TWENTY-SECOND ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND,

Being for the Year 1903.

IN THREE PARTS.

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

PART III.—SCIENTIFIC INVESTIGATIONS.

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

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

And to be purchased, either directly or through any Bookseller, from
OLIVER & BOYD, EDINBURGH; or
EYRE & SPOTTISWOODE, EAST HARDING STREET, FLEET STREET, E.C., and
32 ABINGDON STREET, WESTMINSTER, S.W.; or
E. PONSONBY, 116 GRAFTON STREET, DUBLIN.

1904.

[Cd. 2147.] *Price 5s. 2d.*

CONTENTS.

SCIENTIFIC REPORTS.

TWENTY-SECOND ANNUAL REPORT.

TO THE RIGHT HONOURABLE

ANDREW GRAHAM MURRAY, K.C., M.P., &c.,

His Majesty's Secretary for Scotland.

Office of The Fishery Board
for Scotland,
Edinburgh, 1st *July*, 1904.

My Lord,

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

PART III.—SCIENTIFIC INVESTIGATIONS.

GENERAL STATEMENT.

This, the third part of the Twenty-second Annual Report, contains an account of the scientific investigations conducted by the Board in 1903 in connection with the sea fisheries of Scotland, so far as these have been completed, by means of the Parliamentary Vote granted for the purpose. The scientific researches have been carried on for the most part at the Board's Marine Laboratory at the Bay of Nigg, Aberdeen, which was erected a few years ago, and where tanks have now been fitted up for various experiments and observations. The sea-fish hatchery is also situated at the same place, and a statement as to its operations during the year will be found below.

The investigations into the condition of the fishing grounds, more particularly in the Moray Firth and Aberdeen Bay, which were commenced four years ago, were continued last year by means of steam-trawlers. One of the chief objects of these investigations is to ascertain the changes in the abundance of the food and other fishes in the closed waters in different years; but observations are also made on the reproduction of the fish, their spawning, food, and on various other points connected with their life-history; and collections of the plankton or floating organisms are secured, and experiments made with small-meshed and large-meshed nets.

With the large trawl, the efficient ship, and the experienced trawlers in charge, it is possible to make a much more thorough examination of the bays than was formerly the case, and from the fact that the actual trawling operations are carried on exactly as they are in commercial fishing, opportunities are thus afforded for certain observations of importance, as the proportion of the marketable and unmarketable fishes which are caught, and the destruction of immature fish on different grounds and at different seasons.

Trawling Investigations.

In the course of the year the results of 148 hauls of the large otter-trawl were recorded, of which 101 were made in the Moray Firth and 29 in Aberdeen Bay, making 130 in the closed waters; and in addition 18 drags were recorded in the waters offshore, the aggregate thus being 148. In the Moray Firth the more important areas were examined in February, March, April, June, October, November, and December, and the grounds in Aberdeen Bay were visited in the same months. The localities in the Moray Firth which were most thoroughly examined were Burghead Bay and the Dornoch Firth, as well as Smith Bank, the grounds off Lossiemouth, off the Suters of Cromarty, and the coast of Caithness.

The total quantity of fish recorded in the course of the investigations was large, viz., 180,515, of which 126,485 were of a kind and size to be marketable, and 54,030 were found to be unmarketable, either because they were of inedible varieties, or too small to be profitably sold. Those which belong to the former category are comparatively not numerous, comprising mostly long rough dabs and various odd kinds, but they may include large numbers of the angler or monk fish and gurnards, though these are very often brought to market. The great majority of the unmarketable fishes belong to edible and saleable forms, and are simply rejected because of their small size, such as small haddocks, whitings, plaice, &c. In the hauls in the inshore waters the proportion of the unmarketable fishes varied from 7·4 per cent. for cod to 78·2 per cent. for gurnards among the round fishes, and from 0·5 per cent. for brill to 89 per cent. for common dabs among the flat fishes. The percentage of unmarketable plaice was relatively large, namely, 30·3, due to the fact that the fishing was to a large extent carried on in shallow water. The proportion of the marketable and unmarketable was found to vary very greatly according to the depth of the water and the season.

In the paper by Dr. Wemyss Fulton, the Scientific Superintendent, on this subject, will be found described also the results of an investigation on the proportion of the marketable fishes which are immature—that is, which have not yet reached a size at which reproduction takes place. The limit between the mature fishes and the immature in respect to size is first dealt with, and it is shown that in most cases it is not the average size of the generation which first becomes mature that is the true dividing line, but something under it, the precise point varying in different species according to whether the reproductive stage is reached early or late in the growth of the species.

The proportion of the immature, whether regarded in terms of weight or of size, of different species brought to market varies very greatly according to the species. Among some flat-fishes, such as the common dab, practically all that are marketable are mature, this fish becoming reproductive at a small size. Among plaice, on the other hand, which does not attain maturity until it is several years of age and of some size, the proportion of the immature amounts to about twenty-four pér cent. of the marketable fishes, but with this species in particular the proportion varies much according to the chief areas of fishing. Among the witch sole the proportion amounts to about fifteen per cent., and it is still less among lemon soles, viz., about seven per cent. From the large size at which the cod first reaches maturity, the proportion of the immature that are marketable is considerable; these comprise codlings, and of the total quantity landed about thirty per cent. are sexually immature. With haddocks, and still more with whitings, the proportion is much less, these species first attaining maturity at about the size at which they become marketable. The calculation in regard to haddocks shows that the proportion of the marketable which are immature is small, amounting to only about one per cent. of the quantity landed, while among whitings it is less, practically all the whitings caught by trawlers which are of marketable size being adult.

It must be borne in mind, with reference to this subject, that the limit between the mature and the immature is a biological one, having reference, not to the size of the fish from the market point of view, but in relation to the size when reproduction begins.

Investigations on the Rate of Growth of Fishes.

In the present Report will be found a paper by Dr. T. Wemyss Fulton describing the results of his further investigations on this subject, in continuation of the researches detailed in some of the preceding Reports. In addition to the measurement of large numbers of fishes obtained during the trawling investigations by the use of a small-meshed net, numerous observations were made to determine the relation between the size and weight of fishes belonging to nineteen species, and a series of experiments were carried on to show the influence of temperature upon growth.

With regard to the ratio between the length and weight of fishes, it might be assumed, without experimental evidence, that their growth was in consonance with the physical law governing the relation of similarly-shaped bodies of uniform specific gravity with regard to weight and dimensions—that the weight increased as the cube of the length, so that a fish which doubled its length should increase its weight eight times. The observations, which have been made on between 5000 and 6000 fishes, show that this law does not apply with exactitude in any of the species examined, the weight increasing in proportion more rapidly than the length, the conclusion being that, if the specific gravity remains the same, growth takes place to a greater extent in some other dimension than in length, whether in breadth or thickness. The various species examined displayed great differences in the relation between the weight and length at a given size, the heaviest in proportion to its length being the turbot, and the lightest the witch, the extremes being found among the flat-fishes.

With regard to the influence of temperature upon growth, it is well known from previous observations that fishes, at least in the waters near the shore, grow less quickly in winter than in summer, and may not grow at all if the temperature be very low. In the experiments referred to a number of the food-fishes were kept in tanks in which the water was of different temperature—in one it was considerably above the normal—and the effect on the growth was determined by measuring the fishes after they had been subjected for some time to the various temperatures and comparing the measurement with what it was at first. With a mean temperature of 40·1 F. it was found that the mean increase in the length of whitings was 1·6 millimetres per ten days, and 2·5 millimetres when the temperature was 48·7 F.; under the same conditions haddocks grew at the rate of 2·7 and 5·1 millimetres respectively, and codlings increased under the lower temperature at the rate of 3·6 millimetres, and under the higher temperature at the rate of 6·87 millimetres in each ten days. In another tank where the mean temperature was 54·5 F., the rate of growth in length in each ten days was, on the average, 2·8 millimetres for whitings, 6·45 for codlings, 3·0 for common dabs, and 3·29 for plaice. The growth in length varied generally in relation to the size of the fish as well as to the species, the smaller individuals as a rule growing the quickest, and considerable difference was exhibited in many cases among individuals of the same species approximately equal in size.

The influence of temperature is exerted directly in connection with the metabolism of the fish, that is, the chemical changes in its tissues, which result in growth as well as in the expenditure of energy. In low temperatures the process of digestion was greatly impaired, and appetite was more or less in abeyance, the fishes refusing their food or eating sparingly. It has been shown that the action of the digestive ferments is suspended at low temperatures and increased at high temperatures. The bearing of these observations on the growth of fishes in winter, whether in the sea or in fresh water, is obvious.

In the same paper the results of the investigations made as to the growth of the Sprat, the Witch Sole, the Norway Pout, and the Sharp-tailed Lumpenus are described, and illustrated by a series of diagrams.

The Hatching and Rearing of Food-Fishes.

During the hatching-season of 1903 the number of eggs of the plaice collected from the spawning pond at the Hatchery, Bay of Nigg, was approximately 65,940,000. This was almost the same number as in 1901, and about seven millions less than in the previous year. The number of fry that were hatched from these eggs and retained in the hatching apparatus until approaching the post-larval stage was estimated at about 53,600,000, or a little over 81 per cent. The fry were liberated for the most part off Aberdeen, but on three occasions they were taken further north and liberated off Fraserburgh.

The first eggs were collected on 23rd January and the last on 16th May, the period of collection thus extending over 113 days, but the greater number were obtained in March, when 37,080,000 were collected, the number in April being nearly sixteen millions, and in February nearly twelve millions. It may be stated that the collection of eggs extends over a longer period at the Bay of Nigg than was the case at Dunbar, where the work did not usually ommence until March, the average duration at the former being 65 days and at the latter 86 days. The difference is due, not to variation in the spawning season, but to the circumstance that the fishes at Dunbar, being for the most part collected a little before the spawning, did not become accustomed to confinement sufficiently to part with their eggs until the spawning season was some way advanced, while at the Bay of Nigg they are kept in the large pond throughout the year, and spawn under natural conditions approximately during the same time that plaice are found spawning in the sea. An abundant supply of pure sea-water, of suitable temperature and specific gravity, has materially aided in the success of the work; and as mentioned in last year's Report, the cost of the fish hatching, when the hatchery is operated in conjunction with the Marine Laboratory, is materially reduced, and does not exceed £100 per annum.

The period for which the embryonic and larval fishes are protected in the hatching apparatus amounts to about half the duration of their pelagic life, but the benefit would be considerably increased if it were possible to rear them in any large numbers through their post-larval stages—that is, until they have completed their transformation and become adapted to live on the bottom. The rearing is not an easy matter, owing to the difficulty of providing suitable food for multitudes of larvæ confined in relatively small volumes of water, but the attempt to do so will be made by the use of a special tank.

Since the hatchery was established the number of fry of the food fishes which have been produced is as follows:—Plaice, 340,455,000; lemon soles, 5,727,000; turbot, 5,160,000; cod, 4,010,000; and other kinds, 2,000,000—the aggregate being 357,352,000.

During the season deputations of fishermen from Aberdeenshire, who visited the establishment by arrangement with the Technical Education Committee of the County Council, received demonstrations as to the operations and the life-histories of the food fishes.

The Life-History of the Crab.

In the present Report will be found a paper, illustrated by four plates, in which Dr. H. C. Williamson gives the results of further observations on the life-history of the edible crab and some other Decapod Crustacea. The observations deal mainly with the reproduction, and in this connection with the processes of casting, impregnation, and spawning. The spawning of the crab takes place in November, December, and January, and the casting of the shell and impregnation take place in summer; and it appears probable that in most cases spawning does not follow until about fourteen or fifteen months after the process of casting.

On extrusion the eggs are attached to the swimmerets of the mother, and remain there for about seven months. The mode by which the eggs are attached is of interest, the author having discovered that they are skewered on to the long delicate hairs with which the inner branches of the swimmerets are provided, and are not, as has generally been believed, fixed to them by a mucilaginous secretion. The eggs themselves are never found cemented together although crowded in close contact. The mode in which the eggs are skewered on to the stiff hairs is as follows. When the eggs are extruded they imbibe sea water and become swollen, so that the egg-mass is separated from the shell, and this space soon attains large dimensions. The eggs are retained in a semi-fluid mass in the "apron" of the crab, and by the continuous stabbing movement of the stiff hairs on the swimmerets the eggs are pierced and skewered as described. Dr. Williamson also treats of the rate of growth, the migrations, and the distribution of the crab, and in connection with the former subject had the use of the data furnished by Mr. Waddington, Bournemouth, of the various successive casts of certain edible crabs which had been kept in confinement for periods up to two years, and these are represented in a series of figures, and are of much interest.

Further descriptions are given of the results of labelling crabs which were afterwards liberated, in order to throw light on their migrations. In contrast to some of the previous results, it may be said that one of the labelled crabs, an adult male, was obtained three years after its liberation very near the spot where it was set free.

The Young of the Witch Sole.

During the trawling investigations in the Moray Firth a very complete series of the young of the Witch Sole was obtained, one of the flat-fishes now brought to market in considerable numbers by the trawlers working in deep water, and in the knowledge of whose life-history there were considerable gaps. Dr. Williamson describes these in a paper in the present Report. Some dubiety has existed as to the identity of the post-larval stages of this form, which differ from the corresponding stages of most flat-fishes by their great length and slenderness, as well as by other characters, so that the first one described was supposed to be a young halibut. The present series, by filling up the blanks between the previously-recorded stages, completes the chain connecting the egg with the parent fish. The paper is illustrated with a number of figures.

The Marine Crustacea.

In this Report will be found a paper, illustrated by three plates of figures, by Dr. Thomas Scott, descriptive of a number of rare crustacea, obtained for the most part during the trawling investigations. The forms described are all small, and include two groups of the Copepoda that are somewhat abnormal both in their structure and habits. Among the nine species belonging to the first of these groups—the Monstrillidæ—three are new to science and are now described for the first time, and of the seven species which belong to the second of the groups—the Choniostomatidæ—five are new to science and are here described for the first time, and these are all minute forms which are parasitic on small species of Crustacea.

The occurrence of other rare species belonging to the Amphipoda, the Isopoda, and the Sympoda, other groups of Crustacea, is also recorded.

Apart from the zoological interest of these discoveries, it is to be noted that the minute crustacea with which they deal play an important *rôle* in connection with the food of fishes, many forms living upon them almost exclusively at some stage or another of their existence.

The Parasites of Fishes.

In continuation of his researches on the forms which are parasitic on marine fishes, Dr. Thomas Scott also contributes a paper to the present Report on this subject, illustrated with a series of figures. The parasites described include four Copepods and two Trematode worms. One of the former is new to science, and the other three have not previously been recorded from the Scottish seas. Both the Trematodes are new to science, and were obtained, along with two of the Copepods, on a specimen of the sting ray (*Trygon pastinaca*)—a fish closely allied to the skates—which was caught in the Moray Firth during the trawling investigations.

In this paper there is also a description of a figure of a post-larval fish which has been attacked by two small crustaceans, furnishing an example of one of the dangers to which young fishes are exposed.

The Young of the Conger.

In the course of the trawling investigations in the Moray Firth, two specimens of the pelagic young of the Conger-eel were taken in the small-meshed net used around the cod-end of the otter trawl. These forms, which are characterised in their younger stages by their singularly flattened form, are known as Leptocephali, and were until comparatively lately believed to represent distinct species of fish. They are very rarely seen in British waters. The two specimens referred to are described and figured in a paper by Dr. T. Wemyss Fulton in the present Report, along with other rare fishes obtained during the investigations. Among the others may be mentioned a larval Fierasfer, an extremely rare form which, in the adult condition, lives within Holothurians; it was taken in a tow-net easterly from Aberdeen. A specimen of the pilchard was also secured in the Moray Firth—a fish which is said to have been at one time fairly common at some places in the southern part of the East Coast, but is now hardly ever seen in these waters. Other rare specimens comprised the sting-ray and the thickback sole, both secured in the Moray Firth. It is indeed remarkable that in several respects the fauna of the Moray Firth offers resemblances to that of the West Coast; it appears to indicate that a connection is established by means of the sea currents entering the Firth from the north.

Investigations on the Herring in the Firth of Clyde.

In connection with the winter herring fishing at Ballantrae Bank, off the coast of Ayr, arrangements were made for an investigation of the conditions of the fishing in relation to the operation of the Bye-law No. 18, by which the use of the seine for the capture of herrings within a defined area off the coast is prohibited. Owing, however, to the stormy weather that prevailed on these exposed grounds the fishing was almost a complete failure, only thirty-five crans of herrings being obtained within the area specified, although 232 crans were caught in the more sheltered waters of Lochryan, where fishing operations could be carried on. Under the circumstances it was not found possible to make the investigations desired; but it may be noted that the weather conditions made an effective close-time in protecting the herrings frequenting the grounds, and if, as there is every reason to believe was the case, the herrings spawned there in February and March, the result ought to tend to increase the number of herrings in some future season.

Investigations have also been undertaken with regard to the herrings in the Firth of Clyde generally, more particularly in connection with their migratory movements and spawning, about which comparatively little is known, and which will require some considerable time to complete. In reference to this enquiry a research is being made by Professor Milroy, Queen's College, Belfast, on behalf of the Board, as to the chemical composition of the herring in relation more especially to the reproduction of the fish.

We have the honour to be,

Right Hon. Sir,

Your most obedient Servants,

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

WM. C. ROBERTSON, *Secretary.*

SCIENTIFIC REPORTS.

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

Introductory.

The investigations into the condition of the fishing grounds, particularly in the closed waters of the Moray Firth and Aberdeen Bay, which were commenced four years ago by means of steam-trawlers, were continued last year, and a voyage was also made to the offshore waters lying off the mouth of the Firth of Forth. In the Moray Firth the more important areas were examined in February, March, April, June, October, November, and December, and the grounds in Aberdeen Bay were visited in the same months. On each occasion the places where fish were found to be most abundant were chiefly worked over; the total number of hauls made in the Moray Firth, the results of which were recorded, was 101, and the number in Aberdeen Bay was 29, making a total in the closed waters of these areas of 130 drags, in addition to 18 in the offshore waters, or 148 altogether. The localities in the Moray Firth which were most thoroughly examined were Burghead Bay and the Dornoch Firth, as well as Smith Bank, the grounds off Lossiemouth, off the Suters of Cromarty, and the coast of Caithness.

The total quantity of fish taken in the course of the investigation was large, amounting to 180,515 in the completely recorded hauls, and of these 126,485 were of a kind or size to be marketable, and 54,030 were unmarketable and were thrown overboard.

One of the chief objects of these investigations is to ascertain the changes in the abundance of the food and other fish in the closed waters in different years and seasons, but observations are also made on the condition of the reproductive organs of the fish, their spawning, food, and on various other points connected with their life-history; while at the same time the temperature of the surface and bottom water at the various places is observed and recorded; and from the fact that the actual trawling work is carried on precisely as it is for commercial purposes, opportunities are thus afforded for certain observations, as, for example, the proportion of the various kinds of fish captured in the net which are marketable and the proportion unmarketable, the influence of the size of the mesh of the net on the size of the fish caught, &c., which would be otherwise difficult to obtain. Collections of the floating organisms or plankton were also secured, and a number of experiments made with small-meshed nets with the object of procuring collections in connection with the study of the rate of growth of fishes and their distribution.

With the large commercial trawl, the efficient ship, and the experienced trawlers in charge it is possible to make a much more extensive and thorough examination of the grounds than could formerly be done.

The results of the investigation are given in detail in the following pages and in the Tables which are appended.

The Proportion of Marketable to Unmarketable Fishes.

As already mentioned, the proportion of the unmarketable to the marketable was 54,030 to 126,485, which is therefore a very considerable proportion. The unmarketable fishes vary in amount in several ways. There are some which are never taken to market under any circumstances, being inedible or at least unsaleable. The most common of these is the long rough dab, which, however, is not found in any quantity in the shallow inshore waters. Dog-fishes are also unmarketable in the same way, and they are sometimes taken in large numbers by the trawl in the deep water in the northern part of the North Sea, but much less commonly in the Moray Firth or Aberdeen Bay. There are a few other species occasionally brought up in the trawl which are for the same reason never taken to market. But the great majority of the unmarketable fishes belong to forms which are quite edible and marketable and are rejected merely because of their small size, such as small haddocks, whiting, plaice, &c. In some instances the question whether a particular species is taken to market or thrown overboard depends upon circumstances, irrespective of the size of the fish, as, for instance, with gurnards and anglers. These two forms are now, however, generally brought to market, in the latter case only the tail part being made use of. The proportion of the unmarketable fishes of the class referred to depends also to a very large extent on the grounds fished over and the season of the year. Examples of this fact are described in the following pages, as, for instance, in connection with the plaice and haddock (p. 30, 32, 36, 42).

In the accompanying Table I have tabulated the numbers of marketable and unmarketable fishes taken in 103 hauls of the net in the Moray Firth and Aberdeen Bay, and have represented the proportions of each for the various species in percentages of the total.

Fish.	Marketable.		Unmarketable.		Total.
	Number.	Per Cent.	Number.	Per Cent.	
Cod, ...	4,283	92·5	343	7·4	4,626
Haddock, ...	46,287	86·0	7,525	14·0	53,812
Whiting, ...	4,694	57·3	3,495	42·4	8,189
Coalfish, ...	45	91·8	4	8·2	49
Ling, ...	6	—	—	—	6
Hake, ...	4	—	1	—	5
Gurnard, ...	465	21·7	1,675	78·2	2,140
Catfish, ...	76	100·0	—	—	76
	55,860	81·0	13,043	19·0	68,903
Plaice, ...	27,669	69·6	12,057	30·3	39,726
Common Dab, ...	1,779	10·9	14,543	89·0	16,322
Flounder, ...	904	91·6	83	8·2	987
Witch, ...	5,089	84·8	911	15·1	6,000
Lemon Dab, ...	518	95·7	23	4·2	541
Halibut, ...	6	100·0	—	—	6
Turbot, ...	23	100·0	—	—	23
Brill, ...	220	99·5	1	0·5	221
Long Rough Dab	—	—	2,533	100·0	2,533
Sole, ...	3	—	—	—	3
	36,211	54·5	30,151	45·5	66,362
Skates and Rays,...	407	55·2	331	44·8	738
Anglers, ...	173	28·6	432	71·2	605
Other Fish, ...	—	—	186	—	186
	92,651	68·0	44,143	32·0	136,794

From this Table it will be seen that the percentages for the gross catch of fish are 68 for the marketable and 32 for the unmarketable, and these figures may be taken as fairly well representing the proportions in the inshore waters referred to, although the ratio varies on different grounds and at different times.

The percentage of cod which were unfit for the market by reason of their small size was small, and less than with any other round fish save the catfish; it amounted to only 7·4 per cent., the marketable, including cod and codling, being 92·5 per cent. The proportion of unmarketable haddocks was much higher, viz., 14, as against 86 per cent. marketable; but the proportion was found to vary very greatly in different cases. In the hauls made in Burghead Bay in December, for example, about five-sixths of the haddocks taken were too small to be marketable, while on other occasions the proportion of these small haddocks was very slight.

The proportion of unmarketable whitings taken was still greater, amounting to 42·4 per cent. of the total, the marketable being 57·3 per cent. The unmarketable coalfish—of which, however, comparatively few were caught—amounted to 8·2 per cent., while all the catfishes obtained were of marketable size. Gurnards, which, as stated, are not always taken to market, show a high percentage of the "unmarketable," partly for this reason, 78·2.

The proportion of round fishes of edible and saleable kinds which were unmarketable was collectively 19 per cent., the marketable being 81 per cent.

With flat-fishes, apart from the long rough dab, which is never taken to market, the highest percentage unmarketable were among the common dabs, viz. 89, the marketable being only 10·9 per cent. This is owing to the generally small size of this fish, and sometimes trawlers are not very particular about it, when they are getting good catches of more valuable kinds. The proportion of unmarketable plaice was also high, 30·3 per cent., and in this case, even more than with the haddocks, the proportion varied greatly according to the depth of water and the season. In some places, as at Burghead Bay, where the fishing was as a rule conducted in water over seven fathoms in depth, comparatively few small unmarketable plaice were caught, while in the Dornoch Firth, in from five to eleven fathoms, in June, the majority of the plaice got were too small to be marketable. In two hauls here, of a total of 9649 plaice caught, no less than 6419, or 70·1 per cent., were unmarketable.

The proportion of unmarketable flounders taken was comparatively small, 8·2 per cent., no less than 91·6 per cent. being large enough to be taken to market. The reason of this high proportion is that these flounders were almost without exception spawning fish which had migrated out from the shallow waters near the beach for the purpose of spawning, the smaller and sexually immature forms remaining inshore beyond the reach of the trawl. The same reason no doubt explains the fact that all the turbot and almost all the brill taken were also large enough to be marketable. The number of turbot was not great, 23, but of the 221 brill all but one were marketable, or a proportion of 99·5 per cent. The shape of both these fishes makes them eminently liable to capture in the trawl-net, if they are on the ground, and there is little doubt that the smaller forms, under about nine or ten inches, are close inshore on the sands.

Among the skates and rays 44·8 per cent. were unmarketable, and 55·2 per cent. marketable, and the other unmarketable fishes were made up of anglers, herrings, sprats, dragonets, and a few others.

The number of hauls on the offshore grounds was comparatively small last year, and the same contrast is therefore based on fewer results. Of a total of 27,156 fishes in the completely recorded hauls, 22,051 were marketable and 5105 unmarketable, the percentage of the former being 81·2, and of the latter 18·7—the proportion of the unmarketable being thus considerably under what it was on the inshore grounds. In these series of hauls also all the gurnards were classed as unmarketable, while, on the other hand, owing to the depth of water, all the plaice were marketable.

The proportion of cod, including codling, which was marketable was 77·2 per cent., 22·8 per cent. being unmarketable ; in the case of haddocks, the percentage marketable was 86·7 and unmarketable 13·3 ; while with whitings the respective proportions were 54·4 and 45·6 per cent.

The Proportion of Immature Fish Landed.

The information given above and detailed in the Tables as to the proportion of fish of the different kinds which are caught in the operations of commercial trawl-fishing and thrown away as unmarketable, enables an opinion to be formed as to the degree of destruction which may take place on the inshore grounds.

It is also of some importance to be able to ascertain the proportion of the fish caught and landed which are immature, that is to say, which have never developed milt or roe and reproduced their species. In most cases it may be said that the greater proportion of the unmarketable individuals of the class which is unmarketable owing to the small size, are immature, although in some instances mature fishes may also be too small to be marketable. This is the case with the common dabs, none of the immature individuals being large enough to be marketable, and those landed are therefore adult fishes which have either reproduced or are large enough to reproduce. The same is true of the flounder, which, however, is not taken often in the trawl in ordinary commercial fishing. It is also true to some extent of the haddock, and still more of the whiting, comparatively few of these under the size at which maturity may be reached being brought to market, and with the whiting, at all events, there is no doubt that a fairly large proportion of the smaller-sized but mature individuals are rejected because of their small size.

With plaice, on the other hand, as with turbot, brill, and halibut, all those which have arrived at the size of maturity, and a large number which are under that limit are eminently marketable. It is the same with the cod and the large round fishes, and it is thus of some importance to be able to show approximately the proportion of the mature and immature fishes of the different species which are under ordinary circumstances brought to market.

In order to do this it is necessary to obtain two classes of facts—the limit of size which separates the mature from the immature in the different kinds of fish, and the numbers of fish at the various sizes which are caught. Information on the former head, as I have elsewhere pointed out, is not as exhaustive as one would like, but, still, numerous observations have been made in Scotland and other countries which enable one to differentiate, sometimes with precision and at other times broadly, the mature from the immature. It happens, however, at all events in the case of some fishes, that the size which separates the mature from the immature is not the same in all places. Thus, with plaice the limit between the mature and immature is higher in the northern parts of the North Sea than the southern parts and the Channel. This difference does not, however, affect the present investigation to any extent, because comparatively a very small proportion of the fish landed at Aberdeen is caught in the southern parts referred to, as is explained in my paper dealing with the statistics in connection with the place of capture in the Board's Twentieth Annual Report.*

For the purpose referred to, certain sizes have been selected as separating the mature from the immature individuals of the various species of fish dealt with; in several instances they exceed the sizes assigned in my earlier papers on the subject,† where the limit had reference rather to the smallest mature individuals which were found than to the average size of the group or generation on first attaining maturity. The latter, no doubt, is the preferable course in many cases, but not in all, as is sometimes supposed.

The subject, indeed—the fixing of the line to separate the mature from the immature, so as to include as few of the latter with the former as possible and *vice versa*—is not by any means as simple as it looks. It is really in some degree a complex problem, and the degree of complexity varies in different cases. If the reproductive generation—that is, the group which first attains maturity—were distinctly separated from the next younger generation or group, then the proper limit would be naturally the point between; on one side all the fishes would be immature and on the other side all would be mature, and in such an example the proper limit would be, not the average size at first maturity, but the size of the smallest mature fish that could be caught. On the other hand, if the first reproductive generation were so fused with the next younger generation—if the over-lapping between the two was such—that it contained, within the range of its sizes, as many immature as the other contained mature, then the proper limit would be the average size at first-maturity. I am not aware of any case in which either of these two conditions occur. In some forms in which reproduction takes place at an early age, as with the whiting and the sprat, the over-lapping of the reproductive generation with the preceding generation is comparatively slight, and in such instances the preferable limit in my opinion is not the average size of the group which is mature—which would exclude a large proportion of the mature fishes and include a very small proportion of the immature in compensation—but a limit placed near the minimum size at first-maturity.

The approximation to the other extreme is to be found in the larger forms, such as the plaice, cod, &c., where reproduction does not take place at an age so early, and where, consequently, from the variations in the rate or growth of the individuals of the different groups or generations, the first reproducing generation becomes to a certain extent fused with the generation immediately preceding. But I do not know of any case in which the fusion is so complete that half of the fishes comprised within it are mature and the other half immature. With the plaice, for example, a study of the curves appended to my paper dealing with the growth of this fish in the Twentieth Annual Report‡ will show that although a considerable number of the fishes belonging to the younger group next to the reproductive group have fused with the latter, the greater number by far are distinct, and in such instances it appears to me that the proper line of division is not the average size of the reproductive group, but the point between the two groups, *i.e.* where the numbers of immature forms contained within the latter is balanced by the number of mature forms contained within the former.

The precise differentiation of the mature from the immature is further complicated by the circumstance that the males and females do not in all

* *Part III.*, p. 80, Pl. I.
† *Eighth Annual Report, Part III.*, p. 160; *Tenth, ibid.* p. 240.
‡ *Part III.*, Pl. XIV.

species grow at the same rate, or attain the same size, the females, as a rule, growing quicker and becoming bigger; and the numbers of the sexes in proportion to one another may vary. Thus, among the flat-fishes the females grow more rapidly, as a whole, than the males, and reach a larger size; while among the gadoids the rate of growth and the relative dimensions of the older forms appear to be, as far as ascertained, nearly or quite uniform. This does not, however, very materially affect the question of the limit at first maturity, since the males and females grow with fairly equal uniformity until the reproductive stage is reached, but in certain cases the male becomes mature at an earlier age than the female and at a smaller size, and it is this which introduces complexity and difficulty. It thus happens that among flat-fishes many more females than males are landed, although the number of males at the stage of reproduction may be equal to or greater than the number of females on the fishing grounds.

I have therefore prepared a statement of the limit between the mature and the immature fishes of the various species, based upon the available information, with consideration of the facts concerning the growth of the fishes, which may be used in endeavouring approximately to determine the proportion of the immature and the mature which are marketable, as follows:—

Whiting, -	8½	Turbot, -	17
Haddock, -	11	Brill, - -	15
Cod, - -	26	Common Dab,	6
Plaice, - -	15	Witch, -	12
Lemon Dab, -	10		

With regard to the other point of the investigation, the proportions of the fish at different sizes and weights which are landed, I have for a considerable time past devoted attention to this subject, and have measured and weighed a large number of fishes, amounting in the aggregate to over twenty tons, as they are landed and sold. With some kinds the average size and the limits of size are very regular, and these as a rule belong to the more important species. The information thus obtained as to the size and weight of the various classes of fish enables a close approximation to be made as to the proportion of the mature and immature, and thus a comparison instituted between these results and the observations made on board the trawlers on the same subject. Tables containing the particulars of the size and weight of the fish referred to will be found appended to this paper (p. 89), and other information relative to the size and weight is given in a paper on the rate of growth of fishes (*see* p. 142).

I have therefore made a series of calculations to show the proportion of the mature and the immature fishes of certain kinds caught by trawlers, the data being contained in the Tables and in preceding reports of the Fishery Board, particularly the paper above referred to, and the limit of size between the two classes being the biological one as defined.

There are marked differences in the proportions among different fishes. As already stated in the case of the dab, all those which are marketable are of mature size; no immature individuals of this species are, therefore, landed. Among plaice, all those classed as large, or firsts, are of adult size, while all those belonging to the third, or small, class are under the biological size and are immature. Among mediums a certain proportion are immature, rather under one half in number being under the limit of maturity. When calculated out it is found that approximately 24 per cent., or about one quarter of the total marketable plaice, by weight, are under the limit or immature. The proportion with the plaice varies greatly according to the depth of water, and the figure given offers a contrast to what obtains in the southern and eastern parts of the North Sea.

Among lemon dabs all those classed as large, or firsts, are over the biological limit of maturity, but a fair proportion of the second class, or smalls, are immature, the percentage being about seven for the total weight of the marketable fishes.

Among witches, all those classed as firsts, or large, are over the limit of maturity, and have either spawned or are large enough to do so. Among the class of seconds, which range in size from a little over 8 inches to about 14 inches, with an average length of, approximately, 11½ inches, a considerable proportion are below the size of maturity, but the percentage of the immature, by weight, of the total number of marketable witches is only about 15.

From the large size at which the cod first attains maturity, the proportion of the immature that are marketable is very considerable. Among boxed codlings one often finds a few which are over the biological size at maturity, and measuring as much as 28 inches, the selection as cod or codling on the part of the men on board the trawlers often depending on the meagre or fat condition of the fish, as well as on its length. Of all the cod and codling landed about 30 per cent., by weight, are below the biological size of maturity.

With haddocks and whitings it is very different, since the marketable size approximates to the size at which the fishes first become mature. The calculations in regard to haddocks show that the proportion of the marketable which are immature is very small, amounting to only about 1 per cent. of the total quantity landed. This is much under what one might expect from the statements made as to the large quantities of undersized haddocks sometimes landed, but it is the result of careful observations on a large number of fishes, both in regard to size and weight. All the medium and large haddocks, or firsts and seconds, landed are above the mature size, and the great majority also of the small haddocks, or thirds.

With the whiting the proportion of the immature among marketable fishes is still less, and the quantity of small, or second class, whitings brought to market by trawlers is inconsiderable, while the proportion among those which are under the biological size of maturity is also fractional. It may be said that practically all the whitings marketed by trawlers are of adult size.

It must be borne in mind in connection with this subject that the limit taken is a biological one, having reference, not to the size of the fish from the market point of view, but with reference to reproduction.

With regard to the numbers, as apart from the weight, the calculations show that, taking the mean of several years, the following represents approximately the total numbers of the fish of the kinds named which are brought to Aberdeen market:—Cod, including codling, 4,575,000; haddocks, 110,000,000; whitings, 15,000,000; plaice, 2,400,000; lemon dabs, 1,600,000; witches, 3,900,000; and dabs, 260,000.

Investigations in the Moray Firth and Aberdeen Bay.

I.

The first of the series of investigations was made in the Moray Firth in February, the steam trawler employed being the "Ben Edra," the trip extending from the 7th to the 13th; nineteen hauls of the net were recorded. The places visited were Burghead Bay, where most of the hauls were taken, off Cromarty, the Dornoch Firth, and, on the 13th, Aberdeen Bay. The quantity of fish caught was not very great, haddocks particularly being comparatively scarce.

The first haul was made off Burghead Bay, about four miles N.N.W. of Burghead light, in from seventeen to twenty fathoms, and it lasted for four hours and fifteen minutes. The aggregate number of fishes caught was only 228, of which 173 were marketable and fifty-five unmarketable. They included only five haddocks, all marketable, eight cod, fifty plaice, and ninety-four witches, all marketable but eight. The next drag was a little more productive, 692 fishes being caught in the four hours it lasted. Of these 463 were marketable and 229 unmarketable. They included forty-two haddocks, all marketable, fourteen cod, a halibut, three brill, one turbot, 128 plaice, and 191 witches, as well as fourteen lemon dabs, two cat-fish, and nine skates. Other six hauls were made in the same locality, but in rather deeper water, and they were somewhat more productive. The first of these was in from eighteen to twenty-five fathoms, Burghead light bearing from four to five miles S.S.E., and it lasted for four hours and five minutes. The number of fishes obtained was 725, of which 476 were marketable and 249 unmarketable. The former included eighty-eight haddocks, twenty-three cod, fifty-five codling, twenty-one plaice, thirty-eight lemon dabs, and 197 witches, as well as a few cat-fish and skates. The next haul, a little further off in somewhat deeper water—from twenty to thirty fathoms—lasted for four hours and twenty minutes, the aggregate catch being larger, namely, 1029 fishes, of which, however, a larger proportion were unmarketable. The marketable fishes numbered 586, the increase being chiefly in cod, plaice, and witches. The unmarketable consisted of whitings, common and long rough dabs, and herrings, of which seventy-four were taken, showing that a considerable shoal was present on the ground.

The other hauls in this locality were rather less productive, and they were all characterised by the presence of cod, plaice, and especially witches, and the comparative scarcity of haddocks, particularly small haddocks.

In the following Table are given the numbers of the various species of fishes taken in this locality, the marketable being distinguished from the unmarketable. One of the hauls in the deeper water in which the net got fouled is omitted.

	Plaice.	Common Dab.	Witch.	Flounder.	Lemon Dab.	Halibut.	Turbot.	Brill.
I.	495	125	1,699	.	73	1	1	5
II.	.	861	189	.	.	.	.	.
Total	495	986	1,888	.	73	1	1	5

	Long Rough Dab.	Cod.	Codling.	Haddock.	Whiting.	Coal-fish.	Ling.
I.	.	154	117	393	49	20	3
II.	653	.	11	11	150	1	.
Total	653	154	128	404	199	21	3

[*Continued.*

	Cat-fish.	Gurnard.	Grey Skate.	Thorn-back.	Starry Ray.	Angler.
I.	4	.	.	14	11	105
II.	.	1	6	2	9	202
Total	4	1	6	16	20	307

There were also taken in these hauls one dragonet, seventy-seven herrings, and two red gurnards. The aggregate number of fishes taken in the seven hauls, the time of actual fishing being thirty hours, was 5445; the average number caught per hour was thus 181·5. The marketable fishes numbered 3269, with an average per hour of 109·0, and the unmarketable 2176, with an average of 72·5. The fish caught in largest numbers was the witch, viz. 1888, the average per hour's fishing being 62·9.

The next few hauls were taken in the same locality but further to the west towards Cromarty, in water from twenty-five to thirty fathoms deep, and on a muddy bottom. In the first of these 1840 fishes were procured, 1125 being marketable. More than half of these were witches, viz. 826, and haddocks were also more abundant than in the previous hauls, thornbacks and starry rays being also more numerous. The same features characterised the remainder of the hauls here, and a considerable number of cod were obtained.

The next drag was for four hours and fifteen minutes, but the net was badly torn, and the catch amounted to only 355 fishes, of which 208 were marketable. The succeeding two hauls were more productive, the number of fishes taken in one of them being 1160, and in the other 2117, the marketable and unmarketable numbering respectively 688 and 1158, witches being in each case the most abundant.

Other two hauls were made a little closer in to Burghead Bay, 1515 and 2009 fishes being obtained, the majority again consisting of witches. Altogether in this locality fourteen drags were taken. In one of these the net was fouled and in another it was badly torn, and the results from these hauls may be excluded. The total duration of the actual fishing of the remaining twelve drags was fifty-two hours, and the aggregate number of fishes taken was 14,072, or an average of 270·6 per hour's fishing; the marketable fishes numbered 7815, or an average of 150·3 per hour, and the unmarketable 6257, the average being 270·6. In the total were included 11,600 flat-fishes, 5992 being marketable and 5608 unmarketable. The most common was the witch, of which 5819 were caught (4987 marketable); the common dabs numbered 2991 (all unmarketable but 203), and there were 1988 long rough dabs. The quantity of plaice taken was moderate, viz. 707, and all were marketable; only eighty-seven lemon dabs were caught, and all these were also taken to market. One black or common sole was obtained, a fish which is very rare on the east coast. Haddocks and whitings were poorly represented, 933 of the former and 263 of the latter being the whole number. Only eleven of the haddocks were too small to be taken to market—a great contrast to what usually obtains in these waters. The cod numbered 286, and the marketable codlings 208; there were also twenty-five codlings too small to be marketable. Among 211 skates and rays were six grey skates, seventy-six thornbacks, 124 starry rays and five sandy rays. The number of anglers caught was exceptionally large, being 431—150 of them being taken to market. Eighty-three herrings were taken, most of them in one haul, and also twelve sprats.

During most of the time of fishing at Burghead and between it and Cromarty the wind had been blowing with fair strength, although variable in direction. On the 10th it increased in force, and a shift was made to the Dornoch Firth, where four hauls were made in from about six to twelve fathoms. The quantity of fish caught was small, the total in each of three of them being only a little over four hundred of all kinds ; in one it amounted to 710. Few haddocks, cod, or whiting were obtained, the bulk of the catch, such as it was, consisting of plaice. A considerable number of flounders were taken, nearly all of large size and engaged in spawning, the four hauls yielding 215.

The total number of fishes got in the four drags in the Dornoch Firth—the actual time of fishing being seventeen hours and ten minutes—was 2027, which represents an average per hour of 118·0. The marketable amounted to 1476, or an average of 86·0 per hour, and the unmarketable 551, or an average of 32·1 per hour. The flat-fishes greatly exceeded the round-fishes in number, there being 1798 of them and only 203 of the latter. Plaice were the most abundant, and after them common dabs. Only 102 haddocks were got, none of them unmarketable, and six whitings, all of which, except one, were unmarketable. The paucity of small haddocks during the whole period of fishing on this occasion is noteworthy.

Only one recorded haul in Aberdeen Bay was made on this trip, and the number of fishes taken was still less than in the Moray Firth. The haul lasted for four hours, and 155 fishes were caught, of which only thirty-five were marketable. These comprised one cod, thirteen codling, fifteen haddocks, three plaice, two lemon dabs, and one flounder, the unmarketable consisting chiefly of whitings and common dabs.

The aggregate total of fishes taken and recorded in the seventeen hauls in February was 16,268, of which 9340 were marketable and 6298 unmarketable. The total of flat-fishes was 13,455, and of round fishes 2016.

The quantity of fish landed at the market by the vessel, as recorded by the Fishery Officer, amounted to $47\frac{1}{4}$ cwts., as follows :—

Cod.	Codling.	Ling.	Coal-fish.	Haddock.	Whiting.	Turbot.	Brill.	Lemon Dab.
$7\frac{1}{4}$	2	$\frac{1}{3}$	6	$2\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{2}$

Plaice.	Dabs.	Witches.	Cat-fish.	Flounder.	Angler.	Skate.
14	$\frac{3}{4}$	$6\frac{1}{2}$	$1\frac{1}{2}$	1	2	2

II.

The next series of trawlings was made in March on board the "Devanha," the catches being again recorded by Mr. James Ingram, jun. In all, twenty-two recorded hauls were made, three in Aberdeen Bay on the 16th, three in Burghead Bay on the 17th and 18th, four in the Dornoch Firth, five on Smith Bank off the coast of Caithness, four off Lossiemouth on the 20th, and three off Tarbet Ness on the 21st and 22nd.

In Aberdeen Bay there was a heavy sea, with a S.S.E. wind, and the catches were poor. The first haul here, in from thirteen to nineteen fathoms off Newburgh, lasted for four hours, and 514 fishes were captured, 478 being marketable and thirty-six unmarketable. They included 123 cod and 195 marketable codling, as well as 184 plaice—

all but twenty-eight marketable; but only four haddocks were taken. The second drag in the same locality, and lasting for four hours and twenty minutes, yielded only 205 fishes, of which 121 were marketable and eighty-fonr unmarketable. In this haul only eight cod and four codling were taken, but there were ninety-two haddocks—all but eight marketable; the plaice numbered twenty-two, and there were a number of small skates.

A third drag was made off Newburgh to Donmouth for four hours and five minutes, in from eight to sixteen fathoms, and the catch amounted to 375 fishes, 269 of which were marketable and 106 unmarketable. There were included in it forty-seven cod and 126 marketable codlings, a coal-fish, 145 plaice (ninety-two marketable), as well as a number of unmarketable dabs, flounders, and skates. Only three haddocks were taken.

In the three drags in Aberdeen Bay, the time of the fishing being twelve hours and twenty-five minutes, only 1094 fishes were caught, the average per hour's fishing being 88·1. The marketable numbered 868, with an average number per hour of 69·9, and the unmarketable 226, with an average of 18·2. The total number of haddocks caught was ninety-nine, and of whitings, seven. The following Table gives the particulars of the marketable and unmarketable:—

	Plaice.	Common Dab.	Flounder.	Witch.	Lemon Dab.	Cod.	Codling.
I.	268	.	.	.	4	178	325
II.	83	33	14	4	.	.	.
Total	351	33	14	4	4	178	325
	Haddock.	**Whiting.**	**Coal-fish.**	**Gurnard.**	**Grey Skate.**	**Thorn-back.**	**Starry Ray.**
I.	91	.	2	.	.	.	.
II.	8	7	.	1	17	57	1
Total	99	7	2	1	17	57	1

A lumpsucker was also taken in one of the hauls. These fish are occasionally caught in the trawl net near shore in spring, during their sawning time.

The vessel then steamed to the Moray Firth, visiting first the south coast.

At Burghead Bay the catches were not very productive, comparatively few marketable fishes being got except plaice. The first drag, which lasted for three hours and fifty minutes, in from seven to twelve fathoms, yielded a total of 652 fishes, 439 being marketable and 213 unmarketable. The former comprised four cod, three codling, only two haddocks, no whitings, one turbot, eleven brill, 329 plaice, seventy common dabs, fourteen flounders, three cat-fishes, and two anglers—the unmarketable consisting almost entirely of dabs. In the second haul, which lasted for four hours and fifteen minutes, 705 fishes were got, of which 316 were marketable, the majority consisting of plaice. Twenty-eight skates and rays were taken, ten being marketable, and three herrings.

The third drag was more productive, 948 fishes being taken—607 marketable and 341 unmarketable; it lasted for four hours. The bulk of the catch was composed of plaice and common dabs, 469 of the former and 398 of the latter; all the plaice except forty-three were marketable, and 137 of the dabs.

Altogether the number of fishes obtained in the three drags in Burghead Bay aggregated, for the twelve hours and five minutes of actual fishing, 2305, of which 1362 were marketable and 943 unmarketable. The flat-fishes greatly preponderated, 2087 being caught, against only 121 round-fishes. Among the flat-fishes 1314 were taken to market and 773 thrown overboard, while only thirty-one of the round-fishes were marketable, the marketable haddocks numbering two, and there were no marketable whitings. The plaice caught numbered 1024, all but forty-three being taken to market. The productiveness of the grounds in Burghead Bay on this occasion was shown by the number taken per hour's actual fishing, which was 190·8 for all kinds of fish—112·7 for the marketable and 78·1 for the unmarketable. The average for the marketable plaice was 81·2 per hour's fishing.

The particulars of the marketable and unmarketable fishes are as follows:—

	Plaice.	Common Dab.	Flounder.	Lemon Dab.	Turbot.	Brill.	Cod.	Codling.
I.	981	263	39	10	1	20	7	13
II.	43	729	.	.	.	1	.	4
Total	1,024	992	39	10	1	21	7	17

	Had-dock.	Whiting.	Cat-fish.	Gurnard.	Angler.	Thorn-back.	Starry Ray.	Sandy Ray.
I.	2	.	9	.	2	7	5	3
II.	45	40	.	1	37	16	14	5
Total	47	40	9	1	39	23	19	8

There were also taken in these hauls seven herrings and one lump-sucker.

After leaving Burghead Bay the vessel steamed to the Dornoch Firth, where four hauls were made in the usual locality, in sweeps around the bay opposite Dunrobin, Golspie, and Embo, the depth of water being from about eight to sixteen fathoms. In the first haul, which lasted for four hours and five minutes, 999 fishes were taken, of which 822 were marketable and 177 unmarketable. The marketable fishes comprised twenty-four cod, 369 plaice, seventy-one common dabs, 317 flounders, as well as ten cat-fish, three lemon dabs, and eighteen skates and rays. Round-fishes continued to be very scarce, only two haddocks and a single whiting being caught. The second drag was a very poor one, only 229 fishes being obtained, of which 148 were marketable. There were fifty-seven plaice, sixteen cod, twelve common dabs, and fifty-two flounders. Three herrings and twenty-two sprats were also taken. The next haul was better, a hundred cod and 110 marketable codling, as well as 174 plaice, eleven lemon dabs, and a number of common dabs and flounders, being caught. In the fourth drag the net got badly split, and the catch was small, amounting to only 160 fishes, 111 being marketable. It however included thirty-eight cod and forty-seven marketable plaice.

Omitting this imperfect haul, the total number of fishes taken in the other three drags in the Dornoch Firth was 2066, of which 1470 were marketable and 596 unmarketable. The duration of the fishing in these drags was twelve hours and fifteen minutes, and the averages per hour's fishing were therefore as follows:—120·0 for the marketable, 48·7 for the unmarketable, and 168·7 for both included. The average for plaice was 49·0 per hour. The three hauls yielded 140 cod, but only seven haddocks and a single whiting, all marketable. The absence of small haddocks and whitings both here and at Burghead Bay was remarkable, and formed a striking contrast to what obtained later in the year.

The numbers of marketable and unmarketable fishes caught in the three drags in the Dornoch Firth are as follows:—

	Plaice.	Common Dab.	Flounder.	Lemon Dab.	Brill.	Cod.	Codling.	Haddock.
I.	600	128	420	16	2	140	115	7
II.	8	509	48	.	.	.	.	.
Total	608	637	468	16	2	140	115	7

	Whiting.	Cat-fish.	Angler.	Grey Skate.	Thornback.	Starry Ray.	Sandy Ray.
I.	1	14	.	1	.	3	1
II.	.	.	2	.	22	2	.
Total	1	14	2	1	22	5	1

There were also caught three herrings, twenty-two sprats, and two lumpsuckers.

On leaving the Dornoch Firth the vessel ran to Smith Bank, where five hauls were made on the western edge in from about nineteen to twenty-eight fathoms of water, and here much better results were obtained than in the localities above described. The first haul, which lasted for four hours, yielded 726 fishes, of which 262 were marketable and 464 unmarketable. The catch included eleven cod, a halibut, forty plaice, a few lemon dabs and witches, and also 223 haddocks, in the latter respect thus differing from the catches in the Dornoch Firth and Burghead Bay. Eighty-two of the haddocks were too small to be marketable. There were also 117 gurnards, a fish more sparingly represented in the previous localities—at this season it is only found in any number in the deeper waters offshore. The second drag was better than the first, 1016 fishes being caught, of which 670 were marketable. They included thirty cod 574 haddocks, sixty-nine plaice, fifty-eight lemon dabs, and seven cat-fish. Seventy-five of the haddocks were two small to be marketable.

The third haul produced 1934 fishes, 648 being marketable and 1286 unmarketable. On this occasion haddocks were well represented, 1379 being taken; no less than 973 of these were too small to be marketable.

The catch included twenty-eight cod, ninety plaice, 111 lemon dabs, three cat-fish, and a few other kinds. The fourth and fifth hauls were not quite so good as regards the number of fish caught. In the first of them the total was 901, of which only 166 were marketable, and these included sixty-two cod, forty-four plaice, fifty-two lemon dabs, and five cat-fish. There were 333 haddocks, all too small to be marketable, and 126 whitings, of which only one was marketable. The number of fishes in the last haul was still less, viz. 664, and all except 100 were unmarketable. Those taken to market comprised twenty-three cod, fifty-four plaice, two coal-fish, eleven lemon dabs, and a few others. The number of haddocks caught was 127, and of whitings 216, but all the latter and all except three of the haddocks were unmarketable.

Altogether in the five hauls in this locality, the time of actual fishing being twenty hours and twenty-five minutes, 5241 fishes were taken, the average per hour's fishing being 256·7. The proportion of marketable was, however, not large, owing to the numbers of small haddocks and dabs; the number was 1846, the average per hour being 90·4, while there were 3395 unmarketable, giving a ratio of 166·2 per hour.

The aggregate number of flat-fishes in the five drags was 1779, 569 being marketable and 1208 (chiefly common and long rough dabs) unmarketable. Plaice were most numerous, 297 being taken, and lemon dabs next, of which 249 were caught, all but ten marketable. The aggregate of round-fishes was 3395, there being 1268 marketable and 2127 unmarketable. The number of haddocks was 2636, and 1049 of them were marketable and 1587 too small to be taken to market—a considerable proportion. The average number of haddocks taken per hour's fishing was 129·1.

The particulars as regards the marketable and unmarketable of each kind are given in the following Table:—

	Plaice.	Com. Dab.	Flounder.	Witch.	Lemon Dab.	Halibut.	Long Rough Dab.	Brill.	Megrim
I.	297	3	2	22	239	2	.	1	3
II.	.	826	.	44	10	.	328	.	.
Total	297	829	2	66	249	2	328	1	3

	Cod.	Codling.	Haddock.	Whiting.	Coal-fish.	Hake.	Cat-fish.	Gurnard.	Grey Skate.	Thornback.
I.	154	14	1,049	30	4	.	17	.	8	1
II.	.	22	1,587	368	.	1	.	149	6	26
Total	154	36	2,636	398	4	1	17	149	14	27

There were also caught in these hauls eighteen (unmarketed) anglers, one dragonet, and nine red gurnards.

The next place examined was the grounds off Lossiemouth, where four drags were made on the 20th, in from about seven to fourteen fathoms of water. In two of them the net was badly torn, and the catches in these cases was small, and may be neglected. In the first of the others the total number of fishes caught in the four hours during which the drag lasted amounted to 785, and of these 556 were marketable and 229 unmarketable. Very few haddocks were obtained, the total being three, all marketable; the chief fishes were cod, of which fifty were got, codling, plaice, and flounders. In the other haul 690 fishes were obtained, 570 being marketable. On this occasion also the marketable fishes consisted for the most part of cod, codling, plaice, and flounders, while only six haddocks were taken.

The aggregate for the two hauls here, the actual fishing lasting eight hours and fifteen minutes, was 1474, or an average per hour of 178·7. The marketable fishes numbered 1126, an average of 136·5 per hour, and the unmarketable 348, giving an average of 42·2. The flat-fishes greatly preponderated, 1134, or an average of 137·4, being caught, as compared with 327 round-fishes, with an average of 39·6. All the round-fishes were marketable, and they comprised the large number of 127 cod, 172 codling, five coal-fish, and twelve cat-fish, but only nine haddocks and two whitings. The flat-fishes included 524 plaice, all marketable except nine (the average of the former being 62·4), 350 common dabs, and 243 flounders.

Although the catches here were good, the fishing was carried on at some expense of gear, and a shift was made to the north-east, off Tarbet Ness, where three drags were taken in from twenty to twenty-six fathoms of water. In the first, which occupied four hours and thirty-five minutes, only 222 fishes were taken, 174 marketable, but the net was slightly split. In the next haul 449 were caught, of which 130 were marketable, and in the third 259, the marketable numbering 161. The chief fish taken in this locality was cod, 142 being obtained.

Taking the two perfect hauls, the time of actual fishing being eight hours and ten minutes, the number of fishes secured was 708, the average per hour being 86·6. The number of marketable was 291, with an average of only 35·6, and the unmarketable 417, with an average of 51·0 The total included 137 plaice, 124 cod, 201 haddocks, of which only sixteen were marketable, sixteen whitings, all unmarketable, and a few others.

The quantity of fish landed from this trip amounted to $140\frac{3}{4}$ cwts., as follows:—

Cod.	Codling.	Ling.	Coal-fish.	Haddock.	Turbot.	Halibut.	Brill.
81	$5\frac{1}{2}$	$1\frac{1}{3}$	2	$3\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{2}$

Lemon Dab.	Plaice.	Dabs.	Megrim.	Flounder.	Cat-fish.	Skates.
$2\frac{3}{4}$	$28\frac{1}{4}$	$1\frac{3}{4}$	$\frac{1}{4}$	$4\frac{1}{4}$	5	5

III.

From the 8th to the 13th of June another series of trawlings was made on board the "Drumblair," the places visited being Burghead Bay, the grounds off Lossiemouth, the Dornoch Firth, the ground off Lybster, Smith Bank, and Aberdeen Bay, twenty-two hauls being recorded.

The fishing in Burghead Bay, where three drags were made on the 8th and 9th, was very poor, the total number of fish taken being only 560, of which 203 were marketable, the duration of the fishing being six hours and forty minutes. In one of the hauls the net was slightly torn, and in the other two, lasting for four hours and forty minutes, 390 were caught, 125 of them being marketable. The average per hour at this time in Burghead Bay was 84·1, the average for the marketable being only 30·5. The catch consisted chiefly of plaice; only one cod, two codlings, a single haddock, and three whitings were caught. An explanation of the poor takes was probably the very large quantity of weed which was found in the net, which was with difficulty cleansed of it, experience showing that under such circumstances fish are usually scarce.

On leaving Burghead Bay the vessel proceeded to the ground off Lossiemouth, where a haul was made in from eleven to fourteen fathoms, about three miles off. The net was hauled in fifty minutes, and it contained 278 fishes, of which only forty-one were marketable, viz. forty plaice and one black or common sole. The unmarketable fishes numbered 237, and consisted of common dabs, small plaice, and gurnards, of which there were 110. The weather both here and at Burghead Bay was quite calm, the sea smooth, and there was a slight fog.

The vessel then steamed to the Dornoch Firth, where a number of drags were taken. In the first, which lasted for only twenty-eight minutes, the net having caught on something on the bottom, ninety-five fishes were taken, of which forty-one were marketable and fifty-four unmarketable. They consisted mostly of plaice and common dabs; only one haddock was obtained, and there were no whitings. For the time the net was fishing the catch was fairly good, and a "dan" was put down and a few of the succeeding hauls were made around it. In the first of these, in from five to eleven fathoms, and in two hours and forty-two minutes actual fishing, a large bag of fish was secured. The total number of fishes was 4928, of which 1555 were marketable and 3373 unmarketable. With the exception of fifty gurnards and twenty-four thornbacks, they were all flat-fishes and nearly all plaice. These numbered no less than 4638, of which 1525 were marketable and 3113 unmarketable; the former consisted of eleven "large," 205 "mediums," 370 "small," and 939 "fourths." The small unmarketable plaice measured from three and three-quarter inches up to ten inches in length. The catch also included four brill and six flounders.

In the next recorded haul, on the same ground and lasting for four hours, 4859 fishes were taken, of which 1318 were marketable and 3541 unmarketable. The great bulk again consisted of plaice, which numbered 4517, and of these 1211 were marketable and 3306 unmarketable. The other marketable fishes included one turbot, one brill, eighty-five common dabs, one lemon dab, and nineteen thornbacks. The small "offal" plaice were of the same sizes as in the former haul, and their great abundance showed how destructive the otter-trawl may be on such shallow-water grounds in certain cases. In the two hauls forty-three thornbacks were got, and the males greatly preponderated. In fifty-six examined from these and other catches, there were fifty-one males and only five females—a proportion the reverse of what usually obtains.* The larger and medium-sized gurnards were spawning, and they were found to be feeding on shore-crabs.

Owing to the quantity of small plaice taken, it was decided to shift a little further out so as to avoid the shallow water, and the result was immediately apparent. In the first haul made here, in from nine to thirteen fathoms, the "bag" was not so large, but the fish were of better size. The haul lasted for four hours and two minutes, and the fishes caught numbered 1144, of which 432 were marketable and 712 unmarketable. The former included 412 plaice, of a total of 1105, the large numbering twenty-eight, the medium fifty-eight, the small 110, and the fourths 216. There were also two cod, ten common dabs, two flounders, one cat-fish, and five thornbacks. The fourth class of marketable plaice consisted of fish measuring from 23 centimetres (nine inches) to a little over 31 centimetres (twelve and a half inches), and the unmarketable from 19·8 cm.

* *Twenty-first Annual Report*, Part III., p. 230.

(seven and three-quarter inches) to about 23·5 cm., or nine and a quarter inches; a few were a little larger. The selection of the various classes by the men, being solely by the eye, is never perfect, one class always overlapping another more or less.

A number of other hauls were made on this ground with the same general results, the marketable fishes consisting of plaice and scarcely anything else, round-fishes, with the exception of gurnards, being almost absent. During the time in the Dornoch Firth the weather was very favourable for fishing operations on the whole, though on the 10th there was some wind from the east, which made the sea a little choppy, causing the vessel to roll.

In the ten recorded hauls in the somewhat deeper water, from eight to thirteen fathoms and mostly from eight to eleven, the time of actual fishing being thirty-eight hours and thirty-two minutes, the aggregate number of fishes captured was 7613, of which 3565 were marketable and 4046 unmarketable. They consisted mostly of flat-fishes, and chiefly of plaice, the former numbering 7316, and the round-fishes, nearly all gurnards, only 279. The average per hour's fishing was 92·5 for the marketable, and 105·0 for the unmarketable, the general average for both combined being 197·5. Only five cod, two (unmarketable) codlings, thirty-two haddocks, all marketable, were taken, and not a single whiting. The plaice numbered 6680, of which 3450 were marketable and 3230 unmarketable, the respective averages per hour's fishing being 89·5 and 83·8 for the marketable and unmarketable, and 173·3 for both together.

In the two first hauls in the somewhat shallower water above described a greater number of fishes were captured in the six hours and forty-two hours of fishing, viz. 9787, the average per hour being 1460·7; the marketable numbered 2873, with an average of 428·7, and the unmarketable 6914, with an average of 1032·0. The number of plaice in these two hauls was 9155, the average per hour being 1366·4; the marketable amounted to 2736, with an average of 408·4, and the unmarketable to 6419, with an average of 958·0. These numbers are very rarely reached.

The number of marketable and unmarketable fishes taken in the twelve hauls was as follows:—

	Plaice.	Com. Dab.	Flounder.	Brill.	Turbot.	Lemon Dab.	Cod.	Codling.
I.	6,186	141	11	7	1	1	5	.
II.	9,649	963	3	.	.	.	.	2
Total	15,835	1,101	14	7	1	1	5	2

	Haddock.	Hake.	Cat-fish.	Gurnard.	Angler.	Thorn-back.	Sprat.
I	32	1	5	.	.	50	.
II.	.	.	.	234	8	7	1
Total	32	1	5	234	8	57	1

It is of interest to contrast the proportions in which the plaice of different sizes were caught in the two hauls in the shallower water and in the ten in a little deeper water on this occasion; and in the appended Table I give the percentage of each size to the total, and the average number taken in each hour's fishing in the two cases respectively. The two hauls are indicated by A and the ten by B.

		Large.	Medium.	Small or Thirds.	Fourths.	Unmarketable.
A	No.	27	329	681	1,699	6,419
B	No.	174	775	1,179	1,322	3,230
A	Percentage.	0·29	3·59	7·43	18·55	70·11
B		2·60	11·60	17·65	19·80	48·3
A	No. per Hour's Fishing.	4·0	49·1	101·6	253·6	958·0
B		4·5	20·1	30·6	34·3	83·8

It will be seen how much greater the proportion of small plaice, under about ten inches, is in the former case than in the latter. The actual abundance on the ground, as shown by the average per shot, indicates that while the large plaice were nearly equally distributed, the medium plaice, and still more markedly those still smaller, were far more numerous in the shallower water. Nevertheless it will be observed that the largest average in each case is for the unmarketable fish, that is, under about nine and a half or ten inches.

Two hauls with the small-meshed net around the cod-end were made in the Dornoch Firth. In the first, which was for an hour and twenty-eight minutes, it was found on getting the trawl up that the fine net had been holed. The total number of fishes taken was 143, belonging to eleven species, as follows:—Plaice 55, common dab 38, lemon dab 2, little or yellow sole 3, cod 10, haddock 1, gurnard 14, cat-fish 1, sand-eel 16, goby 1, gemmeous dragonet 2. In the second haul, which lasted for an hour, the catch was also very small, viz. 170 fishes, belonging to five species, viz.—plaice 103, common dab, 57, gurnard 7, sand-eel, 1, angler 2.

The next place where fishing was carried on was off Lybster on the coast of Caithness, where a drag for two hours in twenty-three fathoms gave 584 fishes, of which 383 were marketable and 201 unmarketable. The catch comprised six marketable plaice, forty-six marketable lemon dabs, and forty common dabs, as well as 410 haddocks, 308 of them being marketable, two cod, and forty-four whitings, twenty-five of which were too small to be marketable.

Smith Bank was then visited, and a haul there, in from nineteen to twenty-two fathoms, for two hours and five minutes, gave a total of 773 fishes, 378 being marketable. The flat-fishes consisted of two turbot, 220 common dabs, and twenty-nine lemon dabs, all but seven of them marketable; there were also taken 481 haddocks, 316 marketable, one cod and twelve marketable codlings, as well as two cat-fish and twenty-three gurnards.

After leaving the Moray Firth five hauls were made in Aberdeen Bay, with very good results. The first was in from eight to ten fathoms off the Black Dog, and it lasted for four hours. The number of fishes taken was 1749, of which 1384 were marketable and 365 unmarketable, the bulk of the catch consisting of plaice and haddocks. Of 917 haddocks caught, 707 were marketable and 210 unmarketable; all the former were "thirds" or small. The plaice totalled 597, all but twenty being marketable, and of these twenty-five were large, 363 mediums, and 189 small. There were also one cod, three marketable codlings and fourteen unmarketable, forty small whitings, 150 dabs, twenty-five gurnards, and two anglers.

The next haul in the same place, and also lasting for four hours, gave almost exactly the same numbers, the total being 1745, the marketable 1312 and the unmarketable 433. The haddocks numbered 1013, all being small and 250 of them unmarketable, while of the 507 plaice, all of which were marketable, fifteen were large, 162 medium, and 330 small; there were no "fourths," a still smaller class, as in the Moray Firth.

In these two drags at this place, the duration of fishing being eight hours, 3494 fishes were captured, the average per hour being 436·6. The marketable, numbering 2696, gave an average of 337·0, and the unmarketable, of which there were 798, an average of 99·6.

Three other hauls were made in from twelve to fifteen fathoms, off Slains Castle, with even better results. Only one was completely recorded; it lasted for four hours, and 2068 fishes were taken, 1855 marketable and 213 unmarketable. The number of haddocks was 1797, all but 109 marketable; there were fewer plaice, viz. 160, all marketable, and they comprised sixty mediums and one hundred small. The other marketable fishes were two turbots and five brill. In the next haul, for three hours, 4283 marketable fishes were secured; the unmarketable were not counted, but they consisted of six basketfuls, mostly of small haddocks. The haddocks enumerated amounted to 4126, of which 303 were mediums, 3193, smalls and 630 fourths, or very small. There were also eighty-seven plaice, all marketable, and seventy marketable common dabs. The last drag, for four hours, yielded 1985 marketable fishes, the haddocks numbering 1871 and the plaice 107; all the haddocks were thirds and fourths. The offal was not noted.

The following are the particulars of each class of fish taken in the three completely recorded drags in Aberdeen Bay:—

	Plaice.	Common Dab.	Turbot.	Brill.	Cod.	Cod-ling.	Had-dock.	Whit-ing.	Gur-nard	Ang-ler.
I.	1,244	94	2	7	1	3	3,158	40	-	2
II.	20	263	-	-	-	39	569	56	61	3
Total	1,264	357	2	7	1	42	3,727	96	61	5

The quantity of fish landed at the market, as the result of this trip, as recorded by the Fishery Officer, was 81 cwts., as follows:—

Cod.	Codling.	Coal-fish.	Hake.	Haddock.	Turbot.
$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{10}$	$\frac{1}{5}$	4	$\frac{1}{8}$
Brill.	**Lemon Dab.**	**Plaice.**	**Cat-fish.**	**Flounder.**	**Skates.**
$\frac{1}{8}$	$\frac{5}{8}$	$63\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$	9

IV.

In October another series of trawlings was made, by means of the steam-trawler "Star of the North," the grounds visited being Aberdeen Bay, Burghead Bay, the Dornoch Firth, off Lybster, and Smith Bank.

In Aberdeen Bay five hauls were made on the 16th and 17th of the month, with fair results, a strong breeze blowing from the S.W., while the sea was rough. The first was off Black Dog in from eight to twelve fathoms, and it lasted four hours. The catch amounted to 1978 fishes, of which 1938 were marketable, most consisting of haddocks. Of these 1517 were caught, all marketable, the majority being "large" or "firsts," viz. 749. Thirteen cod and 121 codlings, of which 118 were marketable, were included in the catch, as well as 264 whitings, twenty-two plaice, one lemon dab, and twenty-eight common dabs. The next drag in the same locality, and in from nine to twelve fathoms, gave almost the same result, viz. a total of 1964, of which 1889 were marketable. The number of haddocks was 1099, all marketable, there being 395 large, 164 medium, and 540 thirds. There were also four cod and 282 codlings, all but nine marketable, 275 whitings, ten brill, 194 plaice, twelve lemon dabs, and seventy-three common dabs. A third haul for four hours in the same locality gave 1287 fishes, 1216 of which were marketable, the bulk of the catch consisting of large and medium haddocks, cod, codlings, and plaice.

The fourth drag was made in from twelve to twenty fathoms, from the same place towards Cruden Skerries, and lasted for three hours and a quarter. The catch consisted of 1685 fishes, 1634 being marketable. The number of haddocks was 790, of which 237 were large, 156 mediums, and 397 thirds. Besides nine cod, 387 codlings were taken, all but five marketable, 228 whitings, 204 plaice, some dabs and rays. The fifth haul was made from the Skerries towards Aberdeen and lasted for an hour. The catch amounted to 208 fishes, chiefly haddocks, whitings, and plaice; it was made with the small-meshed net around the cod-end.

The three hauls in from eight to twelve fathoms, the time of actual fishing being eleven hours and fifty minutes, yielded a total of 5229 fishes, the rate per hour being 442·0. The marketable numbered 5043, with an average per hour of 426·3, and the unmarketable 186, with an average of 15·7. The aggregate of haddocks was 3281, with an average per hour of 277·3. A feature was the large number of marketable codlings, of which 570 were taken in three hauls.

The particulars of the catches of the first four drags in Aberdeen Bay are these:—

	Plaice.	Common Dab.	Lemon Dab.	Turbot.	Brill.	Cod.	Codling.
I.	615	71	30	3	23	52	952
II.	-	126	-	-	-	-	28
Total	615	197	30	3	23	52	980

	Haddock.	Whiting.	Gurnard.	Angler.	Grey Skate.	Thorn-back.	Starry Ray.
I.	4,071	830	-	1	16	8	5
II.	-	49	21	2	3	2	6
Total	4,071	879	21	3	19	10	11

In the haul with the small-meshed net, for an hour, the total number of fishes caught was 384, as follows:—Plaice 42, common dab 26, long rough dab 1, cod 22, haddock 94, whiting 190, sprat 9.

The fishing in the Moray Firth was begun on the 19th, Burghead Bay being first visited; the weather was calm, and very large quantities of fish were taken. The first haul was in from twelve to twenty fathoms, but mostly in and about ten, and lasted for four hours. The bag of fish was an exceptionally large one, comprising thirty-one and a half baskets of haddocks, mostly small, and six baskets of plaice, as well as other fishes. The total number of the fishes caught was 8382. of which 7286 were marketable and 1096 unmarketable. Among the former were 6439 haddocks and 622 plaice, sixty whitings, a halibut, two brill, thirty witches, twenty common dabs, and ninety-six gurnards. The unmarketable consisted chiefly of common dabs, whitings, and plaice.

The other four hauls at Burghead Bay were made in water from eight to twelve and thirteen fathoms, and they were also good in regard to the result. In the first, lasting for four hours, 3446 fishes were taken, 2581 marketable and 865 unmarketable. The former included 1463 haddocks, 646 plaice, and 255 whitings, and also a turbot, three brill, two witches, and some common dabs and gurnards. The next, also for four hours, produced 2556 fishes, 1596 marketable and 960 unmarketable, haddocks and plaice predominating. In the next haul, also for four hours, 4037 fishes were caught, 3005 of them being marketable and 1032 unmarketable. The catch included 2119 haddocks and 491 plaice.

In the last haul, for one hour, the catch amounted to 912 fishes, 515 being marketable and 397 unmarketable; most consisted of plaice, haddocks, and common dabs.

The aggregate quantity of fish taken in these five drags, the time of fishing being seventeen hours, was the large one of 19,333 fishes, 14,983 being marketable and 4350 unmarketable. The averages per hour's fishing were 1137·2 for the whole, 881·3 for the marketable, and 255·9 for the unmarketable. The total number of haddocks was 10,910, with an average of 641·8; the number of plaice was 2730, the average being 160·6, and the number of common dabs 3618, giving an average per hour of 212·8. There were very few cod or codlings, viz. three of the former and fifty-two of the latter, and 523 gurnards, of which 379 were taken to market. The productiveness of the grounds in Burghead Bay on this occasion very strikingly contrasted with the condition in spring and in June.

The following Table gives the numbers of the marketable and unmarketable fishes taken in the five hauls, the former being distinguished by the figure I., and the latter by II. :—

	Plaice.	Common Dab.	Witch.	Lemon Dab.	Halibut.	Turbot.	Brill.	Angler.
I.	2,622	218	68	6	1	2	5	-
II.	108	3,400	-	-	-	-	-	43
Total	2,730	3,618	68	6	1	2	5	43

	Cod.	Codling.	Haddock.	Whiting.	Hake.	Gurnard.	Thornback.
I.	3	49	10,753	865	1	379	11
II.	-	3	157	495	-	144	-
Total	3	52	10,910	1,360	1	523	11

The proportion of the small plaice to those of larger size here was very different to what it was in the Dornoch Firth in June. The unmarketable gave only a ratio of 6·3 per hour, as shown in the appended Table, which also gives the numbers, and the average per hour's fishing, for the various classes of haddocks :—

Plaice.	Large.	Medium.	Small.	Fourths.	Unmarketable.
No. . .	22	677	795	1,128	108
Average per Hour .	1·3	39·8	46·8	66·3	6·3
Haddock.	**Large.**	**Medium.**	**Small.**	**Fourths.**	**Unmarketable.**
No. . .	62	521	9,988	182	157
Average per Hour .	3·6	30·6	587·5	10·7	9·2

In one haul, for an hour, in eight to twelve fathoms, with the small-meshed net around the cod-end of the otter-trawl, 997 fishes were obtained, belonging to twelve species, as follows :—

Plaice.	Common Dab.	Witch.	Cod.	Haddock.	Whiting.
229	340	13	21	246	93
Hake.	**Gurnard.**	**Pogge.**	**Angler.**	**Dragonet.**	**Thornback.**
1	50	1	1	1	1

The fishing in the Dornoch Firth, which was the next place visited, was fairly good, but not so productive as at Burghead Bay. The first haul was made on the afternoon of the 20th October, off Dunrobin and Golspie, in from eight to fourteen fathoms of water, and lasted for two hours. The number of fishes caught was 793, of which 677 were marketable and 116 unmarketable. They included forty-two cod, thirty-three codlings, all but seven marketable, 592 haddocks, nearly all marketable, twenty-seven whitings, two brill, twenty-two plaice, and one or two others. The weather was fine, a light wind blowing from the south-west. In the next drag in the same locality, and lasting also for two hours, 842 fishes were caught, 771 being marketable. There were only three cod, but the number of haddocks was increased to 652, and of plaice to a hundred. A number of other hauls were made on the same grounds, the best being one of four hours' duration, by which 2486 fishes were taken, 2239 marketable and 247 unmarketable. Only one cod was included in the catch, but there were 1846 haddocks and 345 plaice, as well as some codlings, whitings, lemon dabs, and others. In the next haul the net was split, but the one succeeding it yielded 2223 fishes, 2081 being marketable. The haddocks numbered 1926, and the plaice 133, and there were also five cod, forty-two codlings, and some dabs.

Altogether there were nine recorded drags in this place, and the aggregate of fishes taken was 12,253, 9611 being marketable and 2642 unmarketable. The averages per hour of actual fishing were 331·4 for the marketable, 91·1 for the unmarketable, and 422·5 for both combined. The average per hour for the haddocks was 266·8 and for the plaice 57·0.

In the following Table are given the totals of each kind of fish taken in these nine hauls, the marketable being indicated by I. and the unmarketable by II. :—

	Plaice.	Common Dab.	Witch.	Lemon Dab.	Brill.	Cod.	Codling.
I.	1,552	89	2	23	5	54	138
II.	100	2,099	-	-	-	-	45
Total	1,652	2,188	2	23	5	54	183

	Haddock.	Whiting.	Coal-fish.	Gurnard.	Cat-fish.	Thornback.
I.	7,666	33	-	35	1	12
II.	70	190	2	99	-	-
Total	7,736	223	2	134	1	12

There were also a conger, seven anglers, twenty-two sprats, five picked dog-fishes, an armed-bullhead, a little or yellow sole, and a sting ray (*Trygon*). The proportions of the plaice and haddocks of different sizes is indicated in the following Table:—

		Large.	Medium.	Small.	Fourths.	Unmarketable.
Plaice	No.	100	261	438	753	100
	Average per Hour	3·4	9·0	15·1	26·0	3·4
Haddock	No.	1,033	879	5,754	-	70
	Average per Hour	35·6	30·3	198·4	-	2·4

In a haul for an hour, in from eight to thirteen fathoms, with the small-meshed net around the cod-end, 1522 fishes were captured, belonging to fifteen species, as follows :—

Brill, - - -	1	Coal-fish, - -	1
Plaice, - - -	364	Gurnard, - -	35
Lemon Dab, -	3	Pogge, - -	4
Common Dab, -	724	Sprat, - -	43
Little Sole, - -	8	Sting Ray, -	1
Cod, - - - -	8	Thornback, -	1
Haddock, - -	95	Piked Dog-fish, -	1
Whiting, - -	233		

After leaving the Dornoch Firth the vessel steamed to the grounds off Lybster, where five hauls were made in twenty-three and twenty-four fathoms of water and good catches of haddocks got. In the first, which was for one hour, 1008 fishes were taken, of which 956 were marketable and fifty-two unmarketable. The haddocks numbered 904, all but four marketable ; there were also fifty-one whitings, fourteen plaice, five lemon dabs, and thirty common dabs. The next drag, for two hours, yielded 2740 fishes—2674 being marketable and sixty-six unmarketable. The number of haddocks caught was 2463 (twenty basketfuls), all except nine marketable; there were also 224 whitings and a few flat-fishes. The third haul, for three hours, was scarcely so good, 2810 fishes being taken, of which 2665 were marketable. The catch included 2008 haddocks, nineteen codlings, twenty-six plaice, four lemon dabs, and eighty-six common dabs.

The five drags here—the time of actual fishing being thirteen hours—produced altogether 9992 fishes, or at the rate of 768·6 per hour; the marketable numbered 9536, the average per hour being 732·5, and the unmarketable 456, with an average per hour of 35·1. The total number of haddocks was 8063, of which only forty-nine were unmarketable, the average per hour's fishing being 620·2. Only 349 flat-fishes were caught in the five hauls, and of these 108 were marketable, consisting of eighty-two plaice and twenty-six lemon dabs; the unmarketable were 241 common dabs.

The following Table gives the numbers of the marketable and unmarketable fishes respectively:—

	Plaice.	Lemon Dab.	Common Dab.	Cod.	Cod-ling.	Had-dock.	Whit-ing.	Gur-nard.	Thorn-back.	Ang-ler.
I.	82	26	-	25	45	8,014	1,315	27	2	-
II.	-	-	241	-	28	49	121	16	-	1
Total	82	26	241	25	73	8,063	1,436	43	2	1

The haddocks were on the whole of a good class, 2078 being firsts, 1530 mediums, and 4406 thirds, the respective averages per hour's fishing being as follows:—

	Firsts.	Seconds.	Thirds.	Fourths.	Unmarketable.
No.	2,078	1,530	4,406	—	49
Average	159·8	117·7	339·0	—	3·8

Of the eighty-two plaice obtained, seven were large or firsts, sixty-four were mediums, and eleven thirds.

A small-meshed haul was made here for one hour, but the fine net was torn. The number of fishes taken was 1034, as follows:—

Plaice, - - -	14	Cod, - - -	9
Lemon Dab, -	5	Haddock, - -	906
Common Dab, -	49	Whiting, - -	51

Before leaving the Moray Firth two hauls were made on Smith Bank, on the edge, in about twenty-one and twenty-two fathoms. The first, for an hour, with the small-meshed net attached, yielded 1300 fishes, of which 350 were marketable and 950 unmarketable. The latter chiefly consisted of common dabs and whitings, and the former of haddocks. The total for both nets was 1811 fishes, belonging to twelve species, as follows:—

Plaice, - - -	31	Haddock, - -	306
Common Dab, -	962	Whiting, - -	442
Lemon Dab, -	15	Gurnard, - -	15
Long Rough Dab,-	20	Pogge, - -	4
Little Sole, - -	1	*Gobius minutus*,	1
Cod, - -	10	Dragonet, - -	4

The second drag was for three hours and forty minutes, and the number of fishes taken was 1236, 980 being marketable and 256 unmarketable. They included 107 cod, twenty-seven codlings, all marketable, a ling, 796 haddocks, all but ten marketable, thirty-four plaice, all marketable, fifteen lemon dabs, and some whitings and common dabs.

The haddocks were mostly of the third or small class, only thirty being firsts and 110 seconds.

Another haul with the small-meshed net around the cod-end was made at the "witch ground" about twelve miles off Kinnaird Head, the depth being fifty-one fathoms, and the duration of the haul one hour. The total number of fishes taken in both nets was 2187, belonging to eleven species; no witches were captured. The numbers of each kind were as follows:—

Plaice, - - -	3	Whiting, - -	422
Common Dab, -	412	Norway Pout, -	613
Long Rough Dab,	269	Gurnard, - -	12
Cod, - - -	1	*Gobius minutus*, -	1
Hake, - - -	6	Angler, - -	1
Haddock, - -	447		

The aggregate number of fish taken in twenty-four recorded hauls in this trip in the Moray Firth and Aberdeen Bay—the duration of the actual fishing being seventy-seven hours and forty minutes—was 49,728. Of these, 41,787 were brought to market and 7941 thrown overboard.

The quantity, in cwts., as determined by the Fishery Officer when the fish were landed, was as follows, the total being $271\frac{3}{4}$ cwts.:—

Cod.	Codling.	Ling.	Hake.	Haddock.	Whiting.
$39\frac{1}{2}$	$17\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{8}$	$143\frac{1}{2}$	$14\frac{1}{4}$
Turbot.	**Brill.**	**Lemon Dab.**	**Plaice.**	**Dabs.**	**Witches.**
$\frac{7}{8}$	1	$2\frac{1}{4}$	$44\frac{3}{4}$	$\frac{1}{4}$	$\frac{1}{2}$
	Conger.	**Skate.**	**Gurnard.**	**Angler.**	
	$\frac{1}{4}$	$3\frac{1}{2}$	2	1	

V.

At the end of October six hauls in Aberdeen Bay were made by the steam-trawler "Lochryan," four of which were recorded. In the first, in from eight to fifteen fathoms of water, and which lasted for two hours and twenty minutes, 835 fishes were taken, of which 675 were marketable and 160 unmarketable. The catch included twenty-nine cod, forty-three codlings, all marketable, 399 haddocks, 338 whitings, seven plaice, a brill, and a common sole. In the second haul, in from seven and a half to twelve fathoms, for four hours and thirty-five minutes, 1066 fishes were taken, the number marketable being 930. There were 106 cod, 151 codlings, all except six marketable, four coalfish, 320 haddocks, only eleven of which were unmarketable, 308 plaice, and a number of whitings and others. The succeeding two hauls were rather better, haddocks especially being more abundant, and altogether in the four drags—the time of actual fishing being fifteen hours and twenty-five minutes—6042 fishes were taken, of which 4654 were marketable and 1388 unmarketable, the average per hour's fishing being for the whole catch 392·1, for the marketable 302·0, and for the unmarketable 90·1. The average per hour for haddocks was 196·3, for whitings 117·5, and for plaice 33·5. The numbers of fishes of the various kinds, marketable (I.) and unmarketable (II.), were as follows :—

	Plaice.	Common Dab.	Floun-der.	Lemon Dab.	Sole.	Brill.	Long Rough Dab.	Cod.
I.	507	40	5	3	2	1	-	197
II.	10	33	-	-	-	-	2	-
Total	517	73	5	3	2	1	2	197

	Codling.	Haddock.	Whiting.	Coal-fish.	Gurnard.	Thornback	Starry Ray.
I.	322	2,863	709	4	–	1	-
II.	22	162	1,101	-	9	2	47
Total	344	3,025	1,810	4	9	3	47

In a haul with the small-meshed net, which lasted for an hour, the total number of fishes taken was 1981, belonging to ten species, as follows :—

Plaice, - - -	27	Haddock, - -	1190
Lemon Dab, -	1	Whiting, - -	701
Common Dab, -	6	Gurnard, - -	6
Long Rough Dab,	2	Sprat, - -	2
Cod, - - -	45	Grey Skate, -	1

The total quantity of fish landed, in cwts., was as follows, the time of fishing (including the incompletely recorded drags) being nineteen hours and five minutes :—

Cod.	Codling.	Coal-fish.	Haddock.	Whiting.	Turbot.	Plaice.	Dabs.	
25	$7\frac{1}{2}$	$\frac{1}{2}$	21	$4\frac{1}{2}$	$\frac{1}{8}$	7	$\frac{1}{2}$	$=66\frac{1}{8}$

VI.

The next series of trawling experiments was made in November, the vessel employed being the steam-trawler "Glenogil," and the places examined were Aberdeen Bay, Burghead Bay, the Dornoch Firth, between Burghead and Cromarty, and Smith Bank.

Four hauls were made in Aberdeen Bay on 6th and 7th November, off Newburgh, and between Black Dog and Collieston. In the first, in from eight to ten fathoms, which lasted for three hours, 1383 fishes were secured, 1314 of which were marketable and sixty-nine unmarketable. The former consisted mostly of haddocks and whitings ; of 1013 haddocks taken, 977 were marketable and thirty-six unmarketable, and of 321 whitings all but eighteen were marketable. The other fishes comprised one cod, twenty-seven codlings, a few dabs and gurnards, as well as six herrings and two sprats. Only two plaice were caught in this drag. Most of the haddocks belonged to the third and fourth classes, only 135 were "large" and sixty-nine "medium." The smallest haddocks amongst the unmarketable measured six and seven inches in length.

The next haul in the same locality, in five and a half to twelve fathoms, lasting for two hours, yielded only seventy-one fishes, and there was nothing apparent to account for the very small catch. The marketable fish consisted of thirteen haddocks—viz., one large, six medium, and six fourths—twenty-four whitings, one plaice, and one dab. Other two hauls were made in from four and a half to twelve fathoms, but the catches were small, the marketable fishes consisting chiefly of haddocks, plaice, and whitings. Altogether in the four hauls made in Aberdren Bay—the actual time of fishing being twelve hours and five minutes—the total number of fishes captured was 2630, the average per hour being 217·7; the number of marketable was 2394, with an average of 198·2, and the unmarketable 236, with an average of 19·5. The haddocks numbered 1485, the average per hour's fishing being 122·9; the whitings 573, with an average of 47·4, and the plaice 379, with an average of 31·3.

The numbers of the marketable (I.) and the unmarketable (II.) of each kind are shown in the following Table:—

	Plaice.	Common Dab.	Long Rough Dab.	Brill.	Cod.	Codling.	Haddock.
I.	378	27	-	2	3	77	1,417
II.	1	6	11	-	-	13	68
Total	379	33	11	2	3	90	1,485

	Whiting.	Gurnard.	Grey Skate.	Thorn-back.	Starry Ray.	Herring.	Sprat.
I.	490	-	-	-	-	-	-
II.	83	24	3	1	17	7	2
Total	573	24	3	1	17	7	2

The vessel then landed the fish which had been caught in Aberdeen Bay before proceeding to the Moray Firth, and the quantities as recorded in the market, by the Fishery Officer, in cwts. were as follows:—

Cod.	Codling.	Haddock.	Whiting.	Plaice.
$\frac{1}{2}$	1	$7\frac{1}{4}$	$1\frac{3}{4}$	2

In the Moray Firth the first place visited was Burghead Bay, where five hauls were made, four of which were recorded. In the first, which lasted for three hours and ten minutes, 1682 fishes were caught, of which 1365 were marketable and 317 unmarketable. Among the former were eleven cod, 506 haddocks, ten whitings, nine brill, 790 plaice, and thirty-four common dabs. The unmarketable were composed mostly of small haddocks and gurnards. In the second drag, lasting for four hours and fifteen minutes, 2421 fishes were taken, 1930 marketable and 491 unmarketable. The greater part of the catch again consisted of plaice and haddocks. It also included a turbot, ten brill, and a black or common sole. The number of fishes taken in the third haul, which lasted four hours, was 1779, the number marketable being 1273. They consisted for the most part of plaice, of which 1158 were obtained. There were only seventy-five small haddocks, twenty-five marketable and fifty too small to be marketable. In this drag no less than thirty-one brill were taken, a number that is scarcely ever reached in these trawling operations, and there were also five turbot. The fourth drag lasted for two hours and thirty-five minutes, and 1131 fishes were captured, of which 733 were marketable and 398 unmarketable. Only twenty-five small and unmarketable haddocks were caught in this drag; the marketable plaice numbered 678, and there were seven brill.

During the time of fishing in the Bay the weather was favourable, though somewhat squally, with rain, the wind blowing from the west.

The aggregate number of fishes taken in the four hauls in the fourteen hours of actual fishing was 7013, of which 5301 were marketable and 1712 unmarketable. The average catch per hour's fishing was for the marketable 378·6, and for the unmarketable 122·3; the average for both combined was 500·9. The number of plaice caught was 3588, the average per hour being 256·3, and the number of haddocks 1823, with an average of 130·2.

The numbers of the marketable and unmarketable of each species are given in the following Table:—

	Plaice.	Common Dab.	Witch.	Lemon Dab.	Sole	Turbot.	Brill.
I.	3,476	238	6	9	1	6	57
II.	112	584	-	-	-	-	-
Total	3,588	822	6	9	1	6	57

	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Thornback.	Angler.
I.	19	66	1,358	36	-	23	6
II.	-	35	465	99	396	9	12
Total	19	101	1,823	135	396	32	18

With regard to the general size of the plaice and haddocks captured, the great majority were small. Especially was this the case with the haddocks, only six of the large and forty-five of the medium being taken. The numbers of each class and the average per hour's fishing are given in the following Table:—

	Firsts.	Seconds.	Thirds.	Fourths.	Offal or Unmarketable.
Haddock,	6 0·4	45 3·2	77 5·5	1,230 88·0	465 33·2
Plaice,	77 5·5	575 41·1	2,824 201·7	- -	112 8·0

On leaving Burghead Bay the vessel steamed to the Dornoch Firth, where a number of hauls were made, the weather being calm and the sea smooth, a light wind coming from the north-west.

The first drag was made in from five to thirteen fathoms, off Golspie. It lasted for four hours and five minutes, and the catch was a good one, the marketable fishes numbering 2346, the unmarketable 1139, and the aggregate 3485. Plaice and haddocks formed the bulk of the catch; of the former 2166 were taken, 1264 of which were marketable and 902 unmarketable. Most of the plaice were of small size, only five being large, 167 medium, and 1092 thirds, while the offal in this haul numbered 902. Some of these, however, were quite large enough to go to market as fourths, and after this fourths were also selected. I found that the sizes of the larger specimens of the "unmarketable" plaice were on this occasion between nine and eleven inches: I give the measurements of seventy-six of the larger ones, in centimetres and inches:—

Centimetres, .	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Inches, . .	8¼	-	9	9½	-	10¼	-	11	11½	-	12¼	-	-	13½
No., . . .	4	2	15	23	10	8	4	2	3	1	-	3	-	1

The larger of these plaice were in reality "thirds"; but the selection, as previously mentioned, is never quite exact.

The next haul, in the same locality, was for four hours and twenty-five minutes, but the fishing was chiefly conducted in from eight to ten fathoms. The number of fishes taken was 1808, of which 1368 were marketable and 440 unmarketable. Haddocks were much scarcer, only 375 being caught, and it may be said generally in regard to this fish at this time in the Dornoch Firth that the quantity taken in the various hauls varied very much, there being sometimes only a few and sometimes over a thousand. They were obviously present, as the trawlers describe it, in "spots." The plaice numbered 1237, of which 978 were marketable; there were in addition thirty-two codlings, eight whitings, four brill, twenty-two common dabs, and a thornback ray among the marketable fishes.

The number of fishes caught in the next haul, which lasted for four hours and a half, was 2514, the marketable being 1902 and the unmarketable 612. The haddocks numbered 1282, of which 271 were unmarketable. There were 995 plaice, 881 of them marketable, and in addition to these the marketable fishes included two cod, six codlings, one halibut, and one megrim. The unmarketable consisted mostly of haddocks, dabs, plaice, and gurnards. In the fifth drag, in from six to ten fathoms, only nineteen haddocks were taken, and of these thirteen were unmarketable. The plaice numbered 2101, all but 184 being marketable. The next drag, for five hours, yielded 3033 fishes, 2337 being marketable and 696 unmarketable. There were 634 haddocks, 1981 plaice, 1661 marketable, 371 common dabs, six lemon dabs, and seventeen brill.

Altogether in the six hauls, involving twenty six hours and forty minutes of actual fishing, 14,404 fishes were captured, the rate per hour being the high one of 541·5. The marketable numbered 10,919, with an average of 410·4 per hour, and the unmarketable 3485, with an hourly average of 131·0. The average per hour for the plaice taken was 350·4, and for those which were marketable 277·2; the average for the haddocks was 140·5 per hour. The numbers of the marketable and unmarketable, and the totals, are as follow:—

	Cod.	Codling.	Haddock.	Whiting.	Plaice.	Common Dab.	Brill.	Lemon Dab.
I.	24	78	3,253	10	7,373	129	25	15
II.	-	31	485	4	1,948	746	-	3
Total	24	109	3,738	14	9,321	875	25	18

	Halibut.	Megrim.	Long Rough Dab.	Gurnard.	Grey Skate.	Thornback.	Sandy Ray.	Angler.
I.	1	2	-	-	1	8	-	-
II.	-	-	6	213	-	35	3	11
Total	1	2	6	213	1	43	3	11

Among the haddocks the proportion of large and medium was considerable, and much above what it was on many previous occasions; medium plaice were also well represented. The following figures give the average number of each class taken per hour's fishing:—

	First.	Second.	Third.	Fourth.	Unmarketable.
Haddock,	24·6	24·6	33·3	39·6	18·2
Plaice,	1·1	43·4	137·6	95·0	73·2

In the Dornoch Firth three hauls were also made with the small-meshed net around the cod-end, in from four and a half to twelve fathoms, the time occupied in fishing being three hours and fifty minutes. The number of fishes taken in both nets amounted to 11,590, the great majority having passed through the meshes of the cod-end. They belonged to eleven species, as follows:—

Plaice, - - -	327	Gurnard, - -	4
Brill, - - -	1	Sprat, - -	9351
Common Dab, -	28	Herring, - -	1407
Cod, - - -	4	Sand-eel, - -	3
Haddock, - -	23	Thornback Ray,	1
Whiting, - -	441		

Most of the sprats were taken in one haul, viz. 5477, and most of the herrings in another, 1297.

On leaving the Dornoch Firth the vessel returned to Burghead Bay, where other three drags were made in from five to ten fathoms, a fresh breeze blowing from the south, and a considerable number of plaice were taken. The hauls were also remarkable for the large number of brill captured, the three drags yielding in succession thirty-six, forty-three, and fifteen—a total of ninety-four. Seven turbots were also caught. The aggregate number of fishes secured in the three drags, the time of actual fishing being fourteen hours, was 5367, an average per hour of 383·4. The marketable fishes numbered 3817, with an average per hour of 272·6, and the unmarketable 1550, with an hourly average of 110·7. These averages are under those for the fishing in the same place a few days before. In the following Table are given the number of marketable (I.) and unmarketable (II.) fishes taken in the three drags:—

	Cod.	Codling.	Haddock.	Whiting.	Plaice.	Brill.
I.	84	87	190	-	3,274	94
II.	-	34	98	8	464	-
Total	84	121	288	8	3,738	94
	Turbot	**Lemon Dab.**	**Common Dab.**	**Gurnard.**	**Thornback.**	**Angler.**
I.	7	6	70	-	5	-
II.	-	3	600	322	10	11
Total	7	9	670	322	15	11

A short haul of one hour's duration was then taken off Burghead Bay, between it and Cromarty, in thirty fathoms, with the small-meshed net around the cod-end of the otter-trawl. The total number of fishes taken in both nets was 1805, belonging to fourteen species, as follows:—

Witch, - - -	101	Hake, - - -	2
Plaice, - - -	4	Ling, - - - -	1
Common Dab, - -	130	Gurnard, - - -	46
Long Rough Dab, -	705	Norway Pout, - -	432
Whiting, - - -	339	*Gadus luscus*, - -	7
Haddock, - - -	29	*Callionymus maculata*, -	2
Codling, - - -	4	*Lumpenus lampetriformis*,	3

Smith Bank was then visited, and a haul with the small-meshed net attached was made in twenty-one fathoms for one hour. The tying of the outer net was defective; the knot slipped, and all the fish escaped. In the cod-end were thirty-three haddocks, three cod, five plaice, one lemon dab, five common dabs, and an angler.

The quantity of fish landed by the vessel, as recorded on returning to port amounted to 218¼ cwts., as follows:—

Cod.	Codling.	Haddock.	Turbot.	Brill.
18	3½	58	½	6
Plaice.	**Dabs.**	**Witch.**	**Skate.**	**Angler.**
115	3½	¾	11	2

VII.

The next series of trawling investigations was made on board the "Lochryan," on 11th and 12th December, in Aberdeen Bay, a strong breeze blowing from the south, with a rough sea and rain. The catches were small, but, as often occurs in such conditions of weather, a considerable number of cod were secured. Three recorded hauls were made off the Black Dog in from four and a half to ten fathoms of water, the duration of the actual trawling being twelve hours and ten minutes. The total number of fishes caught in each haul was respectively 344, 243, and 191, the aggregate being 778, with the very low average per hour's fishing of 63·9. The marketable numbered 702, giving an average per hour of 57·7, and the unmarketable numbered seventy-six. The hourly average for cod was 13·0 and for codling 24·5, while it was only 16·8 for haddocks and 1·6 for plaice. The numbers of the various kinds taken were as follows:—

	Cod.	Codling.	Haddock.	Whiting.	Coal-fish.	Brill.	Plaice.	Com. Dab.	Starry Ray.
I.	158	298	205	14	-	1	19	7	-
II.	-	-	-	21	5	-	-	-	50
Total	158	298	205	35	5	1	19	7	50

Two hauls were also made with the small-meshed net around the cod-end of the otter-trawl. In the first of these, which lasted for one hour and twenty minutes, and was made in from eight to twelve fathoms, the total catch was one cod, four codlings, fourteen whitings, two common dabs, one sand-eel, one goby, twenty-two small herrings (from one and three-quarter inches to nearly five inches), and seventy-four sprats. In the second, on the same grounds for one hour, but in seven fathoms, only a single fish—a starry ray—was taken.

VIII.

Towards the end of December another series of trawling investigations was carried on in Aberdeen Bay and the Moray Firth, on board the steam-trawler "Star of the Ocean." Several hauls were taken in Aberdeen Bay on the 23rd and 24th of the month, off Slains Castle, in from ten to thirty fathoms, but the net was usually torn, and the catches were very poor. In the first, which lasted for four hours and twenty minutes, 206 fishes were caught, 182 being marketable. Seventy-seven cod were taken, but only seven haddocks and sixty-six plaice, most of the latter being "thirds." In the next drag, for three hours and a half, the catch was reduced to 108 fishes, twenty-three being cod, and there was the same number of plaice, but only five haddocks. The catch of the third haul was still less, viz. sixty fish, twenty-six being cod, eight haddocks, and eleven plaice. In each case, however, the net was torn on the bottom. Two other unrecorded hauls were made, and the aggregate quantity of fish landed from the five hauls amounted to $30\frac{1}{8}$ cwts., viz. 22 cwts. of cod, $2\frac{3}{4}$ cwts. of codlings, $2\frac{3}{4}$ cwts. of haddocks, $1\frac{3}{8}$ cwts. of plaice, and $1\frac{1}{4}$ cwts. of skates.

On the 25th a number of drags were taken at Burghead Bay, in the Moray Firth, the wind being light, from the south-west, and the weather foggy, and with much better results. In the first of the two recorded, which was in from eight to eleven fathoms, for five hours and five minutes, 1149 fishes were taken, 353 marketable and 796 unmarketable. The catch was chiefly made up of haddocks, mostly small; of a total of 727, the number thrown overboard as unmarketable was 604; there were only three large and no mediums. The second haul, for five hours and ten minutes, yielded 3055 fishes, of which 784 were marketable and 2271 unmarketable. The total number of haddocks captured was 2458, and of these 2086 were too small to be marketable. In the two hauls, the time of fishing being ten hours and fifteen minutes, 4204 fishes were taken, 1137 marketable and 3067 unmarketable. The numbers of the two classes are as follows:—

	Cod.	Codling.	Haddock.	Whiting.	Plaice.	Brill.	Com. Dab.	Turbot.	Lemon Dab.	Gurnard.	Long Rough Dab.
I.	12	9	495	196	366	21	35	2	1	-	-
II.	-	26	2,690	228	14	-	91	-	-	11	7
Total	12	35	3,185	424	380	21	126	2	1	11	7

The very foggy weather which prevailed interfered with fishing operations near the shore; partly for this reason the vessel shifted its position and made a haul in from sixteen to twenty-five fathoms off Tarