{2}$ to 7 fathoms. In April, May, and June the same general distribution was shown, the gurnards being most abundant at Stations I., II., and V. In July and August they were, on the contrary, most numerous at Station IV., and in September and October the numbers at this station nearly equalled or exceeded the numbers at Stations I. or V. Much the same changes in the relative abundance of the gurnards occur at the stations at Montrose and Aberdeen Bays, where, however, the hauls were much fewer in number.

In the Moray Firth no hauls were made in January, February, March, or December, and only one in April, principally for the reason so often referred to, namely—the small size of the "Garland," most of the stations lying at a considerable distance from the coast. But there are data referring to all the other months of the year, and those for the inner stations near the coast (I.-VI.) show much the same relative changes as in the Firth of Forth and St. Andrews Bay. The number of gurnards caught was over 5000. The averages for the various months are as follows :—

May.	June.	July.	August.	September.	October.	November.
21·9	21·1	13·3	21·1	11·4	14·7	1·7

The highest average is thus seen to be in May; that for June is not much lower; there is a fall in July and a rise in August, just as at the inner parts of the Firth of Forth and in St. Andrews Bay; and the average for November is very small, showing that the gurnards leave the inshore waters of the Moray Firth towards the end of the year. At the outer stations (VII.-XVI.), some of which are far from the coast and in deep water, the relative abundance in the various months is different. The averages are as follows :—

May.	June.	July.	August.	October.	November.
21·0	19·2	23·1	37·3	39·4	29·6

Thus in May and June gurnards appear to be fairly equally distributed throughout the Moray Firth generally, both at the offshore and the inshore stations, although slightly more numerous at the latter. In July they begin to leave the inner parts of the Firth and become more abundant in the offshore waters, and especially at the intermediate stations. This outward movement is indicated by the high averages for October and November—the average for October being the highest for any of the months and double the average for June. At Smith Bank gurnards appear to be numerous in May and June, much less abundant in July and August, and very abundant in October and November, when the averages are 40 and 37 respectively. Only 20 hauls, however, were made at Smith Bank in these months.

In the Firth of Clyde, in which over 3000 gurnards were caught by the "Garland," the abundance of this fish in the various months is much the same as in the Moray Firth. Excluding those caught in Loch Fyne, which fall into a different category, the averages for the different months are as follows:—

January.	February.	March.	April.	May.	June.
13·6	0·0	26·5	22·2	18·6	...
July.	August.	September.	October.	November.	December.
10·6	63·6	11·8	27·0	19·0	31·1

No hauls were made in June, and only two in February. The most striking feature of difference between these figures for the Clyde and those for the Firth of Forth area and St. Andrews Bay is the comparatively high averages for January, March, October, November, and December. It is clear that the gurnards do not leave the Clyde area in the winter as they do in the other inshore areas mentioned. With the exception of two or three stations, near shore and in comparatively shallow water, gurnards were present in all the hauls in January and December. They were present at all stations except one in November, and at all except one in October. But in these months and in March by far the greatest numbers were got at the outer stations, in deep water, to the west of Ailsa Craig (VIII.-IX.), and off Rhuad Point, Cantire (VI.). The temperature of the bottom water at these stations in December and January is nearly the same as it is in the Firth of Forth in June and July.

In the upper parts of Loch Fyne gurnards are not present in abundance, but they were found there in all the months when hauls were made—viz., March, April, May, August, October, November, and December. The numbers caught in the 39 hauls were small, but the averages may be given, as follows:—

March.	April.	May.	August.	October.	November.	December.
0·6	3·7	2·2	8·4	14·0	3·6	3·5

The remark regarding temperature applies also here, viz., that the bottom water in Loch Fyne at the stations where the gurnards were caught is as warm in December as the bottom water in the Forth is in July.

The Relation between the Temperature of the Water and the Migratory Movements.

Turning now to the question of the temperature of the water in the Firth of Forth area in the various months of the year, it will be found that a very definite relationship exists between the changes in the temperature and the migratory movements of the gurnards. The mean temperature of the surface and bottom water in each month of the ten years, at all the stations where the gurnards were captured, has been calculated in the Fahrenheit scale as follows, from over 1200 observations:—

TABLE III.

January.		February.		March.		April.		May.		June.	
Surf.	Bot.	Surf.	Bot.	Surf.	Bot.	Surf.	Bot.	Surf.	Bot.	Surf.	Bot.
41·6	42·2	40·6	40·6	40·2	40·0	43·1	42·2	47·2	45·6	51·9	47·6
July.		**August.**		**September.**		**October.**		**November.**		**December.**	
Surf.	Bot.	Surf.	Bot.	Surf.	Bot.	Surf.	Bot.	Surf.	Bot.	Surf.	Bot.
54·6	50·8	55·2	53·5	54·2	53·3	51·0	51·4	47·3	48·1	44·0	44·8

These means refer to the whole of the Firth of Forth area—that is to say, to all the stations combined. The means for the ten years at each of the stations are given in Table IV.:—

TABLE IV.

Months.	I. Surf.	I. Bot.	II. Surf.	II. Bot.	III. Surf.	III. Bot.	IV. Surf.	IV. Bot.	V. Surf.	V. Bot.	VI. Surf.	VI. Bot.	VII. Surf.	VII. Bot.	VIII. Surf.	VIII. Bot.	IX. Surf.	IX. Bot.
	Stations.																	
January, .	40·4	40·9	40·5	40·9	40·0	40·8	39·2	39·5	42·2	43·0	41·7	42·1	40·7	41·4	41·6	42·2	41·7	42·6
February .	40·3	40·6	39·8	40·2	40·2	40·4	39·2	39·4	41·0	41·2	40·5	40·8	40·3	40·3	41·2	41·3	41·3	41·6
March, .	40·4	40·4	40·4	40·3	40·3	40·2	39·9	39·8	40·2	39·5	40·1	40·0	40·4	39·9	39·9	40·0	40·1	40·2
April, .	42·8	42·2	43·0	42·9	45·2	42·7	43·5	42·8	43·0	42·0	43·1	42·2	42·9	42·1	43·2	41·8	43·3	41·4
May, .	47·0	45·6	48·1	46·3	47·5	46·0	47·8	47·8	46·4	44·3	46·2	45·3	48·3	46·0	46·6	44·5	46·5	44·1
June, .	52·6	48·1	53·6	47·2	52·1	48·5	52·9	51·9	51·2	47·5	51·4	48·0	51·5	47·2	51·5	45·4	50·5	44·6
July, .	55·0	51·2	54·0	50·8	55·2	51·9	56·3	54·2	54·0	49·2	53·8	50·9	54·0	51·5	54·2	49·3	54·4	47·9
August, .	54·8	53·9	54·9	53·7	55·6	53·8	55·8	55·5	55·0	53·4	54·8	54·1	55·6	54·0	55·2	52·3	55·0	50·7
September,	54·1	53·7	54·1	53·6	54·0	53·5	54·1	54·1	53·9	52·9	53·9	53·2	53·9	53·4	54·3	53·2	54·3	52·6
October, .	51·4	51·5	51·8	51·8	51·2	51·1	50·8	51·2	51·3	51·3	51·0	51·0	51·2	51·5	51·2	51·5	51·6	51·7
November,	47·1	48·1	47·5	48·0	47·1	47·8	46·5	47·2	47·6	48·2	47·4	47·8	46·5	48·5	48·5	49·2	49·0	49·5
December,	44·2	45·0	43·7	44·6	43·4	44·4	42·6	42·9	44·3	45·0	44·3	44·6	43·3	44·6	45·0	45·8	45·2	46·0
Range of Means .	14·7	13·5	14·5	13·5	15·6	13·6	17·1	16·1	14·8	13·9	14·7	14·1	15·3	14·1	15·3	13·2	14·9	12·4

Reference to these Tables shows that the mean minimum temperature of the surface and bottom water is in March, and the mean maximum temperature of both in August. In February and early in September the temperature of the surface and bottom water is the same. It is, however, the changes in the temperature of the water at the bottom that chiefly concern us here, for although the gurnard not infrequently leaves the bottom, especially, as we shall see, during the night, it is typically a bottom or ground fish. The lowest temperature of the bottom water occurs about the middle of March, usually a little before the middle, and in the latter part of the month the rise begins, which continues to increase until about the middle of the following August; thereafter it declines until the next March. The maximum and minimum temperatures may vary by a week or two in different years. We see from the Tables that the mean rise in April is 2·2 deg. F. above the temperature in March, and in May there is an additional rise of 3·4 deg. F.

Now it appears to be just at the time when the temperature of the bottom water begins to rise that the gurnards first make their appearance in the Firth of Forth area. They have been waiting, as it were, in the open sea offshore until this sign of the new season reaches them, and then they begin to move inwards. And the temperature at which the inward migration begins seems to be fairly definite. In Table I. it is shown that only three gurnards were captured in February, and fifteen in March. The particulars in regard to these are of interest, and are represented in the accompanying Table :—

Date.	Station.	Gurnards.		Temperature of Bottom Water.	Difference from mean Temperature.
		No.	Size in inches.		
Feb. 18th, 1896.	VIII.	2	12, 12.	43	+ 1·7°
„ 19th, 1891.	IX.	1	10	42·3	+ 0·7°
March 13th, 1891.	II.	1	4	40·6	+ 0·3°
„ 19th, 1891.	V.	1	12	40·6	+ 1·1°
„ 21st, 1891.	VI.	1	13	40·6	+ 0·6°
„ 18th, 1890.	IX.	1	13	42·0	+ 1·8°
„ 14th, 1890.	VI.	1	14½	42·0	+ 0·2°
„ 14th, 1894.	VIII.	1	14	40·6	+ 0·6°
„ 29th, 1894.	VII.	4	6, 10, 14, 14	41·2	+ 1·3°
„ 30th, 1894.	VI.	2	12, 14	41·2	+ 1·2°
„ 30th, 1894.	V.	3	10, 10, 12	41·0	+ 1·5°

In all cases it will be seen that the temperature of the bottom water at the stations where gurnards were captured in February and March was above the mean for these months at these stations (*vide* Table IV.). In St. Andrews Bay all the gurnards taken in March, fourteen in number, were obtained in 1890. In that year two series of hauls were made at the stations there: one series on the 3rd, 4th, and 5th, when the bottom temperature varied at different stations from 40·5 deg. F. to 41·3 deg. F., and exhibited a mean for the area of 40·9 deg. F. Both the mean temperature and the station temperatures were higher than in March of any other year, and one gurnard, 16 inches in length, was caught at Station II., where the temperature was 40·80 deg. F. The second series of hauls was made on March 26th, 27th, and 28th, when the mean temperature was 42·2 deg. F., and the individual temperatures at the various stations ranged from 42·1 deg. F. to 42·3 deg. F. Thirteen gurnards were caught, as follows :—

	I.	II.	III.	IV.	V.
No.	5	4	1	0	3
Size (inches),	16,16,14,14,11	15,15,13,13	7	...	13½,13½,13½
Temperature.	42·1°	42·2°	42·1°	42·3°	42·1°

When these facts are considered with those relating to the Firth of Forth it appears that no gurnards are caught in these areas when the temperature of the bottom water is below 40·5 deg. F. It is not until the temperature has risen about 0·5 deg. F. above the minimum mean temperature that the gurnards begin to make their appearance at the outer stations.

An examination of the details for each station at which gurnards were caught in March shows that as a general rule they were caught in years when the bottom temperature was highest, and that when the bottom temperature was lowest no gurnards were obtained.

In April, as we have already seen, gurnards were caught at all stations, the general average per haul being 11·1. The mean bottom temperature in this month is 42·2 deg. F., or 2·2 deg. F. above the mean for March. An examination of the temperatures at each station in each year shows the operation of the general law, most of the gurnards being caught when the temperature was highest, and few or none when it was lowest. This applies without exception to the inner and intermediate groups of stations, except that in 1890, when the temperature was highest, no gurnards were caught at Station I. or Station V.

The migrating gurnards move into the Forth with considerable rapidity, and it is possible that this movement takes place chiefly at night. At all events, by far the most gurnards are got on the bottom in daylight. Thus, in a number of hauls which were made by night and by day at the same stations in the Firth of Clyde, at intervals of usually a few days between the day and night hauls, the proportion of gurnards captured was very different. In 20 hauls in daylight 513 gurnards were caught, an average of 26, and no haul was blank; 20 hauls at night caught 95 gurnards, an average of 5, and thirteen hauls were blank.

In May, when the bottom mean temperature is increased by 3·4 deg. F. over the mean of April, the abundance of gurnards is greatest (Table I.); but from this period, although the temperature of the water goes on increasing until it reaches its maximum in August, the number of gurnards diminishes. It is noteworthy, however, that in August, and in some places in September, there is again an increase in their numbers. The reason of this will be indicated later. It occurs in the inner parts of the Firth of Forth, in St. Andrews Bay, the Moray Firth, and the Firth of Clyde. About the middle of August—in some years a little earlier, and in some years a little later—the temperature of the bottom water in the Firth of Forth and St. Andrews Bay, and in the inshore waters on the East Coast generally, begins to decline. The fall is at first very gradual, so that the temperature for September is not very much below the temperature for August, but in October the fall is very marked, amounting to about 2 deg. F. under that for September. It is at this time that the gurnards begin to leave the inshore waters for the open sea. Just as their inshore migration in spring is associated with the initiation of the rise in temperature, so is their offshore migration associated with the fall in the temperature. At first, in September, their numbers are not greatly diminished, but in October the exodus is marked, and the mean temperature is about 2 deg. F. below that of the previous month. In November, when the temperature has sunk about 5·5 deg. F. below the maximum, comparatively few gurnards remain. In December, a few still linger in the inshore waters, with the mean temperature nearly 9 deg. F. below the maximum. In January, when the mean temperature is about 11 deg. F. below the maximum, they may be regarded as absent from the Firth of Forth and St. Andrew's Bay. Only one small specimen was caught in the Firth of Forth (see p. 211); another was got at Liston Bank in the open sea, 22 miles east from the Isle of May.

The close connection between the changes in the temperature in the Firth of Forth area and the abundance and migratory movements of the gurnards is shown in the adjoining diagram (Fig. 2), which also shows the spawning period (see p. 222).

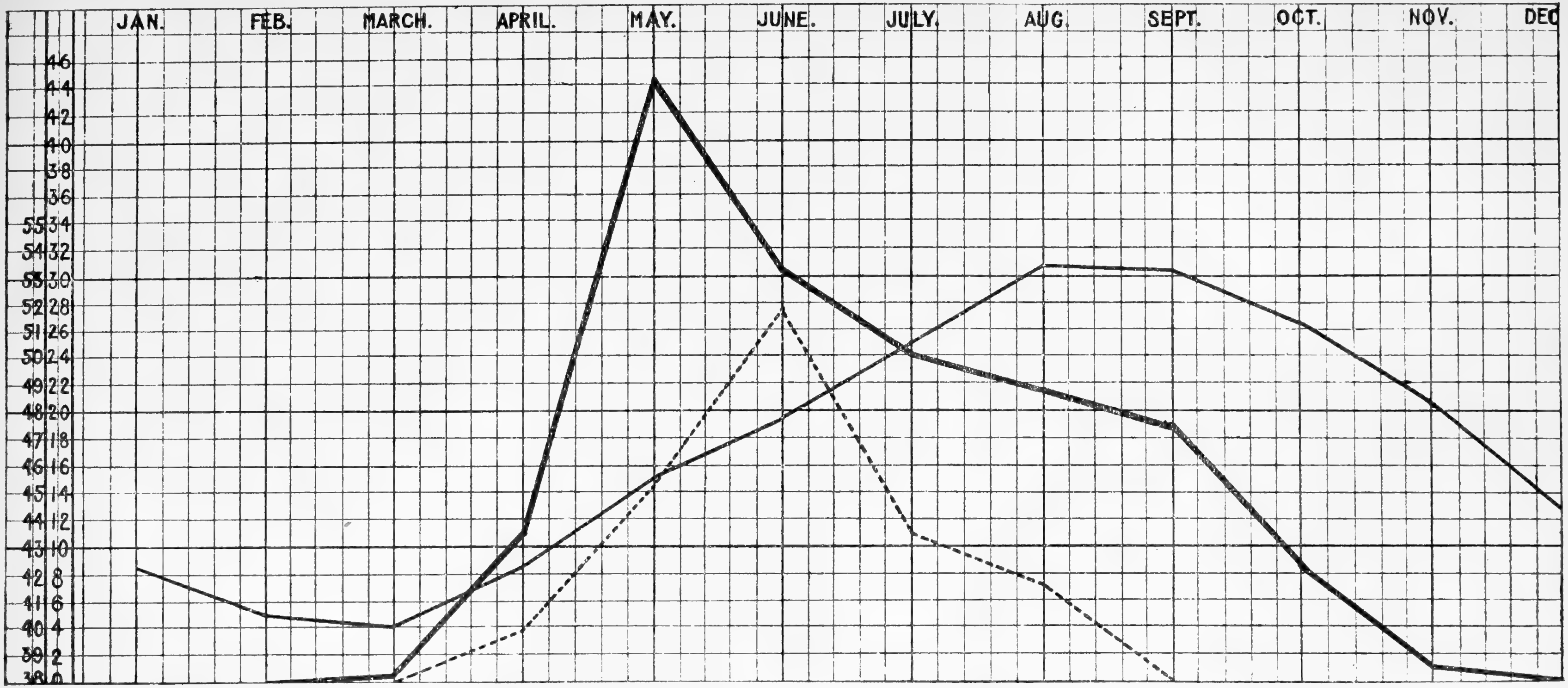


Fig. 2.—Showing the relation between the migratory movements of the common gurnard, the temperature of the bottom water, and the reproduction of the fish. The thick line represents the variation in the numbers of gurnards in different months; the thin line represents the variations in the temperature of the bottom water; and the dotted line represents the duration of the spawning period and the proportion of spawning fish in the different months of the period. The first series of figures on the left shows the temperature in the Fahrenheit scale; the second series shows the average number of gurnards caught per haul of the net in each month.

The temperature changes are practically similar in St. Andrews Bay, but they differ in the outer parts of the Moray Firth and in the Clyde, although the observations in these areas are neither so numerous nor so extensive. At the inshore stations in the Moray Firth (I.-VI.) the changes in the abundance of gurnards in the various months resemble those occuring in the inner parts of the Firth of Forth, except that in October they are more abundant in the northern waters. When the temperature observations are calculated, it is found that they agree fairly well with this result. The means for the various months in which observations were taken and hauls made at these stations are as follows:—

May.	June.	July.	August.	September.	October.	November.
48·1°	50·5°	52·3°	54·2°	52·8°	52·3°	47·6°

The corresponding temperatures for the Firth of Forth stations are given in Tables III. and IV., and it will be seen that the temperature in October is about 1 deg. F. less. At the outer offshore stations in the Moray Firth the temperature observations are not so complete, but they show that the bottom water in October and especially in November is still warmer, and this is related to the greater abundance of gurnards in these months. (See p. 215). The mean temperatures are as follows:—

May.	June.	July.	August.	October.	November.
45·5 deg.	47·7 deg.	50·2 deg.	52·1 deg.	52·6 deg.	49·4 deg.

There are unfortunately no records for January, February, March, April, and December.

Similarly, the presence of gurnards in the Clyde area in January and December, and their abundance in October and November, are explained by reference to the higher temperature of the bottom water in that area. The observations in the Clyde are not very numerous, but they show that in January the temperature at the deeper stations where the gurnards were chiefly caught ranges from 47 deg. F. to over 48 deg. F., or about 5 deg. or 6 deg. higher than in the Firth of Forth, where the same bottom temperature exists in the latter part of June. In March, at the Clyde stations, the bottom temperature is about 3 deg. higher than in the Firth of Forth; in October, at the outer stations, it is about 1 deg. higher; in November it is about 2·5 deg. higher, and in December the difference may amount to over 6 deg. F., the temperature corresponding then to the bottom temperature in the Firth of Forth at the end of July.

The Relation of the Migratory Movement to Reproduction.

The gurnard begins to spawn in April, and the spawning period extends until the latter part of August, in some cases into September. Spawning reaches its height in the early part of June, when the percentage of ripe fish is greatest. The curve, based on the percentage of ripe fish among those examined, is shown in the diagram (Fig. 2). The period over which spawning occurs is therefore extensive, more prolonged indeed than in most sea fishes.* Another feature in the reproduction of the gurnard, first established by the investigations of the "Garland," is that the spawning fish frequent the inshore waters, and shed their eggs there, within the Firth of Forth, as well as in the waters a little further off. In this respect the gurnard differs from most other fishes, and especially round-fishes. Most other adult fishes, such as the cod, haddock, plaice, lemon sole, &c., leave the shallower inshore waters at the spawning period, and shed their eggs offshore. The gurnard, on the other hand, approaches

* Fulton—"The Spawning and Spawning Places of Marine Food Fishes." *Eighth Annual Report Fishery Board for Scotland,* Part III., p. 257. *Tenth Annual Report,* Part III., p. 232.

closer to the coast at spawning time in this area, and it appears to be the only fish whose eggs are pelagic that does so. It resembles the herring in this particular. The other fishes with pelagic eggs which spawn in the inshore waters on the East Coast, as well as in the offshore waters, are the common dab, the long rough dab, the flounder, and the sprat. In the case of the flounder there is distinct evidence of a movement at the spawning time into deeper water than the usual habitat of this fish. In the case of the dabs there does not appear to be any marked movement of the kind. The migration of the gurnard in April and May from the open sea towards the shores is therefore primarily connected with reproduction; but that it is not solely connected with reproduction is shown by the fact that great numbers of small immature fish, which do not develop eggs in the same season, follow the larger mature gurnards in May. A study of the components of the migrating shoals makes these points clear; and for this purpose the sizes of all the gurnards have been tabulated.

The size at which the gurnard reaches maturity is about nine inches, sometimes a little less.* The great majority under nine inches may be regarded as immature, and the great majority above nine inches as mature. All under eight inches may be considered immature, and all over 10 inches, at the spawning period, may be looked upon as mature spawning fish. It has already been stated that the gurnards caught in the Forth area in February and March, when the inshore migratory movement commences, were of large size (Table, p. 219). Only one was under 10 inches—viz., one of the four caught at Station VII. at the end of March 1894, which was only six inches long. Of the fourteen obtained in St. Andrews Bay in March, only one was under eleven inches—viz., seven inches. With these two exceptions, the March gurnards, the pioneers of the migrating shoals, were all spawners. The numbers caught in March were small. Of the fourteen caught in the Forth area, ten, or 71·4 per cent., were twelve inches or more in length, and thirteen, or 93 per cent., over ten inches. Of fourteen caught in March in St. Andrews Bay, thirteen, or 93 per cent., were twelve inches or more in length. Of the 545 caught in April, whose sizes were measured,‡ 412, or 75·6 per cent., were over nine inches in length; 359, or 65·9 per cent., were over ten inches; and 171, or 31·3 per cent., were over 12 inches in length. The gurnards under nine inches, the great majority of which were no doubt immature, numbered 133, or 24·4 per cent.; those under eight inches numbered only 53, or 9·7 per cent. Only two gurnards at five inches were caught in April (0·3 per cent.), and none smaller.

We therefore see that in April, while the great majority of the migrating gurnards are adults, moving to the inshore waters to spawn, immature forms begin to accompany or follow them. All the gurnards caught from four inches to seventeen inches have been tabulated for each month, according to their length, into groups differing from each other by intervals of an inch, and curves constructed, which need not be reproduced here. They show that in April the largest number caught were ten inches in length, then came those of twelve inches, very nearly as numerous; the next most numerous were those at eight inches, and then those at six inches. In the next month this feature became strongly marked, the majority of the gurnards caught in May being under nine inches in length. Instead of 31·3 per cent. being twelve inches or over,

* Fulton, *Eighth Annual Report*, Part III., p. 161. *Tenth Annual Report*, Part III., p. 240. Holt, *Journal Marine Biological Association*, Vol. II., p. 218. Royal Dublin Society, Report of Council, 1891, p. 275.

‡ The fish were first measured in 1888.

there are now only 10·2 per cent. of that size. Those over ten inches have sunk from 65·9 to 29·6 per cent.; 58·8 per cent. are under nine inches, and 41·2 per cent. are over nine inches; 36·6 per cent. are under eight inches instead of 9·7 per cent. as in April. And now we find also the very small gurnards, between three and five inches, figuring as an important component of the shoals, of which they form 8·1 per cent. Gurnards at eight inches were by far the most common in May (576); the next most abundant were at six inches (438), and then seven inches (303), and nine inches (300), ten inches (285), and eleven inches (220); 153 measured five inches, and sixty-one four inches.

In June the young gurnards continue to augument in numbers. Those measuring nine inches or over, the adults, form only 39·5 per cent. of the shoals, while those under nine inches have increased to 60·5 per cent. The larger forms, at or over twelve inches, have sunk to 7·8 per cent., and those at or over ten inches to 22·2 per cent. On the other hand, gurnards under eight inches in length have increased to 43·3 per cent. of the totals; but the very small ones, between three and five inches in length, have slightly diminished, and form now 4·1 per cent. of the shoals. Thus it would be erroneous to assume that the inshore migration of the gurnard is solely in connexion with reproduction, for in June, the month in which spawning chiefly takes place, the shoals are composed for the most part of immature forms. The proportion of those under nine inches is the highest for the year; the proportion of those under eight inches is only exceeded slightly in July and in September. The most common size of the gurnards in June was seven inches; of these 448 were caught. The next most common sizes were eight and nine inches.

In July the total, or average per shot, continues to diminish (Table I)., but the adult gurnards are rather more numerous; and this increase in the proportion of adult (and probably spawning) gurnards becomes much more pronounced in August. The proportion of adults—those over nine inches—in July rises to 41·4 per cent., an increase of 2 per cent.; but the increase of the larger forms is more marked, those over ten inches rising to 30·3 per cent., an increase of 8, and those over twelve inches rising to 14·4 per cent., or very nearly double the proportion in June. The gurnards under nine inches form 58·6 per cent., those under eight inches 45·3 per cent., and those between four and five inches show a great increase to 21·2 per cent. The feature of the month is the increase in the abundance of very small gurnards and of the larger adults, and a diminution of the medium-sized, from seven to ten inches in length.

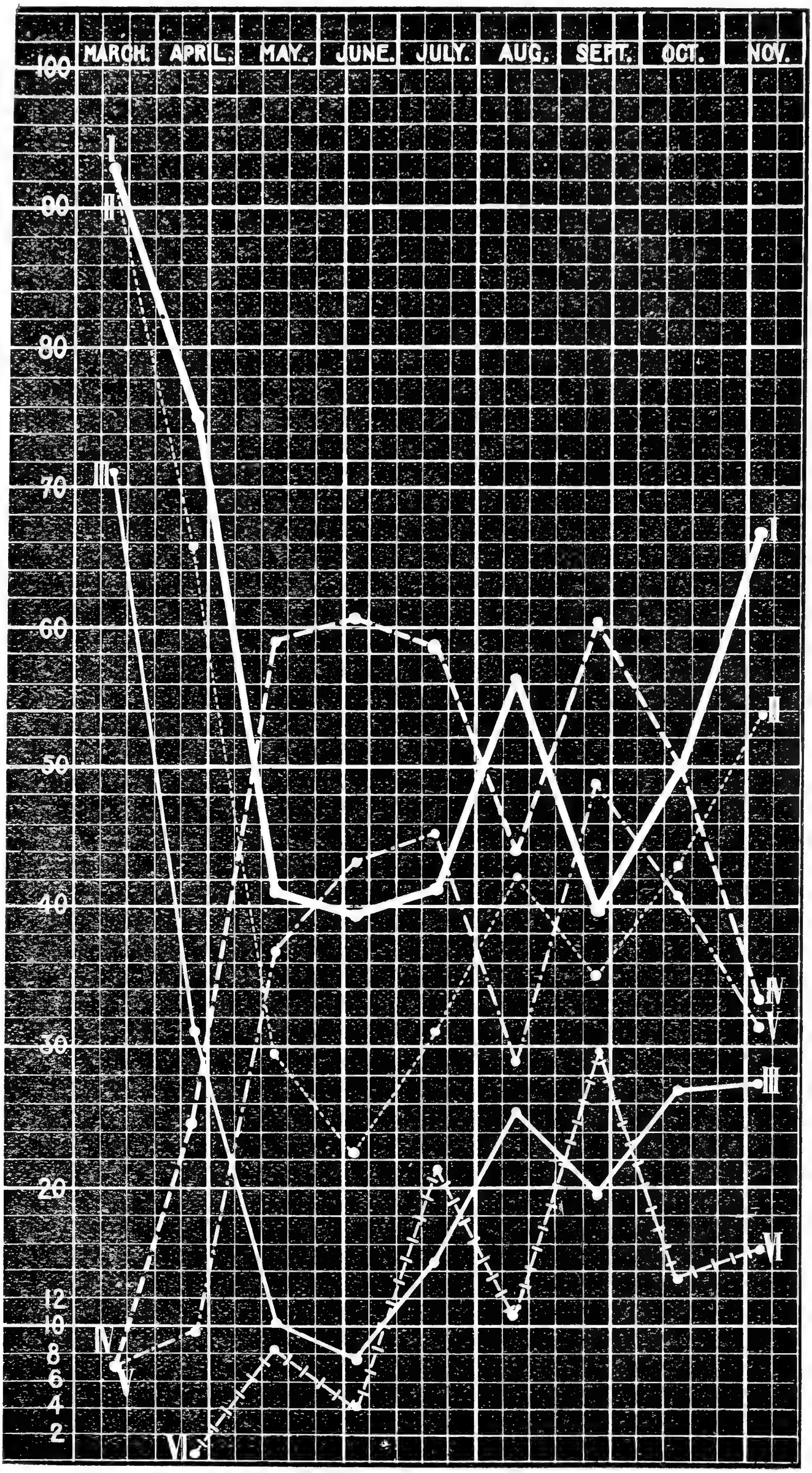


Fig. 3.—Showing the proportions of adult and immature gurnards, of various sizes, in the different months. Line I., over nine inches in length; II., at or over ten inches; III., at or over twelve inches; IV., under nine inches; V., under eight inches; VI., under five inches.

In August, as has been said, the increase in the larger adults is still more pronounced. Thus the percentage of those at or over 12 inches in length rises to 25·6, more than three times what it was in June; the proportion of those at or over ten inches rises to 42·1 per cent., nearly double what it was in June; those over nine inches form 56 per cent. of the shoals, those under nine inches amount to 44 per cent., and those under eight inches to 28·9 per cent. The feature of the month is the increased abundance of the larger adults. In September, the proportion between the adults and the immature reverts to what it was in June, the percentage of those over nine inches in length being 39·8, and of those under nine inches 60·2. The proportion of large adults is still, however, high—viz., 19·5 per cent., those over ten inches amounting to 35·1 per cent. The special feature is an increase in the numbers of small gurnards, those under eight inches amounting to 48·6 per cent., the highest of the year, and it is chiefly caused by an increase in those at four and five inches, the percentage of which rises to 29·7. In October the percentage of the adults and immature is exactly equal. The proportion of large adults is still higher, and the special feature is the diminution in the numbers of the smaller gurnards under five inches, which is also marked in November, when the proportion of adults and of large adults rises to approach what it was at the beginging of the inshore migration. Thus the adults appear to remain longest in the inshore waters; they come first and leave last. The immature forms come in later and leave sooner. The proportions of the different sizes in the various months are given in Table V. :—

TABLE V.

	5 Inches and under.	Under 8 Inches.	Under 9 Inches.	9 Inches and over.	10 Inches and over.	12 Inches and over.
March, . .		7.1	7·1	92·9	92·9	71·4
April, . .	0·3	9·7	24·4	75·6	65·9	31·3
May, . . .	8·1	36·6	58·8	41·2	29·6	10·2
June, . . .	4·1	43·3	60·5	39.5	22·2	7·8
July, . . .	21·2	45·3	58·6	41·4	30·3	14·4
August, . .	10·3	28·9	44·0	56·0	42·1	25·6
September, .	29·7	48·6	60·2	39·8	35·1	19·5
October, . .	13·7	40·7	50·0	50·0	43·4	26·8
November, . .	15·9	31·7	33·7	66·3	53·9	27·0

Two points may be specially considered in connection with the above facts, first, the increase in the number of adults in autumn, and second, the migration of the immature gurnards into the inshore waters.

With regard to the former, it appears probable that towards the end of July new shoals of spawning adults make their way into the inshore waters. The relative increase in the numbers of these large gurnards is also an absolute increase; that is to say, the average per haul of the trawl is higher, as well as the percentage proportion. Thus the average per haul of those at or over nine inches, ten inches, and twelve inches in the various months is as follows:—

	9 Inches.	10 Inches.	12 Inches.
April, - - - - -	7·6	6·8	3·2
May, - - - - -	17·3	12·4	4·3
June, - - - - -	13·9	7·8	2·7
July, - - - - -	11·0	8·0	3·8
August, - - - - -	13·5	10·1	6·1
September, - - -	8·1	7·1	4·0
October. - - - - -	4·3	3·7	2·3
November, - - -	0·8	0·7	0·3

It will be observed that in August the number of those at or over nine inches in length approaches the number in May and June, and that the increase is chiefly in the larger sizes. The average per haul of those at or over 12 inches is the highest of the year. It will also be noticed that the absolute numbers of the larger sizes, as well as their ratio to the other components of the shoals, increase somewhat in July. We possess at present very little definite information as to the duration of spawning in the individual fishes of any species; but it is known from the condition of the ovaries and the comparatively small proportion of eggs that become matured at the same time that the period in many cases for all the eggs to be shed is considerable. This is especially so in fishes which produce pelagic eggs, and it is a marked feature in the reproduction of the gurnard.* It is no doubt partly for this reason that the spawning period of the gurnard as a species is so prolonged; but it is unlikely that the gurnards which begin to spawn in April and May continue spawning in July and August. The spawning fishes at the latter part of the period more probably do not begin to spawn until the season is well advanced, and this opinion is supported by a study of the proportions of ripe gurnards in different months. In the diagram (Fig. 2) it will be seen that the downward slope of the curve from June is interrupted in July and August, so that it is prolonged into September, and this agrees with the curves representing the proportion of adults at the same time. In all cases, whether the average per haul or the percentage is considered, there is seen to be a rise in the numbers of the larger adults in July and especially in August; and this increase is common to the other areas—viz., St. Andrews Bay, the Moray Firth, and the Firth of Clyde. Moreover, it is found on analysis of the data referring to the different stations in the Firth of Forth area that in July there is a rise from June at the outer stations (VIII.-IX.), and a fall there from July to August and September. At the inner stations (I.-IV.) there is, on the other hand, a rise from July to September, which might be accounted for on the supposition that spawning adults had then moved inwards.

The migration of the immature gurnards is obviously due to some other cause than reproduction, and may be owing to more abundant food supply, the shoaling instinct, or simply to the increasing temperature of the inshore waters. It seems reasonable to suppose that the movement of the adult gurnards to the inshore grounds at the spawning time would be followed by the smaller gurnards also moving inwards, provided the supply of food was at least equally abundant. The average numbers caught per haul of the net in the various months are as follows :—

* The Comparative Fecundity of Sea Fishes. *Ninth Annual Report Fishery Board for Scotland*, Part III., p. 250.

	9 Inches and under.	Under 8 Inches.	5 Inches and under.
April, - - - -	2·5	1·0	0·04
May, - - - -	24·7	15·4	3·4
June, - - - -	21·2	15·2	1·4
July, - - - -	15·5	12·0	5·6
August, - - - -	10·6	7·0	2·5
September, - - -	12·2	9·9	6·0
October, - - - -	4·3	3·5	1·2
November, - - -	0·4	0·4	0·2

The food of the gurnard consists for the most part of crustacea, especially *Crangon, Pandalus,* and *Portunus,* and also to a considerable extent of other fishes ;* but whether the supply of food is more abundant on the inshore than the offshore grounds when the immature gurnards begin to come in, and forms a factor in inducing the migration, is not clear. It may be that the younger forms are specially susceptible to the changes in the temperature of the bottom water. It may be seen from Table IV. that from April to the end of September and October the mean temperature of the bottom water is higher within the Firth than it is outside (VIII.-IX.), and the great bulk of the gurnards are always to be found in the warmest water.

The Rate of Growth.

Owing to the prolonged spawning period of the gurnard, the difficulty of determining the rate of growth from the collation of the measurements at different seasons is very great. It is clear that individuals hatched in April or May, and those hatched in August or September of the same year, will be of very different sizes in the spring of the following year. It is not only that the period of hatching is separated by an interval of four or five months; even more important is the circumstance that those which are hatched in the spring pass their post-larval and young stages in the warm water of the summer months when growth is most rapid, while those hatched at the end of August or the beginning of September meet at once with a falling temperature. It is well known that the growth of fishes during the winter months is very slight; and thus, for the two reasons indicated, the size of the young gurnards hatched in one season may show considerable range of size even early in the next season. There is a further cause of difficulty not always borne in mind—viz., that the sizes of the sexes differ—the females being usually somewhat larger, as in the gurnard ;† and there is little doubt that the rate of growth of the female is somewhat more rapid. The rate of growth of different individuals of the same sex also varies. It would therefore require a large series of minute and detailed measurements of both sexes to determine accurately the rate of growth.

The very young gurnards are not, of course, caught in the ordinary trawl-net of the "Garland"; most of them under five inches, and almost all at or under three inches, escape through the meshes.‡ But the majority of these small forms are captured by the "shrimp" trawl-net, in which

* W. R. Smith, *Tenth Annual Report Fishery Board for Scotland,* Part III. pp. 215-218.

† *Tenth Annual Report,* Part III., p. 239.

‡ *Twelfth Annual Report,* Part III., p. 312.

the meshes are smaller, and larval and post-larval stages are taken in the tow-nets. The latter may be first dealt with. In August and September forms ranging up to 16 millimetres in length were taken in the Moray Firth; and at the end of October one 12mm. long (= ½ an inch), was taken in the same area.

Date.	No.	Size.	Locality.	Net.
August 8th, 1895.	1	13mm.	Moray Firth, IX.	Surface.
,, 9th, ,,	1	11mm.	,, XIII.	Midwater.
,, ,,	2	13 and 15mm.	,, XIV.	,,
,, 25th, 1896.	2	5 and 10mm.	,, VI.	Surface.
,, ,,	2	6mm.	,, VI.	Bottom.
,, ,,	1	11mm.	,, VII.	Surface.
,, ,,	8	5•8mm.	,, VIII.	Bottom.
,, ,,	1	10mm.	,, ,,	Surface.
,, ,,	4	7·5–8·5mm.	,, ,,	Bottom.
,, ,,	3	5–7mm.	,, IX.	,,
,, 26th, ,,	5	5–10mm.	,, X.	,,
,, 29th, 1894.	1	16mm.	Firth of Forth, IX.	,,
Sept. 21st, 1896.	1	4mm.	Moray Firth, II.	Surface.
,, ,,	4	10–11mm.	,, ,,	,,
Oct. 29th, 1894.	1	12mm.	,, off Burghead.	(?)

Some of these were evidently recently hatched. The occurrence of a post-larval form of 12mm. so late as the 29th October is of interest. On the same date in another year (1891) a young gurnard of 29mm. (1⅛in.) was procured in the bottom tow-net in Largo Bay, Firth of Forth. On 2nd September 1892—nearly two months earlier—a specimen of 32mm. (1¼ inch) and another of 42mm. (1⅝ inch) were obtained in the bottom tow-net at Station VI in the Moray Firth, which clearly belong to the same season and are probably from three to four months old. By means of the shrimp-net young gurnards about the same size and very little larger were procured in November in the Clyde, viz.—under two inches and some between two and three inches. The gurnards caught by the shrimp-net on the bottom, under three inches in length, are as follows:—

[TABLE.

	Date.	No.	Locality.
1. Under two inches (51mm.) - -	Nov. 26th, 1895.	1	...
2. Between two and three inches, -	Jan. 24th, 1899.	1	Station VII., Firth of Clyde.
	April 22nd, 1896.	3	,, X., ,,
	May 4th, 1893.	1 (3in.)	Smith Bank, Moray Firth.
	,, 10th, ,,	7	Station XV., ,,
	Sept. 1st, 1896.	1	,, VII., Firth of Clyde.
	,, 17th, ,,	1	,, IV., ,,
	Oct. 14th, ,,	18	,, XVI., Moray Firth.
	,, 23rd, ,,	1	,, V., ,,
	,, 26th, ,,	4	,, VII., ,,
	,, ,,	2	,, VIII., ,,
	,, ,,	5	,, IX., ,,
	Nov. 8th, 1892.	4 ($2\frac{1}{4}$–3)	,, III., St. Andrews Bay.
	,, ,,	1 ($2\frac{1}{2}$)	,, I., ,,
	,, 9th, 1897.	...	,, IX., Moray Firth.
	,, 11th, ,,	2	,, VII., ,,
	,, ,,	2	,, V., Firth of Clyde.
	,, 22nd, 1895.	1	,, V., ,,
	,, 25th, ,,	2	,, VII., ,,
	,, 26th, ,,	1	,, X., ,,
	,, 26th, 1896.	4	,, VII., Moray Firth.
	,, ,,	2	,, VIII., ,,
	,, ,,	5	,, IX., ,,

It will be observed that no gurnards under three inches in length were caught between May and September, and that the greatest numbers were caught in October and November. The absence of these small gurnards is not due to no hauls having been made in the intervening months. Hauls with the shrimp-net were also made in June (10 in number), July (6), and August (11). The numbers caught in each month in which hauls with the shrimp-net were made are as follows :—

	Jan.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
No. of Hauls. ...	12	41	34	10	6	11	23	25	13
No. of Gurnards under 3 inches, ...	1	3	8	0	0	0	2	30	24
Average, ...	0·08	0·07	0·23	0·0	0·0	0·0	0·09	1·2	1·8

One conclusion from these facts is clear—viz., that the gurnards under three inches in length caught in January, April, and May belong to the previous year's spawning. The increased number caught in May is no doubt due to the participation of the young forms in the migratory movement at that time (see p. 224). The absence of a single specimen under this size in June, July, and August is probably largely owing to the growth of the young gurnards hatched in the previous season to a greater size than three inches. It also appears probable that the gurnards from two to three inches in length caught in October and November belong in part at least to the same year's spawning, so that those caught in October might be five or six months old. Those caught in January must be at least five months old, and those in May eight months old, but in these cases growth would be retarded by the low temperature in the winter months. In considering the sizes somewhat larger the difficulties previously alluded to became more evident, inasmuch as the gap separating the gurnards of different years begins to be bridged over. Still, it is noteworthy that in plotting out the curves of the various sizes for each month, the sizes are aggregated in various groups. Thus in April, there is a group at six inches, a group at eight inches, one at ten inches, and one at twelve inches. In May there are great groups at six inches, and, especially, eight inches, and at ten inches. In June the chief groups are at seven and nine inches. In July a group at five inches is prominent, then one, not so sharply pronounced, at 7–8 inches, and a group at ten inches. In August the group at five inches is sharply marked, there is a group 7–9 inches, and a pronounced group at twelve inches. In September there is a group 4–5 inches, and at eight inches, ten inches, and twelve inches. In October the chief group is at six inches. When the hauls for each individual month in each year are analysed in the same way they indicate a similar grouping. In April there is always a marked drop between six inches and eight inches, which is also shown in May, as well as a rise at ten and twelve inches. Individual hauls, in many cases where the numbers are fairly large, give evidence of a similar grouping. It would appear that the gurnards ranging about six inches in length in the spring of any year are from eighteen months to two years old, and that maturity is not reached until the third year, as in the case of most other sea fishes.

VI.—ON THE RATE OF GROWTH OF PLAICE.

By Harald C. Dannevig.

(Plate IX.)

In connection with various researches that are being carried on at the present time it is a matter of some importance to be able to determine the approximate age of young flat-fishes at different times of the year. Records of observations conducted in their respective countries with regard to several species have been published by Dr. J. G. Joh. Petersen in Denmark, Mr. J. T. Cunningham in England, and several other investigators. But the rate of growth of flat-fishes has been found sometimes to differ considerably in various parts of the North Sea and its branches, so that the information supplied from elsewhere might be at variance with the conditions in Scottish waters. In connection with experiments carried on at present with a view to test the utility of sea-fish hatching in this country it has become of much importance to be able, if possible, to distinguish between the fishes from the different years' hatching; or, in other words, to determine the age of the young plaice found on shallow beaches at the various seasons of the year. With this object in view it was deemed desirable to obtain further information regarding the conditions in this respect in Scottish waters, and in the following report an account is given of some observations that have been made at Dunbar for this purpose.

A very simple method by which information might be gathered regarding the growth of young fishes is to keep specimens in suitable tanks where observations of their growth can be made with ease and accuracy at regular intervals. This was also tried in this case; but it was found that the results thus arrived at did not always correspond with what the case appeared to be in nature. And after all, there are many and strong reasons why fishes reared artificially from the size of a few inches might differ in the rate of growth from those living in the sea. Information gathered in the one case might only be of doubtful value in regard to the other, although useful for comparison. For this reason in particular, but partly also on account of the inconvenience connected with the maintenance of a constant circulation at the time of the year when the hatchery was not working, these experiments were discontinued after the lapse of six months. Another method had in the meantime been adopted—viz., to make observations at regular intervals on young plaice captured in the sea. The Tyningham sands were selected as a suitable locality for such observations, since they form the most important nursery for plaice in this district. These sands, which are situated about one mile to the west of Dunbar, are about two miles long and about half a mile broad between high and low water marks at spring tide. The distance from low-water mark to a depth of four and a half fathoms, where the stony nature of the bottom renders trawling impossible, is also about half a mile. The sands lie open to the north-east, and are fully exposed to the rough weather that is sometimes experienced from that quarter. A shrimp-trawl with a twelve-foot beam was used for the capture of the fish. It was generally towed by a small steam launch, but in a few cases by a fishing yawl. Examination of the sands was made at intervals from July 1896 till June 1897, and on each occasion hauls were made at low water in the various depths from one to four fathoms. It was thought that such trawling might also furnish information with regard to increase or decrease in the abundance of young plaice on the sands from year to year, and detailed records were taken of all the conditions likely to influence the quantity of fish captured on each occasion. The principal conditions in this respect were found to be (1) the state of the sea—whether smooth or rough on the day of trawling and during the preceding days; (2) the transparency of the water; (3) the direction and strength of the wind; and (4) the state of the atmosphere—whether bright sunshine or cloudy, foggy, and dull. Owing to the free north-easterly exposure, the prevailing northerly to easterly winds during the autumn and winter months cause the sea to be very rough on these sands for the greater part of that time; and in this kind of weather the whole locality was sometimes found to be almost deserted of fish. The effect of such disarrangement could be observed for a couple of days after the sea had subsided. But after a storm (or heavy rains) the transparency of the sea-water on this coast is always greatly reduced, and remains so for several (4 to 8) days afterwards if calm weather and neap tides happen to follow. Under these conditions the fishes in the shallow water would not so readily observe the approach of the trawl in time to make their escape, and rich hauls were then always made. When the water was clear and calm, and the sun bright, a considerable number of fish could be seen gliding away from the boat and the trawl when working in the shallow water (from 6 to 15ft.), and very probably a certain number would also escape in this way when trawling was made at a greater depth. Another circumstance that influenced the quantity of fish captured was the speed of the boat, which was affected by the strength and direction of the wind. Owing to the frequent chances in these various conditions, and their strong influence on the number of fish captured, it would be necessary to examine sands thus situated at very frequent intervals and for a long period (years) before reliable statistics could be procured with regard to the changes in the actual abundance of fish there. But while the records of the trawling conducted during the one year cannot be used as a definite standard in this respect, they furnish some interesting results in regard to the main object in view; they show how the different sizes of plaice were found at various depths, according to the prevailing physical conditions and seasons of the year, but what is of still more importance—the fishes captured on each occasion were found to be separable into certain groups, representing the fishes hatched in the different years.

[TABLE.

TABLE I.—SHOWING THE PHYSICAL CONDITIONS WHEN TRAWLING WAS MADE, THE PARTICULARS CONNECTED WITH, AND THE RESULT OF EACH HAUL.

Number of Series.	Date. 1896.	General Conditions.	Number of Hauls each time.	Depth of Water in feet.	Duration of each Haul in minutes.	State of the Tide.	Number of Plaice of the various sizes captured in each Haul. 0–50 m.m.	55–100 m.m.	105–150 m.m.	155–200 m.m.	205–250 m.m.	255–300 m.m.	305–350 m.m.	Total.
I.	June 6.	Sky clear; calm; water clear; sea smooth.	1	9-15	30	1 hour before l.w.	—	26	7	—	—	—	—	33
			2	18-30	15	l.w.	—	2	16	—	—	—	—	18
II.	June 18.	Sky dull; N.W. breeze; water discoloured; sea smooth.	1	6-9	30	1 hour before l.w.	—	15	30	—	1	—	—	46
			2	9-15	30	¼ hour before l.w.	—	10	21	5	—	—	—	36
			3	18-24	15	½ hour after l.w.	—	1	6	—	—	—	—	7
III.	July 16.	Sky clear; strong N.W. breeze; water slightly discoloured; sea smooth.	1	3-9	80	1 hour before l.w.	550	117	4	—	—	—	—	671
			2	15-24	30	½ hour after l.w.	—	—	18	—	—	2	—	20
			3	24-30	15	1¼ hour after l.w.	—	3	19	2	—	—	—	24
IV.	Aug. 31.	Dense fog; light N.E. breeze; sea smooth; water strongly discoloured.	1	3-9	60	1 hour before l.w.	118	284	19	3	—	—	—	424
			2	15-24	60	l.w.	152	224	24	8	14	—	—	422
V.	Sept. 18.	Cloudy; storm from south; water strongly discoloured; sea smooth.	1	9-15	60	1 hour before l.w.	89	320	3	1	3	—	—	416
			2	18-24	60	l.w.	19	362	20	17	10	3	—	431
VI.	Oct. 5.	Sky clear; westerly breeze; sea calm; water clear.	1	9-15	60	1 hour before l.w.	13	163	23	4	2	1	—	206
			2	18-24	60	l.w.	—	4	21	5	5	2	—	37
VII.	Nov. 9.	Rain; strong S.W. breeze; water discoloured; sea smooth.	1	9-15	60	1 hour before l.w.	6	12	3	14	16	1	1	53
			2	18-24	60	l.w.	6	50	1	—	4	2	2	65
			3	24-30	60	1 hour after l.w.	2	10	1	3	6	2	—	24
VIII.	Dec. 9.	Rain; strong S.E. breeze; water much discoloured; some sea.	1	9-15	60	1 hour before l.w.	2	10	—	3	2	—	—	17
			2	18-24	30	l.w.	1	2	—	2	—	1	—	6
			3	24-30	30	½ hour after l.w.	1	5	1	3	—	1	—	11
IX.	1897. Feb. 10.	Sky clear; fresh S.W. breeze; water discoloured; some sea.	1	9-15	30	1 hour before l.w.	—	2	—	1	4	2	—	9
			2	18-24	30	¼ hour before l.w.	1	6	—	—	5	—	2	14
			3	24-30	30	½ hour after l.w.	1	24	—	1	4	2	1	33
X.	Apl. 29.	Sky overcast; strong S.W. breeze; water slightly discoloured; sea smooth.	1	9-15	60	1 hour before l.w.	—	10	9	8	—	—	—	27
			2	18-30	60	l.w.	—	54	13	21	—	—	—	88

In Table I. are recorded the prevailing physical conditions on each occasion when trawling was conducted, and also the particulars connected with, and the result of, each haul. Days with similar transparency of the water were selected as far as possible for the work, but owing to the exposure of the locality during the winter it was often necessary to take advantage of any opportunity that offered when the weather permitted of trawling in the shallow water. For some considerable intervals it was very risky to approach the shore in the boat, and the work had to be suspended for the time.

It was observed to be a general rule that (1) if the water was clear and calm the smallest fishes (below 100 m.m.) were found in the shallow water above the 15ft. limit, while the larger sizes were captured principally at greater depths; (2) if the transparency of the water was low, and the sea smooth, the larger fishes were mixed amongst the small ones close inshore; while (3) if there was any sea on, the smallest fishes were found in the deep water, and the larger ones were scattered all over at various depths. It may be mentioned, as a curious circumstance, that the youngest plaice were invariably found to be most abundant in the same depth of water as the common shrimp. As all the plaice captured on each date represent the sizes for that time, the results of the various hauls have been combined into one series. These series are represented in Table II., where also the detailed measurements, reduced to the nearest 0 or 5 in millimetres, are given.

[Table.

TABLE II.

SHOWING THE NUMBER AND SIZES OF THE PLAICE CAPTURED ON EACH DATE AND AN INDICATION OF THE NATURAL GROUPS INTO WHICH THE FISHES RAE DIVIDED.

Size in m.m. reduced to nearest 5 or 0.	NUMBER AND DATE OF THE SERIES.										Size in inches
	I. June 6	II. June 18	III. July 16	IV. Aug. 31	V. Sep. 18	VI. Oct. 5	VII. Nov. 9	VIII. Dec. 9	IX. Feb. 10	X. Apr. 29	
20	...	...	5	...	...	...	...	...	...	...	$\frac{3}{4}$
25	...	...	59	...	...	...	...	...	...	...	1
30	...	...	119	...	...	...	...	...	...	...	$1\frac{3}{16}$
35	...	...	113	...	...	...	...	...	...	...	$1\frac{3}{8}$
40	...	...	110	9	3	...	...	...	...	...	$1\frac{9}{16}$
45	...	...	74	92	25	1	5	...	...	...	$1\frac{3}{4}$
50	...	...	70	169	80	12	9	4	2	...	2
55	...	...	66	155	205	27	14	5	10	...	$2\frac{3}{16}$
60	...	...	31	190	229	32	26	1	8	4	$2\frac{3}{8}$
65	...	...	17	93	140	36	17	4	7	5	$2\frac{9}{16}$
70	...	...	3	36	67	33	9	4	1	18	$2\frac{3}{4}$
75	...	...		20	18	14	2	...	2	9	$2\frac{15}{16}$
80	...	1	...	12	15	9	2	2	1	12	$3\frac{1}{8}$
85	1	1	...		5	7	2	..	3	6	$3\frac{3}{8}$
90	4	5	...	...	2	6	...	...	...	4	$3\frac{9}{16}$
95	8	6	...	1		2	...	1	...	5	$3\frac{3}{4}$
100	15	13	3	1	1	1	...	...	...	1	$3\frac{15}{16}$
105	7	9	6	1	1			1	...	...	$4\frac{1}{8}$
110	13	14	10	2	1	3	...		...	...	$4\frac{5}{16}$
115	2	10	8	2	...	2	...	...		1	$4\frac{1}{2}$
120	...	5	4	1	...	4	...	...	...		$4\frac{3}{4}$
125	...	4	6	7	4	7	1	...	...	...	$4\frac{15}{19}$
130	...	4	2	4	2	8	...	...	...	2	$5\frac{1}{8}$
135	...	3	...	5	4	6	1	...	...	3	$5\frac{5}{16}$
140	...	2	3	11	4	6	2	...	...	8	$5\frac{1}{2}$
145	...	4	...	3	5	3	...	...	...	4	$5\frac{11}{16}$
150	1	2	2	7	2	5	1	...	...	4	$5\frac{7}{8}$
155			1	4	5	2	1	1	...	4	$6\frac{1}{8}$
160	...	...		3	1	3	2	1	...	2	$6\frac{5}{16}$
165	...	2	...		1	...	1	...	...	5	$6\frac{1}{2}$
170	...	1	...	...	1	1	3	...	...	7	$6\frac{11}{16}$
175	...	...	1	...	2		1	...	...	6	$6\frac{7}{8}$
180	...	..	...	1	2	...	1		...	1	$7\frac{1}{16}$
185	...	...	...	...	1	1	1	1	1	1	$7\frac{5}{16}$
190	...	...	...	1	...	...	3	3		1	$7\frac{1}{2}$
195	...	...	...	2	2	1	1	1	...	2	$7\frac{11}{16}$
200	...	2	...	...	3	1	3	1	1		$7\frac{7}{8}$
205	...	..	...	1	...	...	...	...	...	...	$8\frac{1}{16}$
210	...	..	...	3	..	2	4	1	1	...	$8\frac{1}{4}$
215	...	...	...	2	1	1	4	...	2	...	$8\frac{1}{2}$
220	...	...	...	2	1	...	1	...	2	...	$8\frac{11}{16}$
225	...	1	...	1	3	1	4	...	3	...	$8\frac{7}{8}$
230	...	...	...	2	1	...	5	1	3	...	$9\frac{1}{16}$
235	...	...	...	2	3	2	...	...	2	...	$9\frac{1}{4}$
240	...	...	...	1	1	...	2	...	...	...	$9\frac{7}{16}$
245	...	...	...	...	...	...	...	...	...	...	$9\frac{5}{8}$
250	...	...	...		3	1	6	...	...	...	$9\frac{7}{8}$
255	...	...	...	...	...	...	1	...	1	...	$10\frac{1}{16}$
260	...	...	...	...	1	1	1	...	1	...	$10\frac{1}{4}$
265	...	...	...	...		...	...	...	...	...	$10\frac{7}{16}$
270	...	...	...	...	1		...	...	...	...	$10\frac{5}{8}$
275	...	...	...	...	...	2	1			...	$10\frac{13}{16}$
280	...	...	...	...	...	...	2	1	...	...	$11\frac{1}{16}$
285	...	...	...	...	...	...	...	...	...	...	$11\frac{1}{4}$
290	...	...	...	...	...	...	...	...	2	...	$11\frac{7}{16}$
295	...	...	...	...	...	...	...	...	...	...	$11\frac{5}{8}$
300	...	...	2	...	1	...	...	1	...	...	$11\frac{13}{16}$
305	...	...	...	..	...	...	2	...	...	...	12
310	...	...	...	...	...	...	...	...	3	...	$12\frac{3}{16}$
315	...	...	...	...	...	...	1	...	...	...	$12\frac{3}{8}$
Total number of each Series.	51	89	715	846	844	243	143	34	57	115	

From this Table it will be seen how the plaice captured at the various times of the year separate themselves into more or less distinct groups. The distinction is sometimes well marked, as for instance in Series III. (July 16th), where the size of the fishes in the first group begins at 20 millimetres, and continues to 70mm.; while the sizes in the second group begin at 100mm. A closer examination of each of these groups shows, first, a gradual increase in the number of the fishes for each 5 mm. of increase in length, and then a subsequent decline—a peculiarity justifying the conclusion that each of these groups represents the fish of different years. As was to be expected, the most distinct groups are those formed by the youngest fishes. Although the proportionate difference in rate of growth in some cases might have been considerable, the fishes are still so young and small that the range in size could not be great. But naturally, since the variation in the rate of growth becomes more accentuated, the subsequent groups are more expanded, and in a few cases overlap each other. For this reason it has sometimes been difficult to distinguish these groups. In Table II. the various groups in each series have been separated by a double line (thus ═══), and although the correct position of these limits in some cases might be a little higher or lower, I think the places chosen are justified from the fluctuation in the numbers of the fish of the various sizes. But whether the few specimens that in each case approach the limits drawn are included in the one group or the other, their influence upon the average size of each group is generally very small; and in the following remarks the averages only will be considered. But, when estimating the value of the different averages, the number of fish from which each of them has been deduced must be taken into account, and in Table III. the number of fish in each group is given,

TABLE III.

Showing the Average Size in Millimetres and the Total Number of Plaice contained in each Group of the various Series.

	Series I.		Series II.		Series III.		Series IV.		Series V.	
	Number.	Average.	Number.	Average.	Number.	Average.	Number.	Average.	Number.	Average.
Groups A, -	...	...	...	...	667	40·7	776	56·5	789	59·5
,, B, -	51	104·9	83	112·1	45	118·1	52	135·9	31	138·7
,, C, -	...	...	6	...	1	...	18	214·4	25	214·0

	Series VI.		Series VII.		Series VIII.		Series IX.		Series X.	
	Number.	Average.	Number.	Average.	Number.	Average.	Number.	Average.	Number.	Average.
Groups A, -	180	66·0	86	(60·7)	22	65·2	34	62·9	65	77·2
,, B, -	50	(135·0)	13	155·0	2	...	1	...	50	156·0
,, C, -	11	220·0	37	221·5	8	...	16	226·9	...	...

together with their average size. As the principal hatching time for plaice on this coast is April, and the young fishes after having passed the pelagic post-larval stage are found on the sands in June and July, the plaice that were captured in April (Series X.) must be one year old or more. The measurements show the average size of the youngest group of 65 fishes to be 77·2mm., which therefore indicates the average growth of the plaice during the first year. The average size of the second group in Series X. is 156·0mm., and represent the two-years old fish. The difference between these two averages is 78·8mm., and should indicate the second year's growth. As there is no reason why the difference in size between the first and second, and between the second and third groups should not be the same the whole year round and respectively equal to the second and third year's growth, a comparison of these groups will be of value, and may serve as a basis for calculating the growth-rate during the various years.

TABLE IV.

SHOWING THE RESULT OF COMPARISON BETWEEN A AND B, AND BETWEEN B AND C GROUPS.

Order of the Series comparable, -	III.	IV.	V.	VI.	VII.	X.	Mean Yearly Increase.
Difference in average size between A and B groups,	77·4	79·4	78·2	69·0	94·3	78·8	79·5 mm.
Difference in average size between B and C groups,	...	78·5	75·7	(85·0)	(66·5)	...	76·4 mm.

In Table IV. such comparisons have been made, and they show first of all that, with the exception of Series VI. and VII., the separation of the various groups— A, B, and C—must be nearly correct, and also the calculated average size. The cause of the great irregularities in Series VI. and VII. will be seen from Table III. Thus, in Series VI. the value of the B group (135·0) is clearly too small, and so also is the A group in Series VII. But when the somewhat limited number of fish that were examined in some cases is taken into consideration, it is surprising that the calculations relating to the two first groups should compare so well. Owing to the small numerical representation of the C group, less importance can be attached to the average values that have been deduced. There appears, however, so far as the data go, to be a recognisable decrease in growth-rate during the third year. The above deductions from these experiments may be summed up as follows :—

1. The average growth of the plaice during its first year appears to be about 77·2mm.
2. ,, ,, second ,, 79·5mm.
3. ,, ,, third ,, 76·4mm.
4. The total average length at the end of the first year appears to be about 77·2mm.
5. ,, ,, second ,, 156·7mm.
6. ,, ,, third ,, 233·1mm.

So far as these observations go, it would appear that the average linear growth-rate of the plaice is a little greater in the second than in the third year; and while from want of data it is not possible to prove anything regarding the following (older) groups, it is natural that a continuous decrease in growth-rate should exist in all the groups until the fishes have become full grown.

Another point of interest brought out by these experiments is the growth of the young plaice at the various seasons of the year. The average sizes in the A, B, and C groups in Table III. will also serve as a measure in this respect. Group A represents the first year's growth, and a comparison of the average sizes in the various series shows the gradual growth from July till the following April. In the B group the growth during the second year can be followed; and the C group shows the progress during the third year at the various seasons. In all three groups it will be noticed that the increase in length is greatest between May and October, when it gradually diminishes and almost comes to a standstill during the cold part of the year, from November to March. At that time the growth rate begins to increase again till it reaches its height in the middle of the summer.

In Plate I. is given a graphic illustration of the gradual growth of the plaice, during thirty-two months, from a size of 40·7 to 229·1 mm. when the fishes were about thirty-four months old. The black line (No. 1) combines the average sizes for the various dates, as shown in Tables II. and III.; and the three yearly groups—A, B, and C—have been connected in succession. The small irregularities in this line are caused by undue fluctuations in the averages calculated from the captured fishes, and have already been referred to. But the main curvature of the line is clearly indicated, and has been represented by the red line in the Plate, which is an approximate representation of the gradual growth of the plaice from month to month for almost three years; and it shows clearly the alternate increase and decrease in the growth-rate according to the season.

The sum of the results of these observations may be said to be (1) that the plaice during the first year of its life may be separated with considerable accuracy from the previous year's fish, (2) that distinction is also possible between the second and the third year's fish, although the limits here are less marked, and (3) that the growth-rate of the plaice is greatest in the summer, increasing in the spring and decreasing in the autumn, while it is almost arrested during the winter. It rises and falls very much in correspondence with the temperature of the sea on the coast.

The conclusions arrived at in the previous pages regarding the rate of growth of the plaice, particularly during the first and second years, are based upon the results of systematically conducted fishing. As the average sizes that have been quoted are deduced from the measurements of well-defined groups, there are strong reasons why my results, relating to the first two groups at any rate, ought to be fairly correct representations of the actual facts. But as these results vary considerably from those attained by Dr. Petersen regarding the growth-rate of the plaice in Danish waters, I have found it necessary to subject his records to a somewhat close examination.

Dr. C. G. Joh. Petersen* has conducted some extensive researches in the Kattegat in connection with the plaice, and he has furnished valuable information as to the distribution of this fish and the minimum size at which it becomes mature in these waters. By examination of a large number of specimens Petersen has shown that the plaice in the Kattegat spawns at a comparatively small size. Petersen has estimated the average size of the mature plaice in the Baltic to be about 10 inches, in the Lesser Belt about 17 inches, and in the Kattegat 12–13 inches at least (p. 3). On the East Coast of Scotland the average size of the mature

*Report of the Danish Biological Station IV., 1893.

female plaice appears to be 19–20 inches. These figures, however, are to a certain extent influenced by the amount of fishing, or rather over-fishing, that has taken place at the different places. He found males and females in a ripe condition about seven inches long, and as the minimum size at maturity may be considered a measure in regard to the size of the race it is concluded that the plaice living in these Danish waters belong to a smaller race than the one existing on the Scottish east coast, where Dr. Fulton has found the minimum size of the male at maturity to be about thirteen inches, and of the female about fifteen inches.*

In a series of Tables Petersen has illustrated the results of a great number of hauls made with several kinds of gear in different localities and at various times of the year, and the several groups of plaice shown in the Tables have been marked by him according to the age he considered them to be. From this classification it will appear that the growth-rate of the plaice in these waters should be considerable. Petersen has, for instance, suggested that the smallest spawning fishes are in their second or in their third year (page 3). But if it is taken as proved that the plaice in the Kattegat belongs to a smaller race, then there is strong reason for believing that the growth-rate per year should also be less than on the Scottish east coast. In that case, however, the groups formed by the fishes captured by Petersen cannot always represent the natural annual series, but must be somewhat artificially produced combinations, and therefore misleading. Petersen himself seems to have had a feeling of this kind in one case (page 17), when he suggests that the different ways in which the investigations were sometimes conducted might have had some influence in this respect. I think that this may be proved in several cases from his Tables. And not only the kind of gear will influence the size of fishes captured, but also the depth of water and the extent of bottom area examined at the various depths. Petersen's ideal mode of illustrating the various annual groups appears to be (page 18) to capture, if possible, an equal number of each of them, thus getting rid of undue influence by the greater range of growth shown by the groups comprising the greatest number of fish. This method would certainly give an excellent result if it was known beforehand where the greater mass of each group was located.

But as this is not and cannot be known with accuracy until the fishing has been conducted and the results examined, the choice of the fishing-places will mostly be a mere matter of guess. Petersen has generally investigated certain selected depths only, sometimes miles apart, and the grand total of a number of hauls made, nay even each individual haul, cannot claim to be a true representation of distinct annual series; they may or may not be so; under normal conditions there is no reason why they ought to be. The correctness of this statement is evident from the following:—

[TABLE.

Tenth Annual Report Fishery Board for Scotland, Part III., p. 239, A.

* "Race" is not here meant to imply distinction between the Plaice in the Kattegat and on the East Coast of Scotland further than differences in growth rate, which may be due to more or less favourable conditions of growth only.

TABLE V.—REPRODUCTION OF DR. PETERSEN'S TABLE V.

Size in Danish inches.	1. The five succeeding columns together.* From Shore to 8 fathoms. Prawncatcher and Seine with small meshes.	Petersen's Group-marks.	2. Aalbeck, July 8th, 1893. Prawncatcher, close to the shore.	3. Aalbeck, July 8th, 1893. Ground Seine with small meshes.	4. Off Aalbeck, July 8th, 1893. Seine with small meshes, $2\frac{1}{2}$ fathoms.	5. 4 miles E.N.E. from Aalbeck, July 8th, 1893. Seine with small meshes, 5 fathoms.	6. 6 miles E.N.E. from Aalbeck, July 8th, 1893. Seine with small meshes, 8 fathoms.	7. Total Sum of the five preceding columns, H.C.D.
½—	.		.	.	.	.	.	.
¾	1		1	.	.	.	.	1
1—	7		7	.	.	.	.	7
¼	9	0	9	.	.	.	.	9
½	.		.	.	.	.	.	.
¾	.		.	.	.	.	.	.
2—	.		.	.	4	.	.	4
¼	.		.	.	14	.	.	14
½	25		2	23	55	.	.	80
¾	72		2	70	72	.	.	144
3—	126		1	121	91	.	.	213
¼	72		.	58	94	.	.	152
½	89		2	32	81	.	.	115
¾	83		.	10	38	1	.	49
4—	100	1	.	7	41	2	.	50
¼	100		.	5	37	1	.	43
½	83		.	.	43	2	.	45
¾	47		.	2	20	7	.	29
5—	46		.	.	15	5	.	20
¼	51		.	1	6	12	1	20
½	50		.	.	3	6	1	10
¾	24		.	.	6	5	.	11
6—	24		.	.	5	5	5	15
¼	8		.	.	2	.	2	4
½	15		.	.	2	5	7	14
¾	15		.	.	2	7	2	11
7—	23		.	.	.	6	12	18
¼	15		.	.	.	2	11	13
½	9		.	.	.	2	5	7
¾	8		.	.	.	3	3	6
8—	4		.	.	.	2	2	4
¼	9		.	.	.	5	4	9
½	3		.	.	.	1	2	3
¾	1		.	.	.	1	.	1
9—	3	2	.	.	.	.	3	3
¼	2		.	.	.	.	2	2
½	.		.	.	.	.	.	.
¾	.		.	.	.	.	.	.
10—	1		.	.	.	.	1	1

Dr. Petersen's Table, which is here reproduced in its entirety (Table V.), shows the results of a series of hauls made with different kinds of gear, and at various depths, as specified for each column. On this occasion Petersen has given a good demonstration of how the larger fishes are proportionately most abundant in the deeper water, while the smaller are found at a less depth, and in this respect the Table is of value.

The same, however, can hardly be said as regards its illustration of successive annual series, which, if the grand total is considered, have become almost entirely obliterated.

If the young plaice, say from one to four years old, lived together thoroughly intermixed in a certain area, then the result of one haul, or

* It is difficult to see how this column has been made up—it is not a *summary* of the five following columns, such as is shown in column 7.

the sum of several hauls made in that place, would at once prove or disprove the possibility of pointing out the successive annual groups, and would also show their numerical relation to one another, with an accuracy proportionate to the number of fishes captured. But as the size of the growing fishes must be in some proportion to their age, and as it has been well established that the plaice, under normal conditions, increases in size from shallow to deeper water, it follows that the mass of the older fishes must live at a greater depth than the mass of the younger ones. This, again, means that the annual series of plaice, whether distinguishable or not, in principle must follow one another in succession from the shallow to the deeper water, and though perhaps overlapping one another at the margins, still claim for themselves areas of their own, each of which being inhabited—not solely, but principally—by the greater bulk of one particular series.

Thus the size of the plaice captured very much depends upon what depth of water has been examined. A haul made about the centre of any area which was the special habitat of a particular series would principally contain fishes belonging to that series, and would only show more or less indistinct indications of the neighbouring ones. And hauls made at any place where such areas merged into one another would not contain fishes belonging only to one series, but to the two adjoining series; and these in most cases would become well intermingled, and would have the appearance of one very much extended group. When, therefore, Petersen conducted fishing operations at four or five different places within an area extending from the shore to about six miles at sea, and had a depth ranging from nothing to eight fathoms, it is clear that the result is of doubtful value as regards the demonstration of the true annual series of plaice. His choice of fishing-places, however carefully considered in regard to other purposes, must have been to a large extent a matter of guess as regards the location of the various series, and their representation is therefore often erroneous. It must be remembered, however, that Dr. Petersen's elaborate work was not carried on solely nor principally for the purpose of studying the growth rate of the plaice.

Another, and I think better, method by which the natural series or groups could be well shown would be to capture all the fishes living on a strip of ground, say 10 to 15 yards wide, and extending from the shore to the greatest depth within the locality that he examined. Such a collection ought to show the distinction of all the groups living within the area, and in their approximate numerical proportions to one another. To realise such an ideal method in its entirety would be difficult, or perhaps impossible; but a fair approach may be made if the fishing is conducted on lines at right angles to the shore instead of along it. In the former case all depths and areas could be examined without trouble, while this in the latter case is almost impossible.

I shall now examine some of the groups shown in Petersen's Tables, and when possible single out what fishes appear to me to belong to the various annual series. Most information regarding the smallest fishes is contained in the records for 1893 (Tables III., IV., and V., second part). I shall also confine my examination to the northern portion of the Kattegat, and principally to the coast line north of Hals.

The small plaice not yet one year old (Petersen's "0" group) are only found to inhabit the very shallow water along the shores, and, owing to their comparatively small range in size, they are always marked off distinctly. This group was principally studied from May to October 1893, when fishing with a "prawn-catcher" was conducted near Fredrikshavn. The results are recorded in Petersen's Table III., which I have here reproduced (Table VI.) The "0" group is distinctly shown for May, June, July, September, and October, and in Table VII. is given a summary of the details relating to this group, deduced from Table VI.

TABLE VI.—Reproduced from Petersen's Table III., containing the Records of Fishing conducted near Fredrikshavn from May to October 1893.

Size in Danish inches.	May 12, 1893.	June 10, 1893.	July 9, 1893.	Aug.	Sept. 21, 1893.	Oct. 19, 1893.
	Prawn-catcher, near the shore.	Prawn-catcher and Seine with small meshes, near the shore.	Prawn-catcher, near the shore.		Sandeel-net and Prawn-catcher, near the shore and in $3\frac{1}{2}$ fathoms.	Sandeel-net, near the shore.
$\frac{1}{4}$	Many.	.	.	.	.	.
$\frac{1}{2}$		.	.	.	.	.
$\frac{3}{4}$		17	1	.	.	.
1—	.	11	18	.	.	.
$\frac{1}{4}$	.	.	39	.	.	.
$\frac{1}{2}$	.	.	8	.	5	.
$\frac{3}{4}$	1	.	.	.	50	3
2—	5	.	.	.	63 "Still more."	6
$\frac{1}{4}$	9	.	.	.	39	6
$\frac{1}{2}$	7	3	.	.	12	4
$\frac{3}{4}$	5	14	.	.	2	2
3—	5	15	.	.	1	1
$\frac{1}{4}$	6	4	.	.	1	.
$\frac{1}{2}$	2	2	.	.	2	.
$\frac{3}{4}$	2	3	.	.	3	.
4—	3	.	.	.	5	.
$\frac{1}{4}$	2	.	.	.	7	.
$\frac{1}{2}$	.	.	.	.	8	.
$\frac{3}{4}$	.	.	.	.	5	.
5—	.	.	.	.	2	.
$\frac{1}{4}$	.	.	.	.	4	.
$\frac{1}{2}$	.	.	.	.	1	.
$\frac{3}{4}$	.	.	.	.	2	.
6—	.	.	.	.	1	.
$\frac{1}{4}$	.	.	.	.	.	.
$\frac{1}{2}$	.	.	.	.	.	.
$\frac{3}{4}$	.	.	.	.	2	.
7—	.	.	.	.	1	.
$\frac{1}{4}$	.	.	.	.	3	.

TABLE VII., showing details of Measurements, &c., relating to the "0" Group in Table VI. (Petersen's Table III.).*

	May 12.	June 10.	July 9.	Aug.	Sept. 21.	Oct. 19.
Range of the Group, -	$\frac{1}{4}''$—$\frac{3}{4}''$	$\frac{3}{4}''$—1″	$\frac{3}{4}''$—$1\frac{1}{2}''$	.	$1\frac{1}{2}''$—3″	$1\frac{3}{4}''$—3″
Total Number, - -	"Many."	28	66	.	172	22
Average Size, - -	About 0·5″	0·848″	1·204″	.	2·011″	2·239″

*In this and the other Tables relating to Petersen's work all measurements are given in Danish inches. 1 Danish inch = 26·1mm.

As the group is fairly well represented numerically, the averages deduced will be approximately correct and represent the main growth-rate of the plaice to October 19th. The only other instance where the "0" group is recorded from the Northern Kattegat in 1893 is contained in Petersen's Table V., when 17 specimens were captured at Aalbeck on July 8th. They have an average size of 1·117 inches, which corresponds with the average for July 9th in Table VII. (difference only 0·087 inch). The distinction of the "0" group in the above Tables is in accord with Petersen's own classification, and is undoubtedly correct

The "1" group, comprising fishes of more than one but less than two years of age, is also indicated in Petersen's Table III., and I give here a summary from that Table as regards this group.

TABLE VIII., showing Particulars regarding the "1" group as contained in Table V.

Date.	May 1	June 10.	July.	Aug.	Sept. 21.
Range of the group, Danish inches, - - - - -	$1\frac{3}{4}''$-$3\frac{1}{2}''$	$2\frac{1}{2}''$-$3\frac{3}{4}''$	—	—	$3\frac{1}{4}''$-$5\frac{1}{2}''$
Total numbers in the group, -	40	41	—	—	38
Avge. size in Danish inches, .	2·619	2·982	—	—	4·407

Owing to the presence of this "1" group, it is evident that the fishing was conducted in sufficiently deep water for the "0" group, and this may also be said as regards the group in question here. In conformity with what has already been said, it may be argued that if the fishing had been extended to deeper water, larger fishes would have been captured. Owing to the mode of fishing in this case, it is probable that all depths have been examined within a certain area, and though the greatest depth has not been stated, it is evident that if the net had been shot still further out, particularly on September 21st, a larger portion of a third group would have been captured, which now is only indicated as existing between $5\frac{1}{4}$–$7\frac{1}{4}$ inches. But as on that date—September 21st—the "0" group is present and also part of the "2" group, the "1" group ought to be duly represented. On June 9th (Petersen's Table V.) a group of plaice was captured by a sandeel-net near the Scaw. The fishes ranged from 2 to $4\frac{1}{4}$ inches, and had an average size of 2·796 inches. Petersen has apparently been in doubt as to the age of this group, and has placed his "1" group mark on the 4-inch line, thereby suggesting that the fishes in question belong to an "0" group—that is to say, under one year old. But the proper "0" group at this time has been found to exist at the range $\frac{3}{4}$-inch–1-inch, and has an average size of about 0·848 inch (see Table VII.). The group captured at the Scaw must therefore be more than one year old, and its average size corresponds well with the "1" group for June in Table VIII. But while the great mass of these fishes are representatives of the "1" group, there are not sufficient details to show whether specimens of any other group may be included, and much importance need not be attached to its average value. No further information is supplied regarding this group in the Northern Kattegat for June 1893, but from what has already been said it is evident that the two youngest groups of plaice in these waters in June had an approximate position as indicated, the one averaging about 0·8 inch* and the other about 3·0 inch. The only instance where the "0" and "1" groups may justly be compared in these Tables is for September 21st, when a difference is found = *2·396 inches.* This figure is therefore the only reliable indication of the growth for the first year (September to September).

My own experiments show (which has also been observed by Dr. Petersen) that the growth of the plaice during the winter months, while the water is cold, is very small indeed, and it is therefore reasonable to expect that the "0" group, which can be followed in Table V. from May to October, when it has an average size of about 2·239 inches in the end of March or the beginning of April, will average about 2·4 inches. But it is then one year old, and constitutes the new "1" group. During the latter part of April and the beginning of May the growth-rate is again increasing, and it corresponds well to find that the "1" group at that time (May 12th) averaged about 2·619 inches, and on June 10th 2·982 inches.

I have already explained why the records contained in Petersen's Table V. (reproduced in Table V.) are not well qualified to illustrate the various annual series living within the six-mile limit in the locality where the fishing was made, and an attempt to outline all the series that are present is dangerous, owing to the mode of fishing. Two groups, however, are distinctly indicated, viz. :—(1) the "0" group, or under one year, as previously referred to; it ranges between $\frac{3}{4}$ of an inch and $1\frac{1}{4}$ inches, and has an average size of 1·117 inches. (2) The "1" group, or over one year, which is confined to a range between 2 inches and $4\frac{1}{4}$ inches, must also be considered duly represented. The fishes comprised in it were captured at a depth of $2\frac{1}{2}$ fathoms and below, and the fishing in deeper water shows that another group exists there, merging towards the "1" group. [Column 5 represents (1) part of the "1" group—below $4\frac{1}{4}$ inches, (2) a "2" group—between $4\frac{1}{2}$ inches and 7 inches, and (3) part of a "3" group—above $7\frac{1}{4}$ inches. Column 6 contains chiefly the "3" group—above 7 inches; it is, however, apparently mixed with the "2" group]. This "1" group, the fishes of which were captured on July 8th 1893, and was identified by Petersen, has an average size of 3·332 inches, and agrees with the results regarding this group in May, June, September, and October (see Table VIII.).

The more or less favourable conditions prevailing in different years will no doubt have some influence on the growth of the plaice; but there is no evidence to show, and it must be considered very improbable, that the effect of such variations will be so great as to efface the distinction between similar groups in two successive years. With due care and allowance for possible variations, it ought to be quite possible to supplement the one year's records with those of the preceding. Petersen's Table V. (second part) contains the result of eight hauls, made with an eel-seine net between July 12th and 19th 1892. Of the two groups shown in the record, the smallest one, the fishes in which range in size from $4\frac{3}{4}$ inches to 7 inches, is of great interest. No information is given in regard to the depth of water, yet the group is so circumscribed as to exclude any doubt as to its correctness; it contains 447 fishes with an average size of 5·818 inches, and can only be the annual series following the "1" group already described as existing between 2 inches and $4\frac{1}{4}$ inches and having an average size of 3,332 inches. This "2" group is also recognisable at other dates in 1892. In the records for September 27th (same Table) the result of five hauls with an eel-seine shows the same

*In the months of May and June post-larval plaice are still found in considerable numbers, and the young plaice found on the shore are therefore the oldest (or largest) of those hatched the same year. The average sizes calculated for these two groups are therefore too large, and cannot be used in comparison with Group 1.

group at that time to range between $5\frac{3}{4}$ inches and $8\frac{1}{4}$ inches, and having an average size of 6·963 inches. Also in this case the identification is well justified, owing to a number of specimens of the younger and the older groups being attached. Further confirmation of this group is contained in Petersen's Table VI., where the records from the coast south of Hals for May 25th show the group to range between $4\frac{1}{4}$ inches and $6\frac{1}{2}$ inches, and having an average size of 5·366 inches, and also in the records for June 29th : $4\frac{1}{2}$ inches to $6\frac{1}{2}$ inches, with an average of 5·762 inches. Local variation may possibly exist and influence these groups to a certain extent; but in all the cases here quoted it is necessary to recognise the "2" group in its development from May to September. The difference in size between the "1" group and the "2" group appears to be about 2·535 inches, which is an indication of the second year's growth.

In Dr. Petersen's tabled records this "2" group is not equally well demonstrated. The probable cause of this has already been explained (p. 242). It has in some cases been mixed up with the neighbouring "1" group, when misleading data have been produced and caused Petersen to combine these two groups into one large "1" group with a range of 5 or 6 inches. From these deductions apparently Dr. Petersen has concluded that the smallest mature plaice in the Danish waters (about 7 inches long) are in their second year only (p. 6), while according to my interpretation of his records those fishes should be at least three years old.* According to my calculations this is also the probable age of the smallest mature plaice on the East Coast of Scotland, and if it were known that the plaice becomes mature at the same age in the different seas (which is probable), another strong proof would exist in support of my theory of the growth-rate of the plaice and the probable age at maturity.

In order to compare the apparent growth-rate of the plaice in the Kattegat with my observations on the same subject on the East Coast of Scotland, the various data, as deduced from D. Petersen's Tables, have been represented on Plate I. (No. 2). The figures 1 to 13 have been arranged according to the date of observation and the average size of the group in question. (For furthur particulars see Table IX.) These figures have been connected by the dotted line (No. II.), which should be considered an approximate illustration of the growth of the plaice in the Kattegat at the various seasons, and extending over nearly three years. Owing to the want of sufficient data, it is impossible to say whether the course of this line is in all details correctly drawn ; but for the purpose of a general comparison sufficient information is available. It will be seen that the growth-rate of the plaice in the Kattegat is considerably less than on the Scottish East Coast, and that this difference appears to increase as the fishes grow older.

It is of the greatest importance that these investigations regarding the growth-rate of the plaice should be continued, and also be extended into deeper water than was the case at Dunbar. The difference of opinion regarding the age at which the plaice becomes mature ought to be cleared up, as it is a question of considerable importance in several respects in connection with the fisheries, and the only method by which this may be satisfactorily attained is to carry on systematic fishing from shallow to deep water, so that all the annual series may be demonstrated, and their age accurately determined also, after the earliest stage of maturity.

* In the Fourth Report (1893), p. 6., Dr. Petersen says—"It seems that the plaice, everywhere, generally become mature in their third year, some already in their second, . . ." and in the Sixth Report (1895), p. 14, it is stated—"A plaice is, ordinarily, not mature till its fourth year. . . ." While I have shown why this first statement must be wrong (and also Dr. Petersen's classification of most of his groups), I find that my own interpretations of the Tables, as well as the observations made at Dunbar, correspond with the latter view. It appears that a considerable number of mature plaice are found in the Kattegat about eight and nine inches long, and if these fishes are considered to be, at least, in their fourth year and not yet full-grown, the annual growth cannot be nearly so large as suggested by Dr. Petersen.


GROUP A—FIRST YEAR.
GROUP B—SECOND YEAR.
GROUP C—THIRD YEAR.
Size in m.m.
May. June. July. Aug. Sept. Oct. Nov. Dec. Jan. Feb. March. April.
May. June. July. Aug. Sept. Oct. Nov. Dec. Jan. Feb. March. April.
May. June. July. Aug. Sept. Oct. Nov. Dec. Jan. Feb.
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
No. I.
No. II.
No. I.
No. II.
1 2 3 4 5 6 7 8 9 10 11 12 13

DESCRIPTION OF PLATE.

The curved lines show the rate of growth of the plaice during the first three years. The black line No. I. indicates the average size of the fishes caught at Dunbar in the various months. The red line represents the mean range of variation. The dotted black line No. II. indicates the rate of growth of the plaice in the Kattegat as deduced from Petersen's observations.

TABLE IX.

Showing Particulars Regarding Curve No. II.

Marks of Reference.	Order of the Group.	Average Size in mm.	Reference.
1	A (0)	About 13	Petersen's Table III., Records for May 12th.
2	A (0)	22·03	Do. do. June 10th.
3	A (0)	31·47	Do. do. July 9th.
4	A (0)	52·48	Do. do. Sept. 21st.
5	A (0)	58·43	Do. do. Oct. 19th.
6	B (1)	68·35	Do. do. May 12th.
7	B (1)	77·93	Do. do. June 10th.
8	B (1)	86·96	Table IV. (Col. 4), do. July 8th.
9	B (1)	115·0	Table III. do. Sept. 21st.
10	C (2)	140·0	Table VI. (second part), May 25th.
11	C (2)	150·38	Do. do. June 29th and July 2nd.
12	C (2)	148·84	Table V., do. July 12th to 19th.
13	C (2)	181·73	Do. do. Sept. 27th.

VII. NOTES ON RECENT GATHERINGS OF MICRO-CRUSTACEA FROM THE CLYDE AND THE MORAY FIRTH. By Thomas Scott, F.L.S., Mem. Soc. Zool. de France.

(Plates X–XIII.)

In the following notes my remarks refer chiefly to the rarer forms that have been observed in gatherings of Microcrustacea submitted for examination during 1898. The gatherings examined have been collected in the Moray Firth and the Firth of Clyde, and therefore the notes refer chiefly to these localities. I am indebted to Mr. F. G. Pearcey, naturalist on board the s.s. "Garland," for most of the gatherings forwarded for examination.

Copepoda.

Paracalanus parvus (Claus).

1863. *Calanus parvus,* Claus. Die frei-lebenden Copopoden, p. 173, Pl. XXVI., figs. 10-14; Pl. XXVII., figs. 1-4.

This Copepod, which was observed in the Firth of Clyde for the first time in September 1897, has occurred in several of the tow-net gatherings collected during 1898, both at the surface and bottom. It was obtained at Stations IX. and XIII. in August, and at Stations VII. and VIII. in September. Station XIII. is one of the Upper Loch Fyne stations, and its occurrence there makes it an addition to the Loch Fyne fauna. It is a small species, and may therefore have been previously passed over as a young *Calanus*. It has also been observed in the Moray Firth and in the Firth of Forth.

**Bradyidius armatus* (Brady).

1878. *Pseudocalanus armatus,* G. S. Brady, Mon. Brit. Copep., vol. i., p. 46 (non *P. armatus,* Boeck—see Giesbrecht, *Zool. Anzeiger*, 1897, p. 25).

This species is referred to because its distribution appears to be somewhat restricted. Though not very plentiful, it is one of the more widely diffused of the Clyde Copepoda, and it has been known for many years as a Clyde species. It is usually obtained in gatherings collected with the bottom tow-net, and much less frequently in surface gatherings. Though the species has been recorded from the East Coast of Scotland, it seems to be of rare occurrence there. I do not find a single reference to it in any of the descriptions of tow-net gatherings collected on the East Coast during the past year.

Euchæta norvegica, Boeck.

1864. *Euchæta prestandreæ,* Boeck, Overs. Norg. Kyster iagt. Copep., *Forh. Vid. Selsk. Christiania,* p. 236.

1872. *Euchæta norvegica,* Boeck, Nye Slaegt. og Art. af Salt-vandscopep, *Forh. Vid. Selsk. Christiania,* p. 40.

I have no record of this species for the Moray Firth; but it has, as in previous years, been obtained in tow-net gatherings from various

* See "Additional Notes" at the end of this paper.

parts of the Clyde and Loch Fyne. *Euchæta* appears to be even more restricted in its distribution than *Bradyidius*. According to Sars ("Norw. North Sea Exped.," Crust., Part I., p. 284), this species was at first ascribed by Boeck to *Euchæta prestandreæ*, Philippi, but was afterwards described by him under the name which it now bears.

Scolecithrix hibernica, A. Scott.

1896. *Scolecithrix hibernica*, A. Scott, Ann. and Mag. Nat. Hist., (6) vol. xviii., p. 362, Pl. XVII. and XVIII.

This species, though only recently discovered, is at times not very rare in the Clyde and Loch Fyne tow-net gatherings. The following records of its occurrence will indicate sufficiently the wide distribution of the species in the Clyde district. During August last year it was obtained at Stations III. and IV. (in Kilbrennan Sound), and at Stations XIII., XIV., XV., and XVII. (Upper Loch Fyne), and in September at Stations VII. and VIII. (4 or 5 miles south of Ailsa Craig).

I have now to record its occurrence for the first time in the Moray Firth, having obtained it in a tow-net gathering collected in June last year at Station XVI. (vicinity of Smith Bank) from a depth of about forty fathoms, but it was apparently rare in this gathering. The opinion expressed by the describer of the species that *Scolecithrix hibernica* was really a deep-water form, and that its being so would partly account for its having been so long overlooked, is more or less confirmed by what is observed regarding its distribution in the Clyde and in the Moray Firth.

Scolecithrix pygmæa, sp. n. (Pl. X., figs. 1–9).

Description of the Female.—Somewhat like *Scolecithrix hibernica*, A. Scott, in general appearance but smaller, the length of the specimen figured is, exclusive of tail setæ, ·95 mm. (about $\frac{1}{27}$ of an inch). The rostrum is small. The last segment of the thorax is produced on each side into a hook-like process (fig. 1). The antennules are scarcely as long as the thorax; they are twenty-four jointed; the first two joints are moderately large; the third to the seventh are smaller; but the eighth is about twice as long as the preceding joint, and sub-equal in length to the first and second. The joints that immediately follow the eighth are shorter, but the others gradually increase in length, so that several of the last joints are about as long as the eighth. The end joint is very small. The antennules are only sparingly setiferous, but the terminal joints are furnished with a few plumose hairs as shown by the figure. The formula gives approximately the proportional lengths of all the joints, as follows :—

Numbers of the joints,	1·2·3·4·5·6·7·8·9·10·11·12·13·14·15·16·17·18·19·20·21·22·23·24
Lengths of the joints,	12·15·8·5·6·6·6·12·8·7·8·9·9·9·9·11·11·11·11·11·10·14·12·5

The antennæ, mandibles, and maxillæ are all somewhat similar to those of *Scolecithrix hibernica*. The anterior foot-jaws are furnished with several lobes on the inner aspect as in *Scolecithrix dubia*, Giesbrecht. The distal lobe is armed with a long slender spine, but the others are setiferous. The special joint of each of the anterior foot-jaws carries a number of the long slender worm-like hairs which form one of the principal characters of the genus (fig. 3). The posterior foot-jaws are elongate, and somewhat like those of *Scolecithrix hibernica* (fig. 4). The first four pairs of swimming feet are also somewhat similar to those of *Scolecithrix hibernica*, except that the marginal spines of the outer branches of the fourth pair are stouter than those of the outer branches of the same pair in that species. The terminal spines are also slightly different (figs. 5, 6). The fifth pair appears to be wanting in the female. The abdomen is, proportionally, scarcely so long as that of *Scolecithrix hibernica.* The first segment is about equal to the combined length of the next two, and is rather more dilated ; the second segment is somewhat shorter than the third ; but the length of the third and fourth is about equal. The caudal furcæ, which are about as long as broad, are somewhat longer than the segment to which they are articulated, and the furcal setæ are long and plumose (fig. 8).

Description of the Male.—The male of *Scolecithrix pygmæa* resembles that of *Scolecithrix hibernica* in several aspects, but differs particularly in the structure of the fifth pair of thoracic feet. In this pair the basal joint is stout, and armed with several curved spines as in *Scolecithrix hibernica,* but the right branch is more slender, and the first joint of that branch is not so irregular in outline. In the present species the first joint of the right branch becomes gradually but only slightly dilated towards the distal end, and is not produced into a large lobe as in *Scolecithrix hibernica* ; the second joint is smaller, and proportionally much more slender than in that species ; the marginal thumb-like process is small, and situated near the middle of the joint. The left branch of the present form (fig. 7 l.) is also rather more slender than that of *Scolecithrix hibernica,* but the process at the distal end of the second joint is somewhat more produced and attenuated. The abdomen consists of five segments. The second, which is rather longer than the first, is about one and a half times the length of the following segment ; the third and fourth segments are sub-equal, but the last is very small ; the furcæ are about equal in length to the penultimate segments of the abdomen (fig. 9). Figure 10 represents the fifth thoracic feet of the male of *Scolecithrix hibernica* for comparison with those of the species now described. The figures of both are of the same magnification.

Habitat.—Firth of Clyde and Loch Fyne. Not very rare.

Remarks.—This *Scolecithrix* has been under observation for a considerable time. At first I was inclined to regard it simply as a form of *Scolecithrix hibernica,* but as it continues to turn up both alone and in company with that species, and as all of the specimens are characterised by the same distinctive features, I think it will be more satisfactory to describe it under a separate name. It is distinctly a smaller species than *Scolecithrix hibernica,* being scarcely a millemetre in length. If male and female specimens of the two species be placed side by side—the males together and the females together—the difference in size is readily noticed. The structure of the fifth thoracic feet of the male, and the structure and armature of the anterior foot-jaws of the female, are characters by which the species may be distinguished ; the lengths of the abdominal segments in both male and female are also proportionally different.

Centropages typicus, Kroyer.

1849. *Centropages typicus,* Kroyer. Nat. Tidskr., (2) ii., p. 588, t. 6.

This species appears to be much rarer in the Clyde than *Centropages hamatus,* for while the latter form occurs in nearly all gatherings collected in August and September last year, I have only three records for *Centropages typicus.* On the East Coast of Scotland *Centropages typicus* appears to be more common. In a series of gatherings from the

Moray Firth collected during May and June last year, both species were nearly equally frequent, *Centropages hamatus*, however, was even here rather the more common of the two species.

Isias clavipes, Boeck.

1864. *Isias clavipes*, Boeck. Overs. Norg. Copep., Forh. Vid. Selsk, Christiania, p. 18.

This fine species has been obtained in several of the Clyde tow-net gatherings, both surface and bottom. But though occurring now and again in various parts of the Clyde, it seems to be always a scarce species. The following are a few of the more recent records of *Isias* from the Clyde—at Station II. (Kilbrennan Sound), in surface and bottom tow-nets, at Station XII. (between Arran and the Heads of Ayr), in the bottom tow-net in August, and in the surface tow-net at Station VII. in September 1898.

**Eurytemora lacinulata* (Fischer).

1853. *Cyclopsina lacinulata*, Fischer, Beitr. z. Kenntn. d. Cyclopiden, Bull. Soc. Imp. Natur., Moscow, XXVI., p. 86–90, Pl. II., figs. 4–17, 34.

This species has been obtained during the past year in brackish water-pools at Hunterston, Firth of Clyde. *Eurytemora lacinulata* has been recorded from the Clyde district on one or two former occasions, but not previously from Hunterston.

**Metridia hibernica* (Brady and Robertson).

1873. *Paracalanus hibernicus*, Brady and Robertson, Ann. and Mag. Nat. Hist. (4), vol. xii., p. 126, Pl. VIII., figs. 1–3.

This species has already been recorded from Loch Fyne, and seems to be distributed, though very sparingly, all over the Clyde estuary. *Metridia hibernica* somewhat resembles *Metridia longa* (Lubbock), but is smaller than that species. It may be difficult to discriminate between the young of the two species; but there need be little difficulty in distinguishing the adult forms, especially if males are present. *Metridia hibernica* has also been observed both in the Moray Firth and in the Firth of Forth.

**Candace pectinata*, Brady.

1878. *Candace pectinata*, Brady, Mon. Brit. Copep., vol. i. p. 49, Pl. VIII. figs. 14, 15; Pl. X. figs. 1–12.

Though this species has been obtained both in the Firth of Clyde and the Moray Firth, as well as in the Firth of Forth, it has not been observed within recent months.

Labidocera wollastoni (Lubbock).

1857. *Pontella wollastoni*, Lubbock, Ann. and Mag. Nat. Hist. (2), vol. xx., p. 406, Pl. X. fig. 13; and Pl. XI. figs. 9–11, 18.

The only records of this species I have for the past year are two, and both are for the Clyde. They are as follows:—In a bottom tow-net gathering collected at Station IX. on August 31st, rare; and in a surface gathering collected at Station VIII. on September 23rd (only one specimen was observed in this gathering).

* See "Additional Notes" at the end of this paper.

Anomalocera patersonii, Templeton.

1837. *Anomalocera patersonii*, Templeton, Trans. Entom. Soc., vol. ii. p. 35, Pl. V., figs. 1–3.

This species, which is one of the most richly coloured of the British Copepoda, was occasionally observed during the past year in tow-net gatherings both from the Firth of Clyde and the Moray Firth, but it seldom occurred in any quantity.

Parapontella brevicornis (Lubbock).

1857. *Pontella brevicornis*, Lubbock, Ann. and Mag. Nat. Hist. (2), vol. xx., Pl. XI., figs. 4–8.

Though *Parapontella* may occasionally be found moderately common more frequently one or a few specimens only are obtained in any single gathering—such, at least, is my experience in regard to the distribution of this species in the Scottish seas. *Parapontella brevicornis* has during the past year occurred sparingly both in the Firth of Clyde and in the Moray Firth. Living specimens are readily distinguished, even amongst crowds of *Calanus*, *Pseudocalanus*, *Temora*, etc., by their peculiar dark or blackish colour, but much of this colour is lost when the specimens are preserved in spirit.

Acartia clausii, Giesbrecht.

1889. *Acartia clausii*, Giesbrecht, *Rendiconti R. Accad. d. Lincei*, vol. v., fasc. 11.

This is the only species of *Acartia* I have hitherto observed in the Clyde district. The spines, with which the fifth pair of feet of the female are armed, are short and very stout, and therefore very different from those of *Acartia longiremis*, Lilljeborg. In the Moray Firth district both *Acartia clausii* and *Acartia longiremis* are met with; the first is frequent in the open sea, but it has also been observed inshore. On June 6th, 1898, both species occurred in a gathering collected at Station III. (Cromarty Firth), where there is usually a more or less admixture of fresh water, and also at Stations I. and II. (off the Nairn Coast) on the 7th of the same month. Neither *Acartia bifilosus*, Giesbrecht, nor *Acartia discaudata*, Giesbrecht, have been observed in the Moray Firth district, but it is quite possible that they may yet be found there—especially in that part of the district known as the Beauly and Cromarty Firths, where the conditions seem to be favourable for these two species.

Cervinia bradyi, Norman.

1878. *Cervinia bradyi*, Norman; Brady, Mon. Brit. Copep., vol. i., p. 86, Pl. XXIVa., figs. 3–13.

A single specimen of this curious species was obtained in a small gathering of Microcrustacea washed from a quantity of mud brought up in the bottom tow-net at Station XII. (Firth of Clyde) on 29th August 1898, from a depth of from forty to forty-three fathoms. *Cervinia* was discovered at Oban by the Rev. A. M. Norman in 1877. It has also been recorded from the Irish Sea by I. C. Thompson, of Liverpool; but this appears to be the first time the species has been observed in the Clyde. It is quite distinct from any other species of the British Copepoda.

Ectinosoma curticorne, Boeck.

1864. *Ectinosoma curticorne*, Boeck, Overs. Norg. Copep. Forh. Vid. Selsk. Christiania.

This species has been obtained during the past year at Hunterston, Firth of Clyde.

Ectinosoma herdmani, T. and A. Scott.

1896. *Ectinosoma herdmani*, T. and A. Scott, Rev. Brit. Copep. belonging to the gen. *Bradya* and *Ectinosoma*, p. 432, Pl. XXXVI., &c.

This species was obtained during the past year at Hunterston, Firth of Clyde, and also in a gathering from Cromarty Firth, collected 4th November 1897. The last is a new record for this species.

Ectinosoma gracile, T. and A. Scott.

1896. *Ectinosoma gracile*, T. and A. Scott, Rev. Brit. Copep. belonging to the gen. *Bradya* and *Ectinosoma*, p. 429., Pl. XXXVI., &c.

Several specimens of this apparently rare species were obtained in a shore gathering collected on 4th November 1897, a little to the east of Invergordon, Cromarty Firth. This is the only time I have obtained *Ectinosoma gracile* since it was discovered in the Firth of Forth in 1896. It is a very small species and easily overlooked. One of the Cromarty Firth specimens with ova measured only 0·43mm. ($\frac{1}{58}$th of an inch).

Bradya typica, Boeck.

1872. *Bradya typica*, Boeck, Nye Slægt. og Art. of Saltv. Copep., Forh. Vid. Selsk. Christiania, p. 14.

This species occurred in a gathering collected at Station XVI. (Moray Firth), 10th July 1898, but only one or two specimens were obtained. It has also been obtained in a gathering from Station XII. (Firth of Clyde), collected 29th August 1898; in one from Station XV., collected 22nd August; and in another from Station XVII. (both in Upper Loch Fyne), collected on the 24th of the same month.

Bradya hirsuta, T. and A. Scott.

1896. *Bradya hirsuta*, T. and A. Scott, Rev. Brit. Copep. belonging to the gen. *Bradya* and *Ectinosoma*, p. 423, Pl. XXXV., &c.

This species was obtained in a gathering collected at Station XVI. (Moray Firth), 10th July, 1898, but only a few specimens were observed.

Misophria pallida, Boeck.

1864. *Misophria pallida*, Boeck, Overs. Norg. Copep., p. 24.

This is a somewhat rare species. It has already been recorded for Loch Fyne, and has also been found in Kilbrennan Sound, though not previously recorded. It occurred during the previous year in a bottom tow-net gathering from Station XVII. (Upper Loch Fyne), collected on 7th December, but only two specimens, however, were obtained in this gathering.

Robertsonia tenuis (G. S. Brady and Robertson).

1875. *Ectinosoma tenue*, B. and R., "Proceed. of the Brit. Ass.," p. 196.

A few specimens of this well-marked species occurred in a small gathering of Microcrustacea from Station XVI. (Moray Firth), depth 30 to 40 fathoms, collected on 10th June 1898. The gathering consisted of the washings of some dredged material.

Delavalia mimica, T. Scott.

1897. *Delavalia mimica*, T. S., Fifteenth Ann. Rep. Fish. Board Scot., Pt. III., p. 150, Pl. I., figs. 1–9.

This species was obtained in a gathering from Station XVI. (Moray Firth), collected on 10th June 1898, but was somewhat rare.

Delavalia æmula, T. Scott.

1893. *Delavalia æmula*, T. S., Eleventh Ann. Rep. Fish. Board Scot., Pt. III., p. 204, Pl. IV., figs. 36–47.

This species was obtained in some dredged material collected a little to the west of Invergordon, and was also somewhat rare.

Delavalia giesbrechti, T. and A. Scott, var. (Pl. XIII., figs. 20–22).

1890. *Delavalia giesbrechti*, T. and A. S., Ann. Scot. Nat. Hist., p. 225, Pl. IV., figs. 1–10.

A form of *Delavalia* has been obtained at Hunterston, Firth of Clyde, which resembles *Delavalia giesbrechti* very closely, but it wants the peculiar broad tail setæ that constitute such a marked feature in that species (fig. 22); there is also a slight difference in the arrangement of the four marginal setæ on the inner portion of the basal joints of the fifth thoracic feet (fig. 21). In other respects the two forms appear to be similar. Fig. 20, which represents the first pair of swimming feet, shows the second joint of the inner branches to be rather more slender than the same joint in typical *D. giesbrechti.*

Psyllocamptus, gen. nov.

Similar to *Canthocamptus*, but the inner branches of the first pair of swimming feet, which are about equal in length to the outer branches, are two-jointed, while the inner branches of the next three pairs are all three-jointed. Moreover, the antennules in spirit specimens are distinctly bent at the second joint as in *Nitochra.*

Psyllocamptus fairliensis, sp. n. (Pl. XIII., figs. 12–19).

Description of the Female.—Length about ·6 mm. ($\frac{1}{41}$ of an inch). Body slender and elongate, and resembling *Canthocamptus* in general appearance (fig. 12). Antennules moderately short and setiferous, eight-jointed; the first two robust, the penultimate joint smaller than the others (fig. 13); the formula shows approximately the proportional lengths of all the joints—

Number of the joints,	1 · 2 · 3 · 4 · 5 · 6 · 7 · 8
Proportional lengths of the joints,	24 · 24 · 7 · 9 · 6 · 7 · 4 · 6

Antennæ short, three-jointed; secondary branch small, one-jointed, and furnished with three setæ (fig. 14).

Mandibles as in *Canthocamptus*, mandible-palp one-branched, and furnished with a few setæ; the basal joint is armed with a moderately stout apical spine (fig. 15). Other mouth organs as in *Canthocamptus*. First pair of swimming feet with both branches moderately short, and of nearly the same length; the outer branches are three-jointed, but the inner are composed of only two joints, as in *Attheyella*; the first joint of the inner branch is about equal in length to the first two joints of the outer branches, and is also somewhat stouter; the second joint is little more than half the length of the first one (fig. 16).

The second, third, and fourth pairs of swimming feet have both branches three-jointed; the outer branches are considerably longer than the inner; in the fourth pair the inner branches are only about a third of the length of the outer branches (fig. 17); the first joint of the inner branches of the fourth pair are very small; the outer branches are furnished with long terminal setæ. The fifth pair are small and foliaceous; and the inner portion of the basal joint is considerably produced, and is subcylindrical in outline; the apex is subtruncate and bears four setæ, the two inner ones being small, while the other two are elongate; the secondary joint is ovate, and furnished with several setæ on the outer margin and apex. All the setæ are of considerable length, except a small one near the base of the outer margin (fig. 18). Caudal furca short, and about as broad as long (fig. 19).

Habitat.—Shore between Fairlie and Hunterston, Firth of Clyde. Rather rare. No males have been observed.

Remarks.—The Copepod just described resembles more or less closely not only *Canthocamptus*, but also *Attheyella* and *Mesochra*. It differs from the typical *Canthocamptus* in having the inner branches of the first pair of swimming feet only two-jointed, while the inner branches of all the next three pairs are three-jointed. It also differs from *Attheyella* and *Mesochra* in having the inner branches of the second, third, and fourth pairs three-jointed, though agreeing with these two genera in the structure of the first pair. Moreover, it somewhat resembles *Nitochra* in the antennules being distinctly bent at the second joint; but in that genus all the first four pairs of swimming feet have the inner branches three-jointed.

Psyllocamptus fairliensis seems to form one of the links in a chain of Copepods that at the one end terminates in *Mesochra*, which has the inner branches of all the four pairs of swimming feet two-jointed, and at the other end in *Nitochra*, which has the same branches all three-jointed. The generic name is derived from the two Greek words *psylla*—a flea, and *kamptos*—flexible.

Huntemannia jadensis, S. A. Poppe.

1884. *Huntemannia jadensis*, Poppe, Abhandl. d. nat. Ver. Bremen, Bd. IX., p. 59.

1885. *Huntemannia jadensis*, Poppe, Die freilebenden Copep. des Jadebusens, op. cit., Bd. XI., p. 167, Pl. VII., figs. 10-20

1895. *Huntemannia jadensis*, T. and A. Scott, Ann. and Mag. Nat. Hist. (6), vol. xv., p. 57, Pl. VI., figs. 21, 22.

This species was described by Dr. Poppe in 1884. It was first detected in Scotland in 1894, in brackish water pools, at the head of West Loch Tarbert (Cantyre), and a record of its occurrence there was published in the "Annals and Magazine of Natural History" for 1895, but up till the present time this appears to be the only record of its occurrence in Scotland. On 4th November 1897, Mr. F. G. Pearcey collected a gathering of small crustacea, on the shore near low-water mark, to the east of Invergordon, in the Cromarty Firth; this he afterwards sent to me for examination. Several rare Copepods have been obtained in this gathering, and one of them—*Ectinosoma gracile*—has already been referred to; another of these rare forms is the species under consideration. Only four specimens of *Huntemannia* were obtained in this gathering from Cromarty Firth, so that the species, which is very well marked, is probably rare. The first pair of thoracic feet are stout, the outer branches are three, and the inner one-jointed. They are armed with strong marginal spines. The basal joint of the first feet carry each, interiorly, a comparatively large thumb-like process, instead of a spine. This process was quite conspicuous, even without dissection, in each of the four specimens obtained. Probably the species is local as well as rare.

Pseudotachidius coronatus, T. Scott.

1898. *Pseudotachidius coronatus*, T. Scott, Sixteenth Ann. Rep. Fish. Board for Scot, Pt. III., p. 267, Pl. XIII., figs. 12-26; Pl. XV., figs. 1-4.

This somewhat remarkable species was described in 1898 from one or two specimens obtained amongst some small Crustacea sent to me from Lower Loch Fyne by Mr. F. G. Pearcey. They had been dredged from 105 fathoms. I have now to record the species from other two localities in the Clyde district, and from moderately deep water—viz., from Station XII., 40-43 fathoms, washed from mud brought up in the tow-net, 29th August 1898; and from Station XVII., Upper Loch Fyne, washed from trawl refuse, 7th December 1898. Only one specimen was obtained in each of these two gatherings.

Tetragoniceps macronyx, T. Scott.

1892. *Tetragoniceps macronyx*, T. Scott, Tenth Ann. Rep. Fish. Board for Scot., Pt. III., p. 253, Pl. X., figs. 19, 28.

This well-marked and somewhat rare species was described from specimens obtained in the Firth of Forth. I have now to record its occurrence in the Cromarty Firth, having obtained it in a gathering of material dredged in the vicinity of Invergordon in 1896, but only recently examined.

Laophonte thoracica, Boeck.

1863. *Laophonte thoracica*, Boeck, Overs. Norg. Copep., p. 54.

What appears to be two forms of this species have been observed in the Moray Firth district, one a deep-water form, which appears to be the typical one. This was obtained in a gathering from Station XV. (vicinity of Smith Bank), depth 24-49 fathoms, collected 20th November 1897. The other was obtained in the Cromarty Firth, and a little to the west of Invergordon, where the depth of water is only a few fathoms, and where there is usually a certain admixture of fresh water.

Laophonte serrata (Claus).

1863. *Cleta serrata*, Claus, Die frei-lebenden Copep., p. 123, Pl. XV., figs. 13–20.

Laophonte serrata, which appears to be a rare species, occurred in the same gathering in which the *Huntemannia* was obtained, and is now for the first time recorded for the Cromarty Firth district.

Cletodes tenuipes, T. Scott.

1897. *Cletodes tenuipes*, T. Scott, Fifteenth Ann. Rep. Fish. Board for Scot., Pt. III., p. 170, Pl. I., figs. 19–27.

This species, which is apparently rare, was also obtained in the same gathering from Cromarty Firth in which the *Huntemannia* occurred. *Cletodes tenuipes* was described from Clyde specimens, and it is interesting now to find it also on the East Coast.

Cletodes perplexa, sp. n. (Pl. XI., figs. 12–20; Pl. XII., fig. 1).

Description of the Female.—Length of the specimen figured ·67mm. ($\frac{1}{37}$ of an inch). The body is stout anteriorly but tapers gradually towards the posterior end; in spirit specimens the tail is generally incurved as shown in the figure (fig. 12, Pl. XI.). Rostrum short and slightly recurved. Antennules very short, moderately stout, and composed of five joints; the first and second joints are large; the third is about half the size of the second; the fourth is very small; and the last is about one and a half times the length of the third (fig. 13, Pl. XI.). The approximate proportional lengths of the various joints are shown in the formula—

Numbers of the joints,	1 · 2 · 3 · 4 · 5
Proportional lengths of the joints,	21 · 25 · 12 · 4 · 19

There are a number of coarsely plumose setæ on the distal half of each antennule, and a small asthetask springs from the end of the third joint. Antennæ three-jointed; secondary branches small, each furnished with two coarsely plumose setæ and a small hair (fig. 14, Pl. XI.). Mouth organs nearly as in *Cletodes linearis* (Claus); figs. 15 and 16, Pl. XI., show the form of the anterior and posterior foot-jaws. The inner branches of the first four pairs of swimming feet, which are all two-jointed, have the first joint small, while the second is slender and elongate. The inner branches of the first pair have the first joint somewhat dilated, while the principal terminal seta of each is fully three times the entire length of the inner branches; these branches are also somewhat shorter than the three-jointed outer branches (fig. 17, Pl. XI.). The inner branches of the second, third, and fourth pairs are comparatively shorter than those of the first pair, and the terminal setæ of both the inner and outer branches of these three pairs are long and plumose (fig. 18, Pl. XI.). The fifth pair of feet differ from those usually observed in *Cletodes;* the basal joint, which is proportionally much dilated, is produced into a large and strong spine-like process which is slightly curved at the end and bordered with minute spinules; the secondary joint is rudimentary, and bears three small setæ at its truncate apex; two setæ spring from the opposite margin of the large basal joint (fig. 19, Pl. XI.). The caudal furcæ are long and slender; two small setæ spring from near the middle of the outer margin of each of the furcæ, and they each bear a long spiniform terminal seta (fig. 1, Pl. XII.).

The male differs little from the female, except that the antennules are modified in the usual way. The fifth pair of thoracic feet are nearly the same as those of the female (fig. 20, Pl. XI.).

Habitat.—Vicinity of Smith Bank, Moray Firth. Rare.

Remarks.—This very distinct species was obtained amongst some dredged material collected on the 6th October 1898, and sent to me by Mr. F. G. Pearcey. The fifth thoracic feet form one of the most striking characters of this species, not only because of their remarkable form, but also because in all the specimens examined they projected nearly straight out from the body of the animal instead of being adpressed, as is usually the case. The incurved position of the posterior portion of the abdomen and caudal furca is also a more or less constant feature in this species so far as regards all the specimens examined. Except for the somewhat abnormal form of the fifth pair of feet, the species appears to be a typical *Cletodes.*

Dactylopus tenuiremis, Brady and Robertson.

1895. *Dactylopus tenuiremis*, Brady and Robertson, Brit. Assoc. Report, p. 197.

This apparently rare species occurred in the shore gathering collected to the east of Invergordon, Cromarty Firth, in November 1897. There is no previous record of *Dactylopus tenuiremis* from the Moray Firth district. It is a somewhat critical species, but appears to be distinct.

Dactylopus minutus, Claus.

1863. *Dactylopus minutus*, Claus, Die frei-lebenden Copep., p. 126, Pl. XVI., figs. 14-15.

This *Dactylopus* occurred amongst a number of other things in a gathering from Station VI. (Firth of Clyde) collected 1st September 1898. It is a comparatively small species and appears to be rare.

Thalestris helgolandica, Claus.

1863. *Thalestris helgolandica*, Claus, Die frei-lebenden Copep., p. 131, Pl. XVII., figs. 12-21.

This rare species was obtained in a bottom tow-net gathering from Station IV. (Kilbrennan Sound, Firth of Clyde) on 24th August 1898. The Rev. A. M. Norman has also obtained *Thalestris helgolandica* in the Firth of Clyde. This species of *Thalestris*, as well as *Thalestris hibernica*, has been found recently in some material dredged in 1886 a little to the west of Invergordon, Cromarty Firth, but both appear to be scarce.

Cylindropsyllus fairliensis, sp. n. (Pl. X., figs. 11-14; Pl. XI., figs. 1-4).

Description of the Female.—The body is elongate, slender, and cylindrical. The length of the specimen figured is 1·73mm. (nearly $\frac{1}{15}$ of an inch). The thorax is composed of five distinct segments, the first of which is rather longer than the combined lengths of the next two, but the second to the fifth are sub-equal. The abdomen is also composed of five distinct segments; the first to the fourth are of nearly the same length as the posterior thoracic segments, the last being about one and a half times the length of the penultimate segment. The caudal furcæ are short and broad; the interior half of the apex of each is somewhat produced and bears a long and moderately stout seta and two or three small hairs; the exterior portion of the apex is abruptly concave, the concavity being bounded externally by an acute angle, and interiorly by the produced setiferous portion just referred to and as shown in the figure (fig. 6, Pl. XI.). The rostrum is short. The antennules are moderately short and stout, eight-jointed; the first four joints are larger than the last four, a stout asthetask springs from the produced upper angle of the fourth joint; the fifth joint, which is smaller than any of the others, is only about half the length of the preceding one; the next three are sub-eqnal and somewhat longer than the fifth (fig. 1, Pl. XI.). The formula shows approximately the proportional lengths of all the joints—

Numbers of the joints,	1	2	3	4	5	6	7	8
Proportional lengths of the joints,	22	15	16	12	6	10	11	10

Antennæ stout, three-jointed, with a very small secondary branch bearing a single seta (fig. 2, Pl. XI.). The mandibles are small and elongate; the palp is small and consists of a single slender branch bearing two short apical setæ (fig. 12, Pl. X.). Maxilla short and moderately stout, with the apex broadly truncate and armed with a number of strong teeth. The palp small, two-jointed, and furnished with a few terminal and subterminal hairs (fig. 13, Pl. X.). Posterior foot-jaws stout, armed with a stout terminal claw and two stout marginal processes (fig. 14, Pl. X.). The inner branches of the first four pairs of swimming feet are all two-jointed; those of the first pair are nearly equal in length to the three-jointed outer branches; but in the second, third, and fourth pairs the inner branches are considerably shorter than the three-jointed outer branches. All the four pairs are moderately stout and are furnished with elongate marginal spines, while the terminal setæ of both the outer and inner branches are long and plumose (figs. 3 and 4, Pl. XI.). The fifth pair of thoracic feet are small and provided with about two moderately long spiniform setæ and one or two small hairs (fig. 5, Pl. XI.).

Habitat.—Brackish water-pools near Fairlie, Firth of Clyde. Apparently rare.

Remarks.—This Copepod at first sight closely resembles *Cylindropsyllus lœvis*, Brady, though of somewhat larger size; but even without dissection the caudal furcæ are seen to be distinctly different from those of that species, and if a specimen be dissected several other differences are noticed. The antennæ, for example, are three-jointed, while in the typical *Cylindropsyllus* they are only two-jointed: the inner branches of the swimming feet are also more fully developed than they are in *Cylindropsyllus.* Such differences may yet render it necessary to remove this Copepod to another genus; but, meantime, as no males have yet been observed, I prefer to leave it in the genus to which for the present it is doubtfully ascribed.

Leptocaris, gen. nov.

The Female.—Body slender, somewhat resembling *Cylindropsyllus.* Secondary branches of the antennæ very small, one-jointed. Mandible-palp obsolete—in this respect, the mandibles are somewhat similar to those of *Maraenobiotus.* Maxillæ also somewhat similar to those of *Maraenobiotus,* but the palp is a small cylindrical process with a dilated base. Footjaws similar to those of *Cylindropsyllus.* Inner branches of first, second, third, and fourth pairs of swimming feet two-jointed, and considerably shorter than the three-jointed outer branches; fifth pair very small, one-branched.

The Male.—The male is similar to the female, except that the antennules are modified and hinged for grasping, and that each of the fifth pair of thoracic feet is armed with a stout spine on its inner aspect, in addition to a few small setæ.

Leptocaris minutus, sp. n. (Pl. X., figs. 15-21; Pl. XI., figs. 7-11).

Description of the Female.—Body elongate and slender. No distinction between the thorax and abdomen. Thorax composed of five, and the abdomen of four segments (fig. 15, Pl. X.). The first thoracic segment is somewhat longer than the entire length of the next two, the second to the third are subequal, the fourth and fifth—which are also subequal—are rather longer than the second and third. The first abdominal segment is about one and a half times longer than the next, the second and third are subequal, while the ultimate segment is rather longer than the anterior one. Rostrum small. The antennules are very short, and moderately setiferous—seven-jointed. The first joint is considerably dilated; the second, which is only about half the length of the first, is also somewhat dilated. The third joint is nearly as long as the first. The fourth joint—which is furnished with a moderately long asthetask—and the last are of equal lengths, and are each as long as the second. The fifth and sixth joints are somewhat smaller than the others (fig. 16, Pl. X.). These differences are more clearly shown by the formula annexed—

$$\text{Numbers of the joints,}\quad \frac{1\cdot 2\cdot 3\cdot 4\,.\,5\,.\,6\,.\,7}{12\cdot 6\,.\,10\,.\,6\,.\,4\,.\,5\,.\,6}$$
$$\text{Proportional lengths of the joints,}$$

Antennæ small, three-jointed; secondary branches very small, one-jointed (fig. 18, Pl. X.). The mandibles are also small; the mandible palp is obsolete, being represented by a single small hair (fig. 19, Pl. X.). The maxillæ are very small, the biting part is moderately broad, and armed with a few comparatively elongate teeth. The palp is a small cylindrical process, arising from a moderately broad base, and furnished with a few hairs (fig. 20, Pl. X.). Posterior foot-jaws small. They somewhat resemble those of *Cylindropsyllus lævis* (fig. 21, Pl. X.). The inner branches of the first four pairs of thoracic feet are all two-jointed, and shorter than the three-jointed outer branches. The two joints that compose the inner branches are, in each of the four pairs, more or less subequal, but those of the first pair are rather stouter than the others. All the four pairs of feet are small (figs. 7 and 8, Pl. XI.). The fifth pair are minute. Each consists of a small semicircular appendage bearing three or four small setæ (fig. 9, Pl. XI.). The caudal furcæ, which are small and cylindrical, are scarcely twice as long as broad; but each carries a long terminal spiniform seta, and also a few small hairs (fig. 11, Pl. XI.).

The Male.—So far as can be made out, the male does not differ much from the female, except that the antennules are modified for grasping, as in other Harpactids. The fifth thoracic feet are also each provided with an elongate and stout spine, in addition to the setæ observed on the fifth pair of the female (fig. 10, Pl. X1.).

Habitat.—Brackish water-pools on the shore near Hunterston, Firth of Clyde. Rather rare.

Remarks.—This Copepod is somewhat like a *Moraria* or a *Maraenobiotus* in general appearance, as well as in some of the structural details; but it differs from these two genera, not only in the form of some of the mouth organs, and of the fifth pair of thoracic feet, but in other details of structure as well. Neither does it agree with *Cylindropsyllus,* although it has a general resemblance to the members of that genus. For these and other reasons, I have instituted for its reception the genus *Lepto caris* (Greek—*leptos*, slender; *karis*, a shrimp).

Idya cluthæ, sp. n. (Pl. XII., figs. 2-6).

Description of the Female.—Length of the specimen figured, 1·17mm. ($\frac{1}{22}$ of an inch). Somewhat like *Idya furcata* in general appearance, but rather more slender (fig. 2). The antennules are moderately short; being only about two-fifths of the length of the thorax, they resemble generally the antennules of *Idya furcata*, but the entire length of the first four joints is proportionally shorter. The first four joints are sub-equal in length; the fifth is rather shorter than the one next to it; while the seventh is distinctly smaller than either the fifth or sixth (fig. 3). The proportional lengths of all the joints are nearly as in the annexed formula—

Number of the joints,	1 · 2 · 3 · 4 · 5 · 6 · 7 · 8
Proportional length of the joints,	22 · 28 · 25 · 24 · 6 · 9 · 4 · 18

The antennæ and mouth organs are similar to those of *Idya furcata.* The first pair of thoracic feet resemble those of *Idya furcata*, but the seta that springs from the end of the first joint of the outer branches is short and straight, and none of the terminal or sub-terminal setæ bear secondary spine-like apical cilia so characteristic of *Idya furcata* and one or two other members of the genus. The second joint of the inner branches is proportionally stouter than the same joint in *Idya furcata*, and the terminal claws are long and slender instead of being short and moderately stout. Moreover, the spines on the inner and outer aspects of the second basal joint are also small and slender (fig. 4). The second, third, and fourth pairs of swimming feet are rather more slender than the same appendages in *Idya furcata* (fig. 5). The fifth pair of feet have the second joint long and slender, and the margins do not appear to be ciliated; the seta which springs from the inner angle, and also that which springs from the outer angle, of the basal joint are long and slender, while the terminal setæ of the secondary joint are also elongate (fig. 6). The abdomen is elongate, being equal to nearly two-thirds of the length of the thorax; the first and second segments appear to be, at least partly, coalescent; their combined length is equal to half the entire length of the abdomen; the last abdominal segment is very small. The caudal furca are short, and about as long as broad.

Habitat.—Loch Fyne and Firth of Clyde. Generally distributed, and apparently not very rare.

Remarks.—This distinct species of *Idya* appears to be unlike any previously described member of this genus. The two most prominent characters by which it may be distinguished from all closely allied species are—(1) The armature of the first pair of thoracic feet, and especially the long terminal spines of the inner branches, and (2) the long slender fifth feet. *Idya cluthæ* may by these two characters be distinguished at a glance even without dissection. Like other forms of *Idya*, this one bears a comparatively large ovisac. Both males and females have been obtained, and both are equally distinct. Hitherto this species has occurred only in moderately deep water.

Monstrilla danæ (?), Claparède.

Several specimens of *Monstrilla*, all of which appear to belong to the same species—viz., *Monstrilla danæ*, Claparède—have been obtained during the past year. They are all from the Clyde district, chiefly Upper Loch Fyne and Kilbrennan Sound. Usually one or two, rarely three or four, specimens were obtained in a single gathering.

The gatherings in which *Monstrilla* was observed were from the following stations:—Station II. (three specimens), Station III. (one specimen), Station IV. (two specimens), Station VI. (three specimens), Station XIII. (two specimens), Station XIV. (four specimens), Station XVII., two gatherings (one specimen each). These gatherings were all collected in August and November 1898.

Dermatomyzon nigripes (Brady and Robertson).

1875. *Cyclopicera nigripes*, Brady and Robertson, Brit. Assoc. Report p. 197.

This fine species occurred in only one of the gatherings at present under consideration—viz., in a bottom tow-net gathering from Station XV. (Moray Firth), collected 20th November 1897.

Rhynchomyzon purpurocinctum (T. Scott).

1893. *Cyclopicera purpurocinctum*, T. Scott, Eleventh Ann. Rep. Fish. Board for Scot., Part III., p. 209, Pl. III., figs. 29-40.

This well-marked species was obtained in the gathering from Station XV. (Moray Firth), in which *Dermatomyzon nigripes* occurred, and in another collected at Station II., also in the Moray Firth, 5th November 1897. In this species the last three thoracic segments are of a dark purple colour. Dr. W. Giesbrecht has found *Rhynchomyzon purpurocinctum* in Naples Bay.

Neopontius angularis (T. Scott).

1898. *Neopontius angularis*, T. Scott, Sixteenth Ann. Rep. Fish. Board for Scot., Part III., p. 271, Pl. XIV., figs. 1-11.

This species was described in 1898 from specimens obtained at Otter Spit, Upper Loch Fyne. I have now to record it from a bottom tow-net gathering from Station IV. (Kilbrennan Sound), Firth of Clyde, collected 24th August 1898 (27-29 fathoms).

Bradypontius papillatus (T. Scott) (Pl. XI., fig. 21; Pl. XII., figs. 7-15).

1888. *Artotrogus papillatus*, T. Scott, Sixth Annual Report of the Fishery Board for Scotland (Appendix), p. 232, Pl. VIII., figs. 7-12.

1895. (?) *Bradypontius chelifer*, Giesbrecht, Ann. and Mag. Nat. Hist., ser. 6, vol. xvi. p. 183 (August 1895).

This species, described in 1888 in the Sixth Annual Report of the Fishery Board for Scotland, has recently been re-examined, and some further details of structure have been elucidated which I now propose to notice by way of supplementing the original description.

The length of the specimen figured is 1·2mm. ($\frac{1}{21}$ of an inch). The first thoracic segment is equal to rather more than half the length of the thorax and abdomen combined; the abdomen is moderately elongate, and the furcæ are rather longer than broad. In general appearance this species somewhat resembles *Cribropontius normani* (B. and R.) (fig. 7, Pl. XII.).

The antennules are eight-jointed. The first and second joints are elongate; the third to the seventh are comparatively short; while the last is about twice the length of the penultimate joint (fig. 8, Pl. XII.). The proportional lengths of all the joints are approximately as shown by the formula—

Numbers of the joints,	1 · 2 · 3 · 4 · 5 · 6 · 7 · 8
Proportional lengths of the joints,	36 · 50 · 18 · 10 · 14 · 12 · 16 · 31

A moderately long asthetask springs from the end joint, as shown in the figure.

The antennæ are apparently four-jointed, and a very small secondary branch bearing two minute hairs springs from the end of the second joint (fig. 9, Pl. XII.). The mandibles are long and slender (fig. 10, Pl. XII.). Figure 10A represents the apical portion of one of the mandibles greatly enlarged, which somewhat resembles the apical portion of the mandibles in *Bradypontius magniceps* (Brady). The maxillæ resemble very closely those of *Dyspontius striatus*, Thorell, but the inner lobe is slightly longer than the outer, and the terminal setæ appear to be shorter than those of the maxillæ of that species (fig. 11, Pl. XII.). The first joint of the anterior foot-jaws is large and robust, but the second is elongate and slender, somewhat dilated at the extremity, and armed with a short, stout, and finger-like subapical claw (fig. 12, Pl. XII.). The posterior foot-jaws have the first and second joints moderately robust, but the end joints are somewhat slender, and terminate in a short, stout claw, as shown in the figure (fig. 13, Pl. XII.)

In the first pair of swimming feet, which are moderately stout, the outer and inner branches are nearly of equal length. The outer branches are armed exteriorly with short, stout, dagger-like marginal spines, and the interior marginal setæ are one on the second and five on the last joint. The inner branches are furnished with one seta on the inner margin of the first joint, and two on the second joint; while the third joint has five setæ on the inner margin and apex, and a small one on the outer margin (fig. 14, Pl. XII.).

In the fourth pair the outer branches are stout and elongate; the first and second joints have each one marginal seta; the third joint bears five marginal setæ, and is also armed with a moderately large sabre-like terminal spine in addition to the small spines on the outer margin; the inner branches, which are three-jointed, and scarcely reach to the end of the second joint of the outer branches, are slender, and provided with only a few minute hairs on the margins and two small apical spines (fig. 15, Pl. XII.).

Fifth feet small, one-jointed, subquadrate, each of them furnished with one small marginal and two short apical setæ. There is also close to each foot exteriorly a long seta with a slightly dilated base which springs from the edge of the segment to which the fifth feet are attached (fig. 21, Pl. XI.).

Habitat.—Firth of Forth. Rare. No males observed.

Remarks.—As already stated, this specimen was first partly described and figured in the Appendix to the Sixth Annual Report of the Fishery Board for Scotland, published in 1888. It was described under the name of *Artotrogus papillatus*, but some doubt was expressed as to its being a true *Artotrogus.* No more specimens having been observed, the interest in the species passed away, and it was practically forgotten. Recently, however, my son got hold of the original specimen from which the species was described, and with the assistance of Dr. W. Giesbrecht's work on the "Diagnosis, Synonymy, and Distribution of the Ascomyzontidæ" made a careful examination of the characters by which the species is distinguished, as well as a series of delineations illustrating its principal appendages. The description given above is the result of this extra research. From the additional information that has been obtained by this re-examination, there can be no doubt that our species is a true *Bradypontius.* It agrees perfectly with Dr. Giesbrecht's definition of that genus. It may also be identical with the species described by Dr. Giesbrecht under the name of *Bradypontius chelifer* from the Bay of Naples, and, if so, the distribution of the species will be very considerably extended.

Amphipoda.

A few of the Amphipods observed in the tow-net and other gatherings forwarded to me from the "Garland" may now be referred to.

The Hyperiidæ were of rare occurrence in the tow-net gatherings forwarded from the Clyde or Moray Firth during the past year. *Hyperia galba* (Mont.), *Hyperoche tauriformis* (Bate), and *Parathemisto* were observed in one or two of the Moray Firth gatherings, but in those from the Clyde only *Hyperoche* and *Parathemisto* were observed, the one from Stations I. and VIII. in both the surface and bottom tow-net gatherings, and the other from Station VII.

The Orchestiidæ observed include *Orchestia mediterranea,* a species that appears to be of rare occurrence in the Clyde district. One or two specimens were obtained amongst decaying sea-weed, on the shore between Fairlie and Hunterston in September. *Orchestia mediterranea* is readily distinguished from the more common *Orchestia littorea* by the form of the hands of the second gnathopoda in the male; in these appendages the propodos are triangular instead of ovate; the palm, which is almost straight, extends from near the base of the propodos, and has a triangular tooth-like projection anteriorly near the origin of the claw. The claw is long and somewhat sinuate, and nearly of the same length as the palm (figs. 9-11, Pl. XIII., represent the anterior and posterior gnathopods and one of the posterior pereiopods).

Only two specimens of this species have been recorded from the Clyde district by the late Dr. Robertson in Part I. of his Catalogue of Clyde Amphipoda and Isopoda. One of these he discovered at the west end of Cumbrae; the other was sent to him by Mr. John Smith, Kilwinning, who obtained it at the mouth of the Garnock.

A number of Amphipods belonging to the Lysianassidæ have been observed. I will, however, refer to only one of them—viz., the curious *Normanion quadrimanus* (Bate and Westwood), a single specimen of which was obtained in a bottom tow-net gathering from Station I., Firth of Clyde (near Davaar Island), collected 15th December 1898. In Part II. of the late Dr. Robertson's Catalogue of the Clyde Amphipoda, that author records having, along with the Rev. Dr Norman, captured *Normanion* off Farland Point, Cumbrae, which seems to be the only previous record of its occurrence in the Clyde. Professor Sars has shewn that *N. quadrimanus* is parasitic in its habits, and states that he has found it in great abundance clinging to the skin of fishes (both living and dead) caught on a fishing line set in deep water. It may, therefore, be found to be more common in the Clyde than it has hitherto appeared to be if a careful examination were to be made of the fishes caught in the deeper parts of the estuary.

The Ampeliscidæ were represented in recent tow-net gatherings from the Clyde by one or two moderately rare forms, such as *Ampelisca lævigata,* Lilljeborg; *Ampelisca spinipes,* Boeck; and *Haploops tubicola,* Lilljeborg.

Amongst the Phoxocephalidæ the only species that need be referred to is *Harpina crenulata,* Boeck. Four specimens of this Amphipod were obtained in a gathering of Crustacea dredged in Campbeltown Loch (Cantyre) in 1897. This appears to be the first record of *H. crenulata* for the Clyde.

Argissa hamatipes (Norman)—one of the Pontoporeiidæ—occurred sparingly in tow-net gatherings from the Clyde district as well as from the Moray Firth. Both male and female specimens were observed.

The curious *Stegocephaloides christianensis* (Boeck) occurred in a bottom tow-net gathering collected in the Clyde at Station XVII. (Upper Loch Fyne) on 7th December 1898. This species appears to be somewhat rare in the Clyde district.

Amongst the Amphilochidæ the somewhat rare *Amphilochus tenuimanus*, Boeck, was obtained in a bottom tow-net gathering from Station VII., Firth of Clyde, collected at night on 23rd September 1898. *A. tenuimanus* is recorded in Dr. Robertson's Catalogue, Part I., page 28.

Amphilochoides odontonyx (Boeck).=*Amphilochoides pusillus*, Sars, was obtained in the Clyde at Stations III., IV., VII., and IX., but only in bottom tow-net gatherings; while *Gitana sarsi*, Boeck (another of the same family of Amphipoda), occurred in a gathering from Station VI. collected on 25th August 1898.

The family Stenothoidæ was represented in the tow-net gatherings from the Clyde by *Stenothoë marina* (Spence Bate), *Cressa dubia* (Spence Bate), and one or two other forms ; and in a gathering from Station XV. Moray Firth, *Stenothoë marina*, *Metopa robusta*, G. O. Sars (a species recorded from the Moray Firth a few years ago in "Ann. and Mag. Nat. Hist.," ser. 6, vol. xiii., p. 148, February 1894), and *Cressa dubia* (Spence Bate). In *Metopa robusta*—the record of which in 1894 appears to be the first for Britain—the form of the first gnathopoda is quite distinct from that of the same appendages of any other British species except, perhaps, *Metopa polexiana*.

Monoculodes packardi, Boeck, occurred in a gathering from Station XVII. (Upper Loch Fyne) collected on 7th December 1898; and *Synchelidium brevicarpum* (Spence Bate) at Station IV. (Kilbrennan Sound, Firth of Clyde) on 24th August 1898.

Epimeria tuberculata, G. O. Sars. Two specimens of this fine species were obtained in a gathering from Station IV., Firth of Clyde, on 1st September 1898. *Epimeria tuberculata*, which appears to be a rare species in the Clyde, was added to the British fauna about two years ago.

Eusirus longipes, Boeck, was obtained from the Clyde in gatherings Stations VI., VII., and VIII. It occurred in one gathering from Station VI., collected on 25th August 1890; in two other gatherings from Station VII., collected on 3rd September and 24th September; and in one from Station VIII., collected on the 29th of the same month.

Guernea coalita (Norman). This curious little species was observed in washings of material dredged at Station VI., Firth of Clyde. The same species has been captured off Millport by the late Dr. Robertson, and is recorded in Part II. of his catalogue of Clyde Amphipoda and Isopoda; and his appears to be the only previous record of the occurrence of *G. coalita* for the Clyde.

Melphidippella macera (Norman). This Amphipod, though obtained occasionally in tow-net gatherings, is apparently scarce, as only one or a very few specimens are found in any single gathering. It occurred in four of the series of gatherings at present under consideration, all the four being from the Clyde, viz.:—In a gathering from Stations III. and IV., collected on 24th August 1898; in a gathering from Station VII. collected on 24th September; and in one from Station VIII., collected on 29th of the same month.

Photis longicaudatus (Spence Bate) occurred sparingly in a gathering from Station IV., Firth of Clyde.

Amongst the Podoceridæ *Podocerus palmatus*, Stebbing and Robertson, and *Podocerus pusillus*, G. O. Sars, have been obtained in tow-net gatherings from the Clyde—the first in a gathering from Station VII. collected on 24th September 1898, and the other in a gathering from Station VI., collected on 1st September.

Unciola planiceps, Norman, was obtained in the same gathering from Station VI. in which *Podocerus pusillus* just recorded occurred. *Unciola* appears to be an addition to the Amphipod fauna of the Clyde.

Isopoda.

The following are a few of the more interesting of the Isopoda that have been observed in tow-net and other gatherings recently examined. Those from the Clyde are, *Leptognathia breviremis*, Lillejeborg, collected at Station XII., between the south end of Arran and the Ayrshire coast; *Leptognathia brevimana* (Lilljeborg), at Station VI., 1st September 1898. Another closely allied species—*Tanaopsis laticaudata*, G. O. Sars—was moderately frequent amongst a gathering of material from Campbeltown Loch (Cantyre) collected in May 1897. *Munna boecki*, Kroyer, which is larger than *Munna kroyeri*, Goodsir, and apparently more frequent in the Clyde, has been obtained at Whiting Bay, and one or two other places. Both *Munna boecki* and *Munna kroyeri* have been observed in the Moray Firth district.

Paramunna bilobata, G. O. Sars, recorded for the Clyde in 1894, by the Rev. A. M. Norman (Ann. and Mag. Nat. Hist. (6), vol. xii., p. 280, footnote), was obtained at Station IV. (Kilbrennan Sound). It has already been recorded for Loch Fyne in Part III. of the Sixteenth Annual Report of the Fishery Board for Scotland.

Pleurogonium rubicundum, G. O. Sars, was recorded by the Rev. A. M. Norman, for the Clyde, in 1894, in the same footnote in which *Paramunna* is recorded (see reference under that species), and is, so far as I know, the only record for the Clyde hitherto. *Pleurogonium inerme*, G. O. Sars, has been obtained in a gathering from Campbeltown Loch (Cantyre), collected in 1897, and in one from Station IV. (Kilbrennan Sound), collected on 24th August 1898. *Pleurogonium spinosissimum*, G. O. Sars, another of these minute Isopods, has been recorded for the Clyde by the late Dr. Robertson, of Millport.

Pseudione crenulata, G. O. Sars (a parasite of *Munida rugosa*), apparently new to Britain, and *Pseudione affinis*, G. O. Sars (parasite on *Pandalus montagui*), have both been observed in the Clyde, while *Bopyroides hippolytis* (Kroyer) has been obtained in the Moray Firth.

Microniscus. The little parasite known by this name, and which, in the tow-net gatherings of the "Garland," is sometimes found clinging to *Calanus*, *Pseudocalanus*, and other Copepods, has just been shown by Prof. Sars ("Crustacea of Norway," vol. ii., p. 218-220, 1898) to be one of the post-larval stages of a species of *Phryxus.* In my paper on the "Marine Fishes and Invertebrates of Loch Fyne," published in the Fifteenth Annual Report of the Fishery Board for Scotland (p. 136, 1897), attention was directed to the close resemblance between *Microniscus* and the young of *Phryxus fusticaudatus*, Spence Bate, but no definite opinion was expressed as to the relationship between them. Probably more than one kind of *Bopyrus* is represented by these *Micronisci*, but it may, at this stage, be difficult to distinguish the one kind from the other.

Cumacea.

Several interesting Cumaceans have been observed during the examination of tow-net gatherings recently collected, the following of which may be referred to :—

Lamprops fasciata, G. O. Sars, has been obtained sparingly in a gathering from the Cromarty Firth. *Hemilamprops rosea*, Norman, occurred in a gathering from Station IV. (Kilbrennan Sound), Firth of Clyde. *Leucon nasicus*, Kroyer, was obtained in a gathering from Station XII. (Firth of Clyde), depth 40-43 fathoms. *Eudorellopsis deformis* (Kroyer)—a curious little Cumacean—was taken at Stations VII. and VIII., Firth of Clyde, in moderately deep water. *Eudorella truncatula* (Spence Bate) occurred in gatherings from Clyde Stations VII. and VIII., and *Eudorella marginata* (Kroyer) in a gathering from Station XII.

Campylaspis rubicunda, Lillejeborg, was obtained in gatherings from Clyde Stations XII. and XVII. *Cumella pygmæa*, G. O. Sars, occurred in a gathering from Station IV. (Kilbrennan Sound), Firth of Clyde, 24th August 1898, and in one from Station XV. Moray Firth, 15th November 1897.

Cuma pulchella, G. O. Sars, though only recognised within recent years as a member of the British fauna, has apparently a wide distribution around our shores. It was obtained in the Firth of Forth in 1889-90, and recorded in Part III. of the Eighth Annual Report of the Fishery Board for Scotland, p. 329, and afterwards in the Liverpool Bay District (Eighth Annual Report of the Liverpool Marine Biological Committee, p. 25). I have now to record its occurrence in the Clyde, having obtained one or two specimens in some washings of dredged material from Station VI. As pointed out by Dr. Norman, the first joint of the seventh foot is furnished with a series of backward-directed tooth-like processes, by which character *C. pulchella* may be distinguished from its congeners.

Schizopoda.

The Schizopoda, though plentiful in some of the gatherings, were usually limited to a few species, amongst which the Euphausiidæ were the most numerous. The Schizopod usually of most frequent occurrence in the Clyde and Loch Fyne gatherings is *Boreophausia raschii*, but in the Moray Firth *Thysanoessa neglecta*, Kröyer, is frequently the prevailing form. * *Nyctiphanes norvegicus*, which is also of frequent occurrence, and of large size, in Loch Fyne, is generally comparatively rare in the Moray Firth and in the Firth of Forth. This *Nyctiphanes*, though occasionally met with in considerable numbers in other parts of the Clyde district, seldom attains such a large size as it does in Loch Fyne.

Erythrops serratus and *Erythrops elegans* have been obtained in gatherings collected during the past year both in the Clyde and in Loch Fyne, but neither have been observed in the Moray Firth. *Erythrops serrata* formed part of the contents of a hake's stomach captured at Station XIV. (Loch Fyne). The Epicarid parasite *Aspidoecia Normanni*, Giard and Bonnier, was obtained on *Erythrops elegans* at Station VII., September 1898.

Siriella norvegica, G. O. Sars, was obtained at Station VII. (Firth of Clyde). The *Siriellæ*, though represented in the Clyde by at least four species, are usually of rare occurrence, so that even the commoner forms are worth recording. *Siriella norvegica* is one of the less familiar of the British *Siriellæ*.

Schistomysis ornatus, G. O. Sars, and *Hemimysis lamornæ* (R. Couch) has been occasionally met with in the Clyde tow-net gatherings during the past year. The first has been obtained in gatherings from Stations VII. and VIII., near the mouth of the estuary, and from Stations XIV. and XVII. in Upper Loch Fyne; the other was obtained in a gathering from Station VII.

Leptomysis gracilis, G. O. Sars, and *Leptomysis lingaura*, G. O. Sars, were also obtained in Clyde tow-net gatherings recently examined. *Leptomysis gracilis* occurred in a gathering from Station VIII., and *Leptomysis lingvura* in two different gatherings from Station VII., and in gatherings from Stations XIV. and XVII.

Mysidopsis gibbosa, G. O. Sars, *Mysidopsis didelphys* (Norman), and *Mysidopsis angusta*, G. O. Sars, have all occurred in gatherings recently collected in the Clyde and Upper Loch Fyne. *Mysidopsis gibbosa* was obtained in gatherings from three stations, viz., Stations VII., VIII., and XVII.; *Mysidopsis didelphys* in a gathering also from Station XVII., and *Mysidopsis angusta* in one from Station VIII.

Before concluding these notes on the tow-net gatherings collected on board the "Garland" and forwarded for examination, it may be of interest to refer to a young form of crustacean which is sometimes met with in these gatherings.

The study of the changes of form to be met with in the life-history of the Crustacea is a profoundly interesting one. The variations of form observed in the different species are sometimes so perplexing that they have occasionally puzzled even experienced students. Numerous larval and young forms are now and again captured in the tow-nets, but usually they belong to species that are fairly well known. It sometimes happens, however, that specimens are obtained which are not so easily disposed of, and I now draw attention to a curious form which is occasionally noticed

* *Thysanoessa neglecta* has recently been observed in the Clyde. It occurred in a tow-net gathering from Station X., collected on the 16th of January last. An exposition of the characters which distinguished this from the closely allied species, *T. longicaudata*, will be found in Rev. Dr. A. M. Norman's excellent "Revision of the British Schizopoda," published in the "Annals and Magazine of Natural History," June-September 1892.

in tow-net gatherings from the Clyde—the only Scottish locality where it has as yet been observed. The form referred to, which in general appearance is not very unlike the widely distributed crustacean known as *Lucifer*, has been known for a considerable period; it was described and figured under the name of *Trachelifer*, by the late Mr. George Brook in 1888*, but is evidently immature, and there is still some doubt as to the species to which it really belongs. The neck of this young form is long and slender; the thorax is small, and is furnished with more or less rudimentary appendages; the slender abdomen is more than twice the length of the neck, and the last abdominal segment is as long as all the other segments of the abdomen put together; the telson and uropods are comparatively short, and more or less rudimentary. Figure 16, Pl. XII., represents one of the Clyde specimens, which measured over all about 16·5 millemetres ($\frac{2}{3}$ of an inch). The specimens that have been observed vary in length to a small extent, but all possess the same slender *Lucifer*-like form.

Habitat.—Station VII., Firth of Clyde. (I have also a specimen from Loch Fyne collected in 1886.)

Additional Remarks.—Figures 17 to 20, Plate XII., exhibit on a somewhat enlarged scale portions of the Lucifer-like crustacean referred to above. In fig. 17, which represents the front part of the cephalic segment, the eyes are large and somewhat divergent; the triangular rostrum is slightly shorter than the eyes; both pairs of antennæ are slender and elongate; the antennal scales are also slender and rather shorter than the basal part of the antennules. Fig. 18 represents what appears to be one of the first peræopods. In the specimen dissected this was the only pair that had the extremities of the principal branches chelate; all the other trunk legs appear to be simple. Fig. 19 represents one of the first pair of abdominal appendages, which are all more or less rudimentary; each appendage consists of a single unjointed branch, with a furcated extremity. Fig. 20 represents the posterior end of the last abdominal segment, together with the uropods and telson; the appendages of the last abdominal segment form tapering and slightly curved processes; the uropods are foliaceous, and little more than half the length of the telson; the telson is comparatively of large size. In the specimen dissected for drawing, the telson was somewhat imperfect. The extremity is therefore indicated by dotted lines, but in another specimen in which the telson was fairly perfect the following characters were observed:—The terminal lateral processes had each two small teeth on the inner margin, and the part between the lateral processes was furnished with twenty-two short and slender marginal spines; the two middle spines were rather shorter than the others; and there was a slight but perceptible gradation in the length of those on each side of the two central ones, the spines nearer the centre being somewhat shorter than those more distant. The larva above referred to was described by Claus as *eine in vieler Hinsicht merkwürdigen Larve* in a paper *Zur Kenntniss der Kreislaufsorgane der Schizopoden und Decapoden*, in Arb. d. z. Inst. Univ. Wien. V. 1884, p. 302 (32), Pl. VIII., figs. 48-50. The same writer subsequently described a somewhat more advanced specimen as the larva of *Calliaxis adriatica*, Heller, ibid. VI. 1886, p. 63, Pl. V., fig. 45. The identity of Brook's *Trachelifer* with Claus's *Calliaxis*—larva is pointed out by Korschelt and Heider, Lehrb. d. vergl. Entwicklungsgesch. d. wirbell. Th., I., p. 471. *Calliaxis* is not yet known as a British form, being only known from the Adriatic and from Naples: at the latter station the larva is met with in the surface-fauna, but the adult has only been found once in 25 years (S. Lo Bianco, Mitth. Zool. Stat. Neapel. XIII., p. 503, 1899).

ADDITIONAL NOTES.

Shortly after the MS. of this paper had been sent to the printer I had the privilege of perusing the sixth portion of *Das Tierreich*, which has recently been published. This portion contains a revision of the Copepoda belonging to the sub-order Gymnoplea by Giesbrecht and Schmeil; several of the species of Copepoda mentioned in this paper belong to the same sub-order, and on comparing these with the revision referred to I find that the names of four of them have been somewhat altered, as follows:—

Bradyidius armatus (Brady).—Corrected name, *Bradyidius armatus* (Vanhöffen).

Eurytemora lacinulata (Fischer).—Corrected name, *Eurytemora velox* (Lillj), Brady.

Metridia hibernica (Brady and Robertson).—Corrected name, *Metridia lucens*, Boeck.

Candace pectinata, Brady.—Corrected name, *Candacia pectinata*, Brady

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EXPLANATION OF THE PLATES.

PLATE X.

Scolecithrix pygmæa, sp. n.

Fig. 1.	Female, lateral view	× 53.
Fig. 2.	Antennule	×126.
Fig. 3.	Anterior foot-jaw	×380.
Fig. 4.	Posterior foot-jaw	×380.
Fig. 5.	Foot of first pair of swimming-feet	×250.
Fig. 6.	Foot of fourth pair	×190.
Fig. 7.	Fifth pair of feet, male (r., right; l., left branch)	×127.
Fig. 8.	Abdomen and caudal furca, female, dorsal view	×190.
Fig. 9.	Abdomen and caudal furca, male, dorsal view	×190.

Scolecithrix hibernica, A. Scott.

Fig. 10.	Fifth pair of feet, male	×127.

Cylindropsyllus fairliensis, sp. n.

Fig. 11.	Female, lateral view	× 53.
Fig. 12.	Mandible	×760.
Fig. 13.	Maxilla	×760.
Fig. 14.	Posterior foot-jaw	×760.

Leptocaris minutus, gen. et sp. n.

Fig. 15.	Female, lateral view	× 107.
Fig. 16.	Antennule, female	× 760.
Fig. 17.	Antennule, male	× 760.
Fig. 18.	Antenna	× 760.
Fig. 19.	Mandible	× 760.
Fig. 20.	Maxilla	× 760.
Fig. 21.	Posterior foot-jaw	× 760.

PLATE XI.

Cylindropsyllus fairliensis, sp. n.

Fig. 1.	Antennule	× 380.
Fig. 2.	Antenna	× 380.
Fig. 3.	Foot of first pair of swimming-feet	× 250.
Fig. 4.	Foot of fourth pair	× 190.
Fig. 5.	Foot of fifth pair	× 380.
Fig. 6.	Last abdominal segment, and caudal furca	× 380.

Leptocaris minutus, gen. et sp. n.

Fig. 7.	Foot of first pair of swimming-feet	× 760.
Fig. 8.	Foot of fourth pair	× 760.
Fig. 9.	Foot of fifth pair, female	× 760.
Fig. 10.	Foot of fifth pair, male	× 760.
Fig. 11.	Last abdominal segment, and caudal furca	× 253.

Cletodes perplexa, sp. n.

Fig. 12.	Female, lateral view	× 760.
Fig. 13.	Antennule	× 760.
Fig. 14.	Mandible	× 760.
Fig. 15.	Anterior foot-jaw	× 760.
Fig. 16.	Posterior foot-jaw	× 760.
Fig. 17.	Foot of first pair of swimming-feet	× 760.
Fig. 18.	Foot of fourth pair	× 380
Fig. 19.	Foot of fifth pair, female	× 760.
Fig. 20.	Foot of fifth pair, male	× 760.

Bradypontius papillatus (T. Scott).

Fig. 21. Foot of fifth pair . . .. × 260.

PLATE XII.

Cletodes perplexa, sp. n,

Fig. 1. Caudal furca . . . . × 250.

Idya cluthæ, sp. n.

Fig. 2. Female, dorsal view . . . . × 53.

Fig. 3. Antennule . . . . × 190.

Fig. 4. Foot of first pair of swimming-feet . . . . . × 190.

Fig. 5. Foot of fourth pair . . . . × 190.

Fig. 6. Foot of fifth pair . . . . × 190.

Bradypontius papillatus (T. Scott).

Fig. 7. Female, dorsal view . . . . × 53.

Fig. 8. Antennule . . . . × 190.

Fig. 9. Antenna . . . . × 380.

Fig. 10. Mandible . . . . × 253.

Fig. 10A. Extremity of mandible . . . . × 1520.

Fig. 11. Maxilla . . . . × 380.

Fig. 12. Anterior foot-jaw . . . . × 190.

Fig. 13. Posterior foot-jaw . . . . × 190.

Fig. 14. Foot of first pair of swimming-feet . . . . . × 190.

Fig. 15. Foot of fourth pair . . . . × 190.

Larva of *Calliaxis* (*Trachelifer*).

Fig. 16. Specimen, showing side view . . . . × 10.

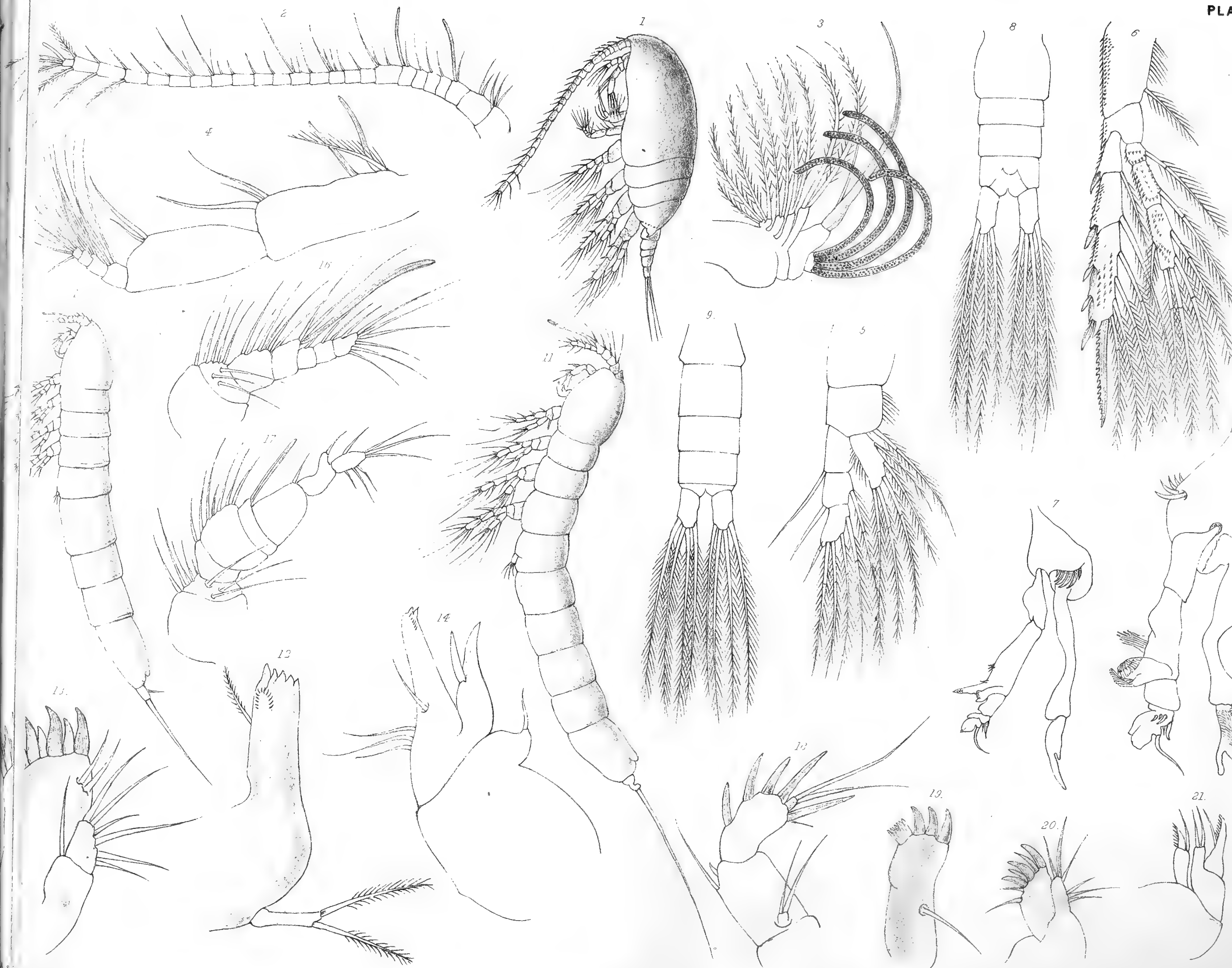
Fig. 17. Head, showing antennæ, etc. . . . . × $26\frac{1}{2}$.

Fig. 18. One of first peræopods . . . . × $26\frac{1}{2}$

Fig. 19. One of the abdominal appendages . . . . . . × 160

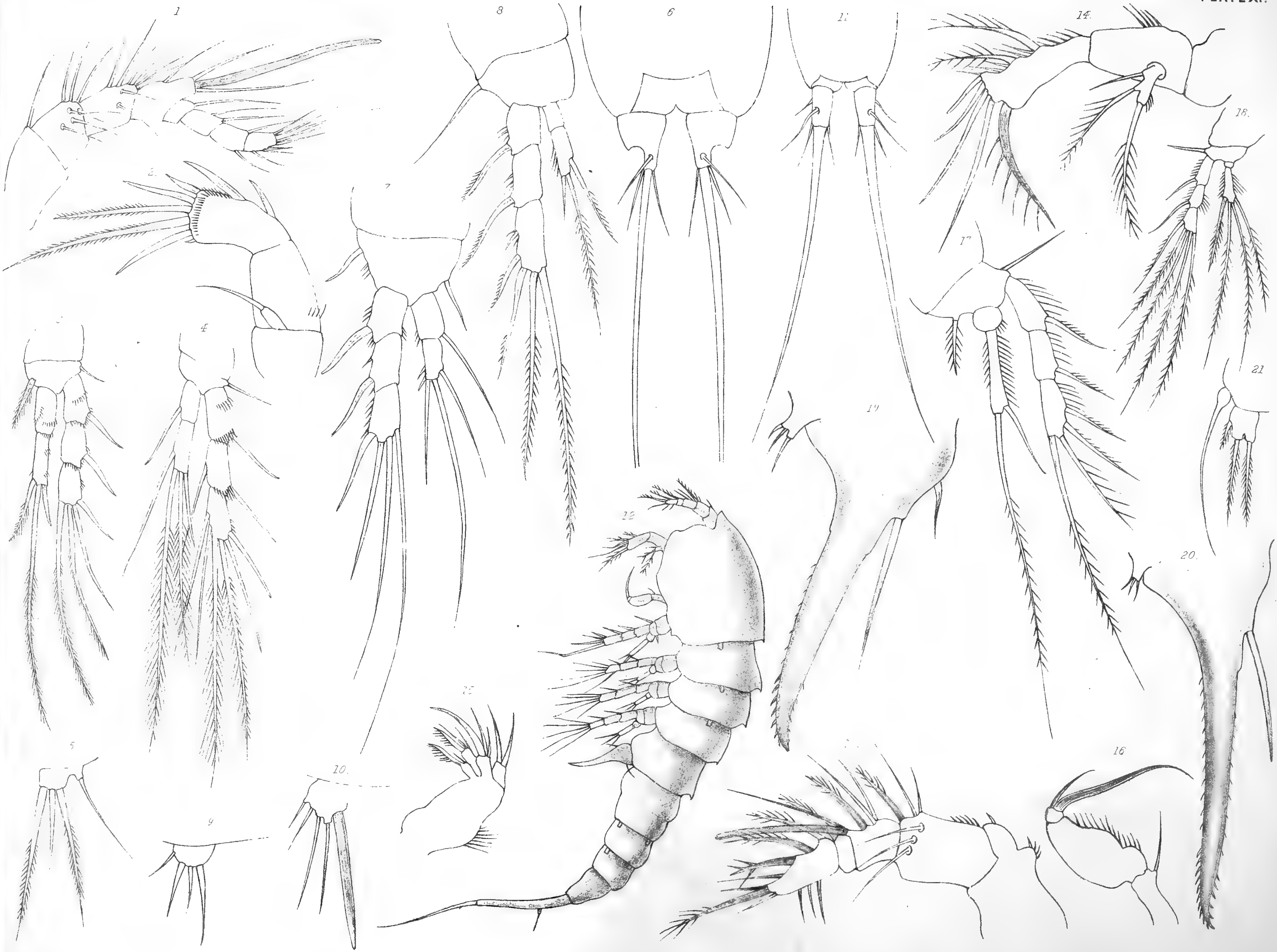
Fig. 20. Telson and uropods . . . . × $26\frac{1}{2}$

PLATE X.



COTT, *del.*

FIGS. 1-9.—*Scolecithrix pygmæa.*
FIGS. 11-14.—*Cylindropsyllus fairliensis.*
FIG. 10.—*Scolecithrix hibernica.*
FIGS. 15-21.—*Leptocaris minutus.*



A. Scott, *del.*

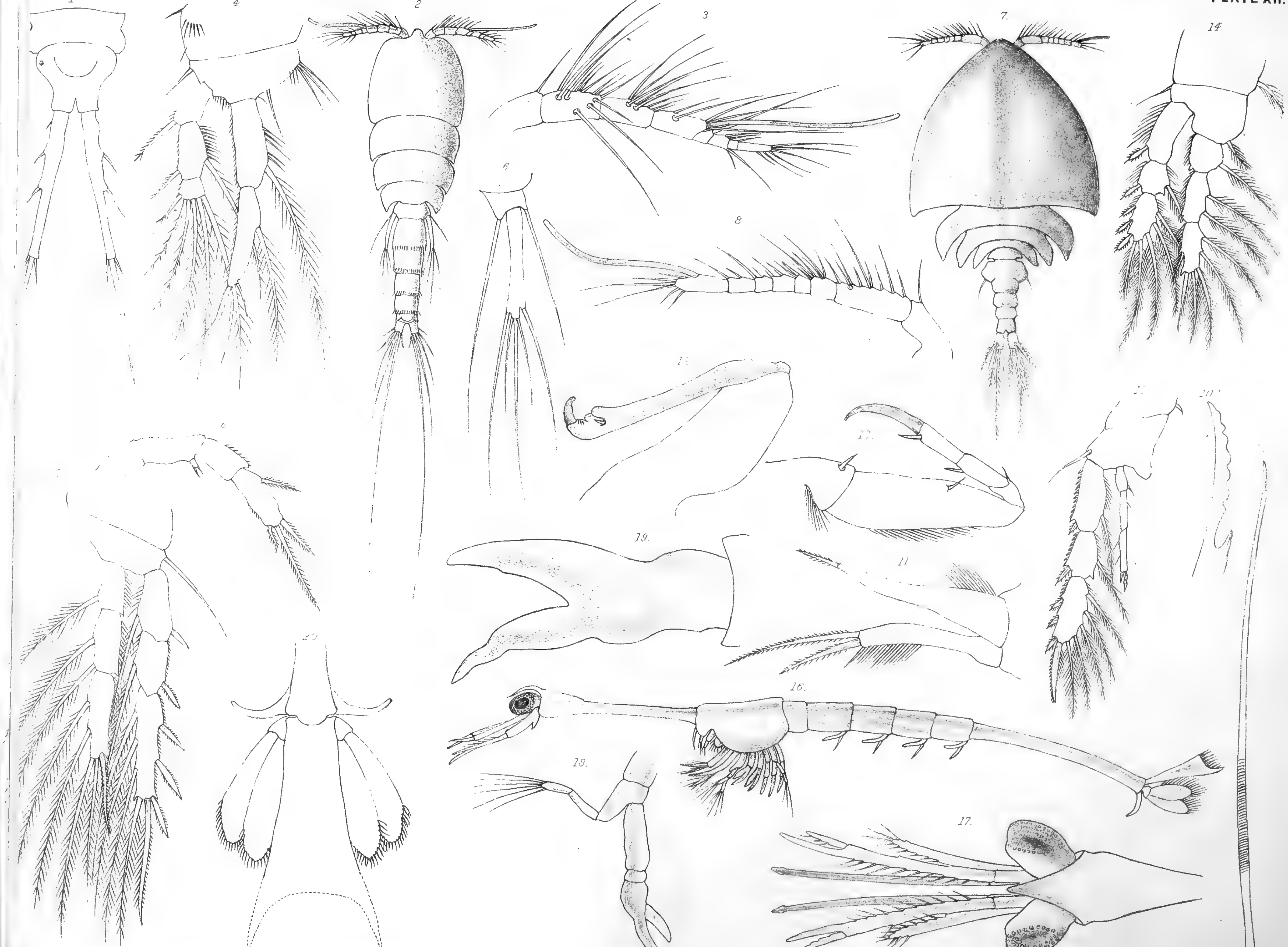
Figs. 1-6.—*Cylindropsyllus fairliensis.*

Figs. 12-20.—*Cletodes perplexa.*

Figs. 7-11.—*Leptosoma minuta.*

Fig. 21.—*Bradypontius papillatus.*

PLATE XII.



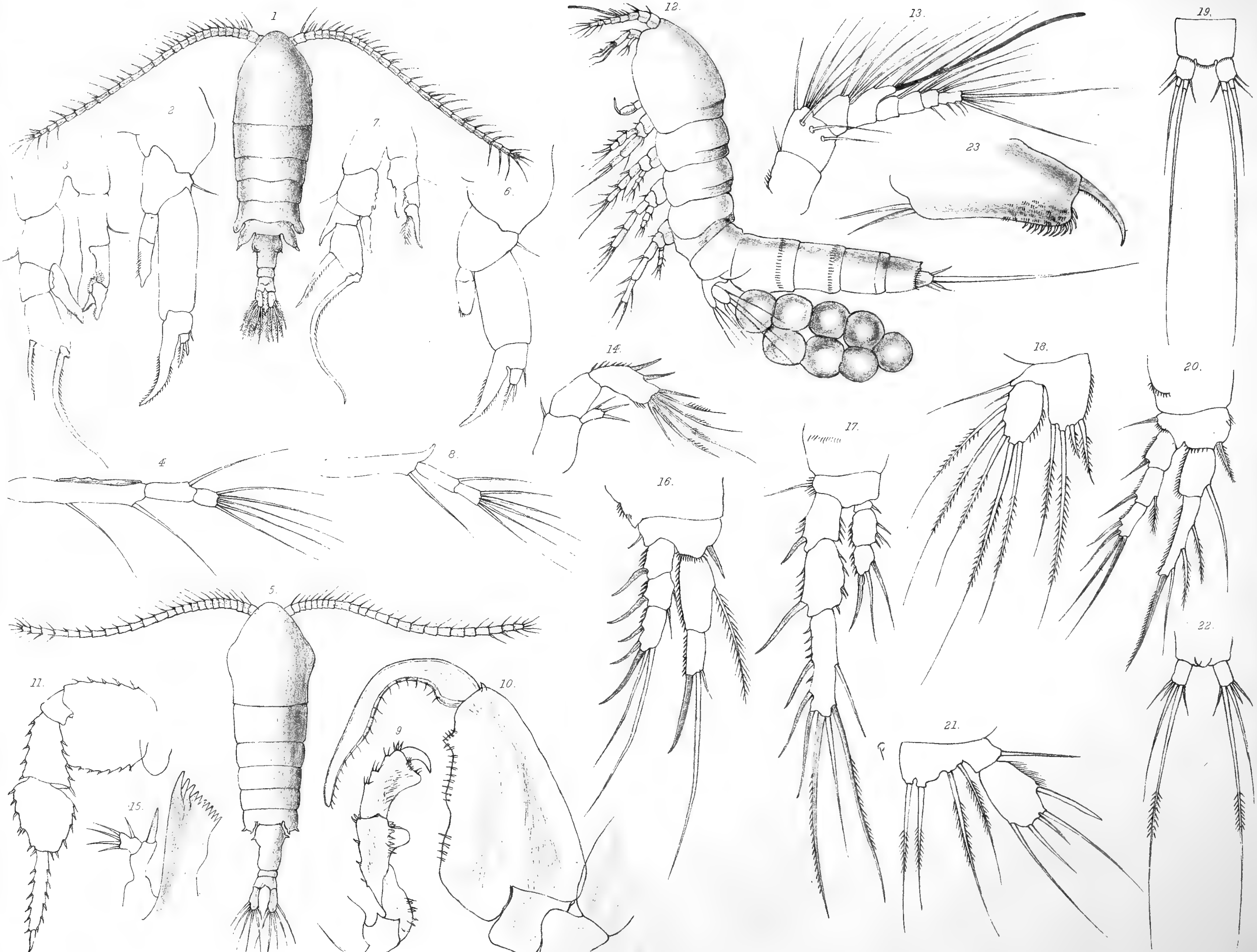
S. SCOTT, del.

FIG. 1.—*Cletodes perplexa.*

FIGS. 7-15.—*Bradypontius papillatus.*

FIGS. 2-6.—*Idya cluthæ.*

FIGS. 16-20.—*Trachelifer.*



A. Scott, *del.*

Figs. 1-4.—*Diaptomus lacinatus.* Figs. 5-8.—*Diaptomus hircus.* Figs. 9-11.—*Orchestia mediterranea.*
Figs. 12-19.—*Psyllocamptus fairliensis.* Figs. 20-22.—*Delavalia giesbrechti*, var. Fig. 23.—*Ceriodaphnia quadrangula.*

PLATE XIII.

* *Diaptomus laciniatus.*

Fig. 1.	Female, dorsal view	× 32.
Fig. 2.	Foot of fifth pair, female	× 190.
Fig. 3.	Foot of fifth pair, male	× 127.
Fig. 4.	Last three joints of right antennule, male	× 190.

* *Diaptomus hircus*, Brady.

Fig. 5.	Female, dorsal view	× 42.
Fig. 6.	Foot of fifth pair, female	× 253.
Fig. 7.	Foot of fifth pair, male	× 127.
Fig. 8.	Last three joints of right antennule, male	× 170.

Orchestia mediterranea.

Fig. 9.	One of the anterior gnathopods	× 18.
Fig. 10.	One of the posterior gnathopods	× 18.
Fig. 11.	One of the last pair of peræopods	× 9.

Pysllocamptus fairliensis, T. Scott.

Fig. 12.	Female, side view	× 160.
Fig. 13.	One of the antennules, female	× 456.
Fig. 14.	One of the antennæ	× 456.
Fig. 15.	One of the mandibles	× 760.
Fig. 16.	Foot of first pair of swimming-feet	× 456.
Fig. 17.	Foot of fourth pair of swimming-feet	× 456.
Fig. 18.	Foot of fifth pair	× 380.
Fig. 19.	Last abdominal segment, and caudal furca	× 190.

Delavalia giesbrechti, var.

Fig. 20.	Foot of first pair of swimming-feet	× 380.
Fig. 21.	Foot of fifth pair	× 380.
Fig. 22.	Last abdominal segment, and caudal furca	× 190.

* *Ceriodaphnia quadrangula*, var.

Fig. 23.	Post-abdomen of female	× 152

* Reference to these species will be found in my paper on the Fresh-Water Lochs of Scotland in this Report.

VIII. THE NATURAL HISTORY OF THE HERRING.

By Prof. Dr. Friedrich Heincke, Director of the Biological Station, Heligoland.

Abstract by H. M. Kyle, M.A., B.Sc., Exhibition Science Scholar, St. Andrews.

"Although the herring, principally from its great commercial import- "ance, has formed the subject of probably more investigation, and of a "consequent literature both popular and scientific, than any other sea fish, "the too general manner in which most of these investigations have been "conducted has led to the most contradictory results, and very little "to the real advance of our knowledge of the natural history ofthe fish "itself." Thus wrote J. Duncan Matthews in 1885 and, as might be expected, the literature has considerably increased since then, but the general manner of the investigations and the observations have undergone a complete change, becoming more and more accurate and minute, with consequently further-reaching results.

Matthews, however, made one exception, namely the work of Dr. Heincke, who in 1878 and again in 1882 had published the results of several years' study of the herring of the Baltic and North Seas. These studies were not completed with these publications, and the research has gone on, fostered by the German Sea-fisheries Association, year after year, until now in the present year a further large work has appeared. If it has taken so many years to bring this work to maturity, and if, as can easily be seen to be the case, the volume of results has increased, and the accuracy of which Matthews spoke become more perfect, then on those grounds alone this work of Heincke's demands the attention of naturalists in Great Britain, and of all those who take an interest in or are connected with sea fisheries. For naturalists, moreover, there is something of even greater interest than the results— the method, namely, which has gradually changed and become perfected as the subject developed in the mind of Dr. Heincke, so that it has been brought into line with the more advanced ideas in biological science. Dr. Heincke has been aided further by the criticisms of his earlier work which have appeared since its publication, and one can rely upon finding all those criticisms considered and answered in this present work.

The magnitude of the research may be understood from the fact that over 6000 herrings and sprats have been examined, and over 100,000 measurements taken.

With such a volume of work before one, all of it important, it is difficult to choose, for a brief abstract, what should be chosen, without running the risk of being too prolix, but in order to preserve historical continuity somewhat, it will be better to take up the work of Matthews, and show wherein the present work differs both with regard to method and conclusions. The method of Heincke, however, will only be displayed in so far as is necessary for a proper comparison of the works—that is, general notions of it only will be given. It would take up too much space if details were entered upon here, and a future paper will display it in full.

Beginning, then, with the first paper of Matthews, namely, "Report as to Variety among the Herrings of the Scottish Coasts," Part I.,* the object sought and the results attained may be briefly mentioned. As is known, herring fishing goes on round the Scottish coast at two separate seasons, in winter, and in summer and autumn, and the desire of the author was

* *Fourth Report of the Fishery Board for Scotland*, 1885, p. 61.

to ascertain what relation the herring of these two seasons bore to one another, whether they were of one and the same stock, so that the summer-herring might be called the younger specimens of the same race of which the winter was the older, or if they were two distinct varieties. After a prolonged and arduous research, Matthews came to the conclusion that the evidence he had, though good, was not sufficient to decide the question. As a matter of fact, his conclusions, as will be shown, tended in favour of the second hypothesis, but because he demanded too much from nature, because the differences did not satisfy his ideal of what was necessary to give two distinct races, he preferred to leave the question unsolved.

To consider now some of his results; first, with regard to the length of the head, it was found that the winter-herring had a slightly longer head than those of the summer, but that they vary more than the latter do, and further that the ranges of variation overlapped. A further complication arose when immature herring were considered as well as mature. Immature herring have the head relatively longer than the mature, and the relative size gradually decreases from young stages onwards, so that the largest herring have the smallest proportionate head. If, then, the summer-herring were supposed to be the younger of the same stock as the winter-herring, the head in the latter should be relatively smaller, since they are the older. As a matter of fact the reverse is the case; the winter-herring are not only somewhat larger in size but have the longer head.

Again, with regard to the position of the fins, it is shown that in the summer herring the centre of the dorsal fin is behind the body centre, whilst in the winter-herring it is in front. The anal fin, also, is further back (relatively to body length) in the summer- than in the winter-herring, and so again for the pelvics. What has been said above with regard to the head in the immature and mature herrings holds also for the position of the fins. In the young and immature the fins are relatively further forward, and therefore, if the summer-herring are the younger lot of the same race as the winter-herring, the fins ought to be further forward. The reverse again is the case. Moreover, in the winter mature herring the length of the bases of the dorsal and anal fins is relatively greater than the corresponding lengths in the summer-herring.

We might well ask now why Matthews did not consider these differences sufficient to entitle the summer- and winter-herrings to be called two distinct races, seeing that they even agree with his own criterion—viz., the presence of two or more, not necessarily marked, characters, occurring generally together in the fish of certain localities and at certain seasons. The reasons are as follows:—Firstly, he had not examined all the varying characters, nor did he consider the differences, in the young, and in their habits, in the habits of the adults, nor the differences in their surrounding conditions. Secondly, he considered the differences too small. Thirdly, and this summer most confusing to him, the variations overlapped—*i.e.*, the common ground of variation was the same or nearly the same for both summer- and winter-herring.

This cannot be gainsaid, and the greater the number of specimens examined, the greater is the possibility of finding this overlapping. Nor could it be otherwise. If the breeds of domestic animals be considered, or if the races of men be compared, it is seen that this overlapping constantly occurs, more especially where the races are closely allied, and yet the races are regarded as distinct.

It becomes simply a question of how to combine the results so as to show the true meaning of this overlapping—*i.e.*, to bring out the mean or average of both sets, and allow the variations to dovetail into one another on the one side or the other, or both. This Matthews did not attempt, nor could he very well at that time, but what he did was to divide up the grounds of variation into a number of small divisions, and arrange under each division the number or percentage of individuals observed to have this or that variation.

An example may be given in order to show this.

TABLE XXVI.,*

Showing Percentage of Mature Herrings of Progressive Lengths of Body, arranged according to Ratio of Position of Centre of Anal Fin to Body-Length (less Head and Caudal Fin).

		Winter.								Summer.							
Ratio of Fin Position.		·751 to ·762	·763 to ·773	·774 to ·784	·785 to ·795	·796 to ·806	·807 to ·817	·818 to ·828	·829 to ·839	·751 to .762	·763 to ·773	·774 to ·784	·785 to ·795	·796 to ·806	·807 to ·817	·818 to ·828	·829 to ·839
	mm.	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
	150 to 169	..	11·1	5·6	33·3	33·3	11·1	5·6	..	3·6	10·7	14·3	21·4	32·1	10·7	7·2	..
Length of Body.	170 to 189	2·9	12·8	32·8	21·5	25·7	4·3	..	..	·7	4·2	5·7	19·0	29·5	22·5	14·8	3·5
	190 to 209	1·4	11·4	24·3	24·3	25·7	8·6	2·9	1·4	·7	1·4	5·4	15·6	31·3	26·5	13·6	5·5
	210 to 229	..	10·8	22·9	22·9	25·3	14·4	2·4	1 2	..	..	..	10·8	39·1	24·0	19·6	6·5
	230 to 249	..	2·6	13·2	29·0	31·6	21·0	..	2·6	..	..	10·0	10·0	30·0	20·0	30·0	..
Percentage of all Lengths.		·9	9·7	19·8	26·2	28·3	11·9	2·2	1·0	1·0	3·3	7·1	15·4	32·4	20·7	17·0	3·1

The reasoning by which Matthews reached his conclusions should also be given, and as it is common for all the differences recorded, it can be centred round the above example. First, objection was taken to Heincke's earlier method of dividing up the variability into three classes, which, legitimate in itself in order to display small differences, contains the following possibility of error or flaw :—

"We have," says Matthews, "in most of the characters a more or less "common ground of variation—*i.e.*, a region in which the character appears "so commonly as to be entitled to the term *normal*,† and an extreme of "variation on one or both sides of this, and more or less great. By "dividing the total variation into three equal divisions we perhaps in some "cases include the *normal* in the first, in others in the second, or it may "be in the third division. This would not necessarily be very confusing, "but further, as in some of my cases, part of the *normal* cases would be "included with one extreme of variation, part—probably an entirely "different quantity—with another. If for facility in the investigation, so "few artificial divisions of variation as three are used, they should be not "equal in extent, but such as to cover a *normal condition* and an upper "and lower extreme of variation, except where the variation is equally "spread over the individuals."

*Part II., *Fifth Report of the Fishery Board for Scotland*, p. 295, 1887.
† Italics are mine.

If this notion of the *normal condition*, or average as we should call it now, had been rigorously worked out, there can be little doubt that it would not only have altered the conclusions reached by Matthews, but have forestalled to a certain extent the method now used by Heincke. The turning-point of the whole investigation, in fact, depends upon the rigorous determination of this normal or average condition.

In effect, Matthews inclined in the opposite direction—dividing the ground of variability into more numerous divisions, with the notion, apparently, of showing that if two races could be taken from this field of variation, so might three, or even a dozen. The result was that the number of individuals under each heading diminished, rendering it more and more difficult to see any differences, for the mind cannot grasp such a great number of particulars. If the number of divisions be increased they should be increased *ad infinitum*, *i.e.* the characters should be represented as they are in nature. There must be some guiding principle in order that the mind should be able to grasp the meaning of the variations, and the simpler the principle the more likely is it to represent the reality. One can understand, then, the position of Matthews—there was difference, and yet no difference. At first sight one saw the differences; on scrutinising closer, endeavouring to grasp the meaning of the variations, and endeavouring to take into account the infinite number of possibilities that lay outside the bounds of the observed number, the mind became more and more confused, and the only conscientious decision was to examine an enormously larger number of specimens at every season of the year, and for many years consecutively, before a definite answer could be given. And such, in fine, were the conclusions of Matthews.

What, then, is the method of Heincke? Simply, to concentrate the attention on the normal condition or average, to carefully eliminate all errors likely to arise by imperfect observation or arising from different ages, sex, seasons, or regions; to get the average clear and distinct so as to allow it to speak for the specimens examined; and then further, by the mathematical calculation of the possibility of error contained within it, allow it to speak for the whole tribe, or race, or even species.

As an approximation to this method the number of divisions in the above Table, given by Matthews, may be reduced to two.

		Winter.		Summer.	
Ratio of Fin Position.		·751 to ·795	·796 to ·839	·751 to ·795	·796 to ·839
Length of Body.	M.M.				
	150 to 169	50·0	50·0	50·0	50·0
	170 to 189	70·0	30·0	29·6	70·3
	190 to 209	61·4	38·6	23·1	76·9
	210 to 229	56·7	43·3	10·8	89·2
	230 to 249	44·8	55·2	20·0	80·0
Percentage of all Lengths.		56·6	43·4	26·8	73·2

This Table * shows more clearly the difference between the two—

* "Naturgeschichte des Herings," p. 24 *et seq.*, on which this criticism is for the most part based.

show the true meaning of this overlapping—*i.e.*, to bring out the mean or average of both sets, and allow the variations to dovetail into one another on the one side or the other, or both. This Matthews did not attempt, nor could he very well at that time, but what he did was to divide up the grounds of variation into a number of small divisions, and arrange under each division the number or percentage of individuals observed to have this or that variation.

An example may be given in order to show this.

TABLE XXVI.,*

SHOWING PERCENTAGE OF MATURE HERRINGS OF PROGRESSIVE LENGTHS OF BODY, ARRANGED ACCORDING TO RATIO OF POSITION OF CENTRE OF ANAL FIN TO BODY-LENGTH (LESS HEAD AND CAUDAL FIN).

		Winter.								Summer.							
Ratio of Fin Position.		·751 to ·762	·763 to ·773	·774 to ·784	·785 to ·795	·796 to ·806	·807 to ·817	·818 to ·828	·829 to ·839	·751 to .762	·763 to ·773	·774 to ·784	·785 to ·795	·796 to ·806	·807 to ·817	·818 to ·828	·829 to ·839
Length of Body.	mm. 150 to 169	% ..	% 11·1	% 5·6	% 33·3	% 33·3	% 11·1	% 5·6	% ..	% 3·6	% 10·7	% 14·3	% 21·4	% 32·1	% 10·7	% 7·2	% ..
	170 to 189	2·9	12·8	32·8	21·5	25·7	4·3	..	..	·7	4·2	5·7	19·0	29·5	22·5	14·8	3·5
	190 to 209	1·4	11·4	24·3	24·3	25·7	8·6	2·9	1·4	·7	1·4	5·4	15·6	31·3	26·5	13·6	5·5
	210 to 229	..	10·8	22·9	22·9	25·3	14·4	2·4	1 2	..	..	..	10·8	39·1	24·0	19·6	6·5
	230 to 249	..	2·6	13·2	29·0	31·6	21·0	..	2·6	..	..	10·0	10·0	30·0	20·0	30·0	..
Percentage of all Lengths.		·9	9·7	19·8	26·2	28·3	11·9	2·2	1·0	1·0	3·3	7·1	15·4	32·4	20·7	17·0	3·1

The reasoning by which Matthews reached his conclusions should also be given, and as it is common for all the differences recorded, it can be centred round the above example. First, objection was taken to Heincke's earlier method of dividing up the variability into three classes, which, legitimate in itself in order to display small differences, contains the following possibility of error or flaw :—

"We have," says Matthews, "in most of the characters a more or less "common ground of variation—*i.e.*, a region in which the character appears "so commonly as to be entitled to the term *normal*,† and an extreme of "variation on one or both sides of this, and more or less great. By "dividing the total variation into three equal divisions we perhaps in some "cases include the *normal* in the first, in others in the second, or it may "be in the third division. This would not necessarily be very confusing, "but further, as in some of my cases, part of the *normal* cases would be "included with one extreme of variation, part—probably an entirely "different quantity—with another. If for facility in the investigation, so "few artificial divisions of variation as three are used, they should be not "equal in extent, but such as to cover a *normal condition* and an upper "and lower extreme of variation, except where the variation is equally "spread over the individuals."

*Part II., *Fifth Report of the Fishery Board for Scotland*, p. 295, 1887.
† Italics are mine.

If this notion of the *normal condition*, or average as we should call it now, had been rigorously worked out, there can be little doubt that it would not only have altered the conclusions reached by Matthews, but have forestalled to a certain extent the method now used by Heincke. The turning-point of the whole investigation, in fact, depends upon the rigorous determination of this normal or average condition.

In effect, Matthews inclined in the opposite direction—dividing the ground of variability into more numerous divisions, with the notion, apparently, of showing that if two races could be taken from this field of variation, so might three, or even a dozen. The result was that the number of individuals under each heading diminished, rendering it more and more difficult to see any differences, for the mind cannot grasp such a great number of particulars. If the number of divisions be increased they should be increased *ad infinitum*, *i.e.* the characters should be represented as they are in nature. There must be some guiding principle in order that the mind should be able to grasp the meaning of the variations, and the simpler the principle the more likely is it to represent the reality. One can understand, then, the position of Matthews—there was difference, and yet no difference. At first sight one saw the differences; on scrutinising closer, endeavouring to grasp the meaning of the variations, and endeavouring to take into account the infinite number of possibilities that lay outside the bounds of the observed number, the mind became more and more confused, and the only conscientious decision was to examine an enormously larger number of specimens at every season of the year, and for many years consecutively, before a definite answer could be given. And such, in fine, were the conclusions of Matthews.

What, then, is the method of Heincke? Simply, to concentrate the attention on the normal condition or average, to carefully eliminate all errors likely to arise by imperfect observation or arising from different ages, sex, seasons, or regions; to get the average clear and distinct so as to allow it to speak for the specimens examined; and then further, by the mathematical calculation of the possibility of error contained within it, allow it to speak for the whole tribe, or race, or even species.

As an approximation to this method the number of divisions in the above Table, given by Matthews, may be reduced to two.

		Winter.		Summer.	
Ratio of Fin Position.		·751 to ·795	·796 to ·839	·751 to ·795	·796 to ·839
Length of Body.	M.M.				
	150 to 169	50·0	50·0	50·0	50·0
	170 to 189	70·0	30·0	29·6	70·3
	190 to 209	61·4	38·6	23·1	76·9
	210 to 229	56·7	43·3	10·8	89·2
	230 to 249	44·8	55·2	20·0	80·0
Percentage of all Lengths.		56·6	43·4	26·8	73·2

This Table * shows more clearly the difference between the two—

* "Naturgeschichte des Herings," p. 24 *et seq.*, on which this criticism is for the most part based.

(2.) The individuals of a race, both in their separate characters and in the combination of all their characters, are the fortuitous examples or forms of an *ideal type*, which is obtained from the average of all the characters of every individual. It is as if nature were ever aiming to arrive at this ideal and thus presented different combinations of characters in every individual, and different grades of variation in every character.

(3.) Every individual presents the same average amount of variation (in the combination of all the characters) from the *ideal type*, but each individual presents a different *permutation* of the separate variations of the series.

(4.) The *ideal type* of a race and the extent of the degrees of variation in the different characters appear as the expression of the living-conditions *regarded as a whole*, with all their internal combination, organisation, and cyclically recurring changes. The individuals are the expression of this organisation and changings of the living-conditions.

(5.) The existence of local races is certain, and they differ from one another in the same characteristics as species from allied species. As a rule these differences are smaller, but not always. Thus comparing the pilchard, sprat, and herring with regard to the average number of vertebræ, the sprat has 48, the pilchard 52, and the herring 56. But in the Norwegian spring-herring the average is 57·6, and in the herring from the White Sea the average is 53·6, so that the difference with regard to this character between two races of one species is as much as that between the two species of pilchard and herring.

(6.) Those more separated by geographical or rather physical conditions differ more also. So far as geographical conditions are concerned they may or may not be nearly allied, and complex conditions in the surroundings may even call forth in (geographically) the same region distinct season-races, as spring- and autumn-herring. As will be shown, the differences between these must be deeply grounded in nature.

(7.) The result of the study—that small groups of races differ from one another in certain characters in striking fashion will help us in the future, on the way to the physiological solution of race-differences, when we know better the physiological signification of the organs and the nature of the life-conditions.

(8.) The race-characteristics, so far as present evidence goes and until proof of the opposite is forthcoming, are to be considered as hereditary. Thus the herring of Schley, examined in May 1878, and again in April 1888, presented the same averages for the characters—the differences lying within the limits of the possibility of the variation of the average.* It follows, then, that the young of the Schley spring-herring when they have grown to maturity return to the place of their birth in order to spawn. And so we may conclude for others. The place of their birth, of course, must not be construed as this or that particular square mile of the sea, but as being a place where the conditions of ground and water are always the same or similar.

(9.) The dwelling-areas of the herring, which they do not leave as a rule, are large, but vary in extent. This is a most important practical conclusion, but in order to see its full significance we must first discern the races into which the herring as species is divided, and then consider the question of migration.

The herring as species is naturally divided into two great groups of races—the sea-herring or autumn-spawners, and the coast-herring or

*Vol. II., pp. 31 to 42, Tables IX.-XXI.

spring-spawners. It must not be thought that the differences are very great between the groups or that they are sharply marked off: there is no fixed line in nature; but if the habits, characters, and variations of these be regarded in the herrings as a whole, the grouping is seen to be perfectly natural.

Sea-herring or Autumn-spawners (Bank-herring).

These dwell in the open sea from the coast of Scotland and England through the whole North Sea, the Skagerrak, Kattegat, and western Baltic, gradually tailing-off in the middle portions of the eastern Baltic, towards Gotland. They all, in summer or autumn, come from the open sea to spawn on the sandy or stony banks which lie at some distance from the coast towards deeper water. Their body-characteristics are locally very different; in the eastern Baltic they are quite different from those on the Scottish coast. But all the races of this series show certain co-ordinate peculiarities in the composition of their race-characters, differentiating them from the other group of winter- or spring-spawners. They all display a moderate number of vertebræ (56·5 to 55·5 on average), with a high number of keeled scales behind the ventral fins (15·0 to 14·0 on average), and a strong development of these scales, which in the young are often like those of the sprat in their sharpness. The number of the vertebræ to the first hæmal arch is great, mostly 25 and more. The head is thick-set, high, with varyingly prominent foreshortening of the snout, and weaker or stronger *brachycephalism* of the skull. Also characteristic are the length of the back, and the relative shortness of the tail—they are *brachyuric*. Lastly, the pronounced disposition to change the number of the fin-rays in the ventral from 9 to 8, is distinctly characteristic.

These characteristics vary with their dwelling-places; from west to east we get a gradual transition from highest number of vertebræ, of keeled scales, and strongest *brachycephalism*, through decreasing number of these, to a distinctly lower number of vertebræ, of keeled scales, less breadth of skull, and smaller size.

Coast-herring or Spring-spawners.

These dwell in the coast waters of the whole North and Baltic Seas to the innermost corner of the last. They all spawn in winter or spring in the immediate proximity of the coast, and come very often into narrow and brackish bays or river-mouths. Also, their body characteristics are locally very different, even more different than between those of the corresponding races of sea-herring. But they show certain determinate characters in the composition of their race-characteristics which differentiate them from the large group of sea-herring. Thus, the small number of keeled scales (14·0 and fewer on average), and the weak development of these scales. The number of vertebræ is, as a rule, not smaller, but the number to the first hæmal arch is relatively smaller. The head is coarser, longer, with stronger development and elongation of the snout, and mostly smaller skull-breadth—prominent *dolichocephalism*. The back is shorter; head, and especially tail, long—in the extreme forms clearly *dolichuric*. Lastly, the relatively seldom occurrence of 8 rays in the ventral fins.

There are probably two groups of these, geographically :—

(*a*) Those of the southern North Sea and western Baltic from the Zuyder See to the Schley and other brackish bays of the west Baltic.

This s a very strongly marked series, thus the number of the vertebræ is small (55 8 to 55·0).

(*b*) Those of the northern North Sea, beginning with the spring-herring of the Scottish coast and continuing in the coast-herring of the Skagerrak (spring-herring of Bohuslän), through the Sound to the spring-herring of Rügen, and ending with the spring-herring of the eastern Baltic.

Its characteristics, in contrast with the foregoing, are—greater number of vertebræ (and higher number of these to ie first hæmal arch), a somewhat smaller number of keeled scales,[1] a longer head and tail —*i.e.*, they stand between the group (*a*) and the sea-herring. In the west, on the Scottish coast, these herrings are very large in body, with higher number of vertebræ (57·0), and are mostly winter-spawners; in the Skagerrak, somewhat smaller (V., 56·5), and spring-spawners. Towards Rügen the variation continues in the same direction (V., 56·0) as well as in the eastern Baltic (V., 55·5 to 50·0), and the spawning-time reaches further into the summer.

The races of the *sea-herring* of the northern North Sea and as far as Gotland in the Baltic, and the races of northern *coast-herring* from Scotland towards the eastern Baltic, run in a very noteworthy fashion geographically parallel. Especially astonishing is it that the connection of the sea-herring of the eastern Baltic with those of the Kattegat through the Belt and further through the western Baltic (autumn-herring of Korsör) has corresponding to it the connection of the coast-herring of the eastern Baltic with those of the northern North Sea through the Sound by Rügen.

The spring-herring of the Belt and western Baltic (Schley) form a divergent group which, as already mentioned, find their nearest allies in the southern parts of the North Sea (Zuyder See).

To this characteristic parallelism in the location of the sea- and coast-herring there is a corresponding parallelism in the body-characteristics. Each one of the two groups always retains the same characteristic composition of the characters, and one can tell almost always the sea-herring from the coast-herring; but for both groups we find in any one region the same gradation or variation of the characters. The further the sea-herring advances into the Baltic, so much the more do we find a decreasing breadth of skull, decreasing number of vertebræ and number of keeled scales, as well as decreasing length of body, and it is quite the same for the coast-herring.

Having thus obtained some general notions with regard to the natural grouping of the herring, we may now proceed to the particular races and the details of their differences.

Particular Races of the Herring.

I. *Iceland Herring.*—These herrings are of large size, mostly over 300mm. when in maturity; number of vertebræ large, in average over 57; number of keeled scales behind ventral fin (k2) small, in average under 14; tail tolerably long; head thick-set, short, high, and broad, with very short snout; eyes very large, and operculum very broad; length to breadth index of the skull large, in average 31—brachycephalism.

Time of spawning not yet definitely known—probably in spring or summer.

II. *Spring Herring of Norway* (Vaarsild).—Very large in size, in maturity over 300mm.; number of vertebræ very large, in average over

57·5, in single examples up to 60; number of tail vertebræ large, in average 14·5 and more; number of keeled scales under 14.5 in average; body tolerably long, with small difference in position between dorsal and anal fins; head, and especially tail, short; anal fin long, often longer than dorsal; head well formed, with tolerably long (on average, high also) snout, small eyes, and tolerably broad operculum; cranium small, tolerably high and slender; length to breadth index tolerably small (30)—mesodolichocephalism.

One of the most definite marked races; spawning time in February and March. The Norwegian summer and "fat-herring" is the young of the vaarsild.

III. *Spring or Coast Herring of the northerly North Sea and Skagerrak.*—Large, in maturity mostly over 250mm.; sum of vertebræ large, in average 56·5 to 57·0; number of tail vertebræ large, average over 14·0; keeled scales, 14·5 in average; back and tail as in former race; anal and dorsal fins very long; length to breadth index of skull small (30)—mesodolichocephalism.

This race, which strikingly resembles the foregoing and seems to differ from it only in the smaller number of vertebræ, includes those which in spring, in more or less salt water, are spawning on the west and east coasts of Scotland (Ballantrae, Firth of Forth), as well as those of the Skagerrak coast (Värsill of Gothenburg). They differ from the sea- or autumn-herring of the same places in many characteristics—above all, in that they have, as a rule, a more pronounced body stature, longer anal fin, and higher, or at least not smaller, number of vertebræ; against which stands a smaller number of keeled scales, and a smaller skull breadth; and lastly, that in them, as in the Norwegian "vaarsild," the number 8 in the ventral fin-rays occurs much seldomer.

The three races included in this group—the spring-herring of Ballantrae an the west coast of Scotland, the spring-herring of the Firth of Forth, ond the spring-herring of Bohuslän—are quite distinct the one from the other. The last gives a clear and interesting transition to the spring-herring of Rügen.

IV. *Spring or Coast Herring of the southern North Sea and west Baltic, including those of the Kattegat.*—Moderately large, the average at maturity seldom reaching 250mm.; number of vertebræ small, the average over 55·0, highest 56, seldom over 55·5; number of keeled scales under 14·5 in average; number of vertebræ to the first hœmal arch low, in average 24 or less, to highest 24·5; dorsal and ventral fins and the anus mostly in a forward position, especially the two last; head with short and small or medium-sized snout, and tolerably high skull; length to breadth index tolerably large (30 to 31·5 and more), strong brachycephalism; pre-eminently coast-herring which spawn in more or less brackish bays and mouths of rivers, in spring time from March to June; the young grow up in these bays, and wait there quite a year.

This group contains three sub-groups—(1) Herring of southern North-Sea, of Rinkjöbing Fjords, Dollart, and Zuyder See; (2) herring of west Baltic (Schley, Dassower See, &c.); (3) spring-herring of the Lümfjords and Belt.

IVa. Spring-herring of Rügen.—Large size and large number of vertebræ; an intermediate form between the east coast herring of the Skagerrak and the "strömlings" of the east Baltic.

V. *Autumn or Sea Herring of the southern North Sea, including those of the Skagerrak and Kattegat (Northern Bank Herring).*—Large, at maturity mostly over 250mm.; number of vertebræ moderately large, 56·5; number of keeled scales high, mostly over 14·5 to 14·9; number of vertebræ to first hæmal arch mostly at 25; body long, head, and especially tail, short; anal fin moderate to short; head with tolerably short and high snout; snout mesobrachycephalic; tolerably frequent, 8 rays in ventral fin, in from 20 to 30 per cent. of all individuals.

To this race belong all the great shoals in the North Sea, which constitute the material for the great fisheries on the Scottish coast, to the Dogger Bank, in the Skagerrak and Kattegat. These inhabit the open sea, and come for spawning in summer and autumn to places from near the coast to the rising banks (about forty miles out), those on the Scottish side near in, those on the eastern side further out (40 to 60 sea miles). Their young are born and grow up in the open sea, and extend seldom or never into the mouths of rivers.

VI. *Autumn or Sea Herring of the Southern North Sea (Southern Bank Herring).*—Closely allied to foregoing; smaller size of head; extraordinary large number of keeled scales, 15 on average, to 17 and even 20 in individual cases; in young also these scales are much sharper than in any other group; skull strongly brachycephalic—31·0 to 32 on average.

Belonging to this group are the autumn-herring of the German Bight, those of the Dutch coast, probably those of the English coast (though these have not yet been studied), and those to the south of the Dogger Bank. True spawning period not exactly known, from mid-summer to November probably, nor spawning places, which are probably from somewhere near the coast to the Dogger Bank.

The young are born and grow up in the open sea, but may extend to the German and Dutch coasts, as also those somewhat older; those ripe for the first time (young autumn-herring of the mouth of the Elbe) may extend to the mouths of rivers and brackish waters, if the water is still sufficiently saline.

These are small and of poor quality; this was not always so, however. A hundred years ago this fishery was important, and may become so again. If the herring shoals make such great wanderings as they are said to do, from the ocean in the North down along the whole east coast of Great Britain, it is a matter of wonder that they do not proceed even further into the southern parts of the North Sea and into the German Bight. This they never do. We must conclude, then, that there are some unknown invisible limits to their wanderings in the sea.

VII. *Autumn or Sea Herring of the Baltic (Bank Herring of the Baltic).*—Through the intermediary of the autumn-herring of the Kattegat, this group is also allied to Group V.; size, 250mm. on average, but towards Rügen and Gotland Bank growing less to 220 and 210 mm. (in size it is much smaller than the spring-herring of the same regions); number of vertebræ small, 56·0 on average, and less to 55·5; number of vertebræ to the first hæmal arch high, 25·0 and more; number of keeled scales moderate, 14·0 to 14·5; dorsal and ventral fins placed far back; rays of ventral fins show tendency to change from 8 to 9.

The autumn-herring of the Belt, of the western Baltic, and of a stretch of the eastern Baltic from Rügen by Bornholm to Gottland, belong to this group. They spawn from the middle of September to the end of October, on the banks in the open sea, as off the coast of Fehmarn, but never in the bights or brackish waters.

VIII. *Spring-herring of the eastern Baltic or "Streamlings."*—These are of small size, mature for first time at a size much less than 200mm.; in the Bothnian Gulf they have been found mature at only 125mm.; number of vertebræ small, under 55·5 to 55·0 on an average; keeled scales behind ventral fins also small in number, the highest 14·0 going down to 13·5 and less; number of vertebræ to the first hæmal arch is, in contrast to small number of vertebræ, very high, on a average 25·0 and above; head and tail very long, back very short; dorsal and ventral fins posterior, variation of their positions great—the ventral is often under the middle of the dorsal, sometimes even behind this; anal fin very short; snout long and strongly developed, cranium small, tolerably high and narrow; length to breadth index very small, on an average under 30·0 to 28·0 and individually to 27·0—dolichocephalic.

The "Streamlings" inhabit the coast waters especially of the eastern Baltic in great multitudes, and spawn in spring more or less near to he land—seldom before April, often even in June and July.

IX.—*Herring of the English Channel.*—Although only a few specimens from Brighton and from Havre have been studied, they show a clearly marked local character; they stand nearest to Group VI., the autumn-herring of the southern North Sea, and show many of the distinguishing characters of these, developed in the extreme. Size medium, probably on an average not over 250mm.; number of vertebræ seems small, on average to 56·0; number of keeled scales behind ventral fins very large, 15·0 and more; form of head very characteristic, it is very short and high, especially the snout; cranium very high and brachycephalic: length to breadth index on an average 32·0 and individually to 34·0.

These herring form one limit or boundary of the species with regard to their dwelling places. They spawn apparently more in winter than in autumn—from November to February.

X.—*Herring of the White Sea.*—A very distinct race, especially from the European races, and might almost be called a distinct species; size moderate; number of vertebræ very small, only 53·6 on average and descends even to 52; this is a difference of at least 1·5 on average from their nearest allies, the "Streamlings" of the Baltic (VIII.); very small number of keeled scales, 26·5 on an average in front of ventral fins, 12·5 behind—together 39; so small a number does not appear in the other races; in contrast to the small number of vertebræ is the relatively high number of these to the first hæmal arch (25·0), and the high number of the tail vertebræ, 15·0; the forward position of the dorsal fin and the backward position of the anus are also remarkable; further, the great length of the anal and especially of the dorsal fins; snout is very long and high, with large jaws; cranium is large, posteriorly narrow, teeth on vomer very strong with only 2 to 9.

The spawning-time and habits of this group are unknown. They have a special interest because of their near alliance to the pilchard and the sprat, as already pointed out. They further show an alliance to the herring of Japan.

The relationship between the characters of the Herring-races and their surroundings.—So far this brief summary has dealt with the observations of Dr. Heincke and the conclusions or classification drawn therefrom, and with regard to these it should be remembered that nothing must be looked upon as definitely fixed for all time. Future research of Dr. Heincke or of others may cause some of the groups to be broken up, decreasing or increasing their number.

Heincke's work embodies the present state of knowledge on the question, and forms a basis for future research. Its importance is shown when we consider the complex relationships of marine life. The first principle is that the herring as individual, race, and as species, lives in harmony with its surroundings, and therefore undertakes no wanderings into other places with other conditions of life. This principle, seemingly so simple and self-evident, will be seen to be of importance in connection with the question of migration; for the present, what we know of these surroundings may be touched upon.

This subject has been dealt with by the Scotch naturalists Matthews, Ewart, and Brook,* but they did not follow up the relation of the physical and biological surroundings, on the one hand to the wanderings, on the other hand to the bodily structure.

The first relation has been displayed quite recently by the Swedish scientists. † The herring which occur in winter off the Bohuslän coast, in the Kattegat, appear and swim in the "bank-waters" which are formed by the mingling of the Baltic stream and the Atlantic Ocean. These "bank-waters" have certain distinct qualities, of temperature, salinity, and with regard to the organisms living in them. The correlation thus established is of great importance, and may possibly be regarded as the beginning of greater discoveries. In 1896, the herring fishing off Bohuslän was a failure, and it was found that this was associated with the presence of an abnormal amount of Baltic water.

So in other places, as with the fluctuations in the quantities of herring off the Scottish east coast, the changes in the spawning places in the Firth of Clyde and Loch Fyne, the reasons will be similar though much more complex. The return of the shoals periodically, year after year, to the same place will depend for the most part upon whether the conditions at those places remain the same.

On the other hand, Dr. Heincke by his work has been enabled to point out certain relations between bodily structure and the surroundings. How far these are real, of course, only future research can show. Thus, as the *salinity* of the Baltic diminishes from west to east, the "constitutional size of the ripe" herring becomes smaller—so does the number of the vertebræ and the breadth of the skull; the body becomes shorter; the lengths of head and tail become greater, and so does the difference in position between the dorsal and anal fins.

Again, those herring which grow in very warm, shallow, and brackish water, as those of Schley and Zuyder See, have an extremely small number of vertebræ to the first hæmal arch. And again, the herring with the most considerable constitutional size, and likewise the largest number of vertebræ, live on the coasts of the northern North Sea, of Norway and Iceland. These are perhaps most directly under the influence of the salt oceanic waters. Such observations naturally offer a great field of speculation to the physiologist, and—shall we say—also to the "natural selectionist," but for the present we may content ourselves with regarding them as isolated facts until cumulative evidence points to some probable solution.

The consideration of the relations between the herring and its physical and biological surroundings naturally leads to the question of *migration*, and here we find Dr. Heincke still more reserved in his conclusions. It has been the custom to think vaguely and talk vaguely of the periodic incomings and outgoings of the herring shoals between the Atlantic Ocean and the North Sea.

Now, we have no proof of this extensive migration—indeed no signs of it that cannot be explained otherwise, and it may be seen that the whole weight of Heincke's observations is in the scale against it. The division into races simply means division of dwelling-places, and just as there is room enough in the North Sea and Baltic Sea for the gadoids, the pleuronectids, and innumerable other species, there is room enough for a few races of herring. Just as Sir John Murray considered that the

Reports of Scottish Fishery Board, I. to V., also by F. G. Pearcey in 1885, but unfortunately, the work of the latter has not yet been read by me.

† See Summaries by J. T. Cunningham, *Journal Marine Biological Association*, Vol. IV., 1895-97, p. 233 *et seq.*; and by W. Garstang, do., Vol. V., 1897, p. 56 *et seq.*

herring of the Firth of Clyde remained there permanently, coming out of the deep holes to spawn on the flatter, shallower grounds, so Dr. Heincke considers that the herring never go very far away from their spawning places.

A number of reasons to support this view will suggest themselves to those who understand the significance of the race-divisions, and we may be content with the position of Dr. Heincke. These are the facts, let those who uphold the extensive migration theory contradict or explain them away.

There is, however, the appearance of the summer- and autumn -herring on the east coasts of Scotland and England which has always seemed to lend countenance to the migration theory. As is known, the summer herring fishing begins in the North near the Shetland Islands in May or June, then it gradually spreads along the coast in usually a southerly direction, so that off Peterhead the fishing is towards the end of June, further south in August, and so on until the Dogger Bank is reached and there is a break. This is the case with the herring fishing, but it is not necessary to believe that the herring shoal or shoals are taking this course. Indeed, for a fish whose spawning habits are so well defined both in time and place, the fact that the spawning on the east coast is spread over five months—May to September—of the year, would suggest another conclusion—viz., that the shoals, though of the same race or group (V.), may consist of several different local forms with different instincts leading them to spawn at slightly different times, in slightly different regions, and consequently under different conditions of environment. If we suppose that these shoals, impelled by their spawning instinct at the appropriate seasons, emerge from the more northern and middle portions of the North Sea as well as from the neighbouring portions of the Atlantic Ocean (to the west of the Shetlands), the explanation would agree with what we know of the facts. It is like a succession of waves striking obliquely on the shore and thus giving the appearance of the progression of the foam and spray along the beach.

This is the alternative to the extensive migration hypothesis, with the distinct advantage of lending itself more readily to proof or disproof. If the herring shoals fail to appear when and where they are accustomed to appear, we should expect to find them at the same time in similar regions not so very far away.

This leads on to the consideration of the practical importance of these studies and conclusions of Heincke. Since we believe in the rational co-ordination of events which declares that the herring as individual, as race, and as species is in harmony with its surroundings, then, since these races have been shown to be distinct from one another, and we have signs also that the surroundings are distinct, we should be able to connect any changes in the movements of the herring with changes in the environment. This is not a mere truism, as an example will show. The autumn and winter herring-fishing off the Bohuslän coast in the Kattegat has been already referred to, and the question has been much discussed—Whence come these herring; from the Norwegian or Danish coast? Pettersen said originally that they came in with the Danish "bank-water." This was afterwards questioned,† and so a doubt arose. Heincke has, however, shown that his conclusions agree with the first—viz., that these winter- or sea- herring of Bohuslän are the autumn- herring of the Skagerrak and of the bordering portions of the North Sea. They do not come from the Norwegian spring- herring, because they form quite a different race (II.-V.).

Thus from the study of structure we may be able to test the conclusions reached with regard to the natural history of the herring by those starting from the other side—viz., from the study of the surroundings. Both lines of research are far from complete, but they have been well begun.

† *J.M.B.A.*, 1895–97, op. cit

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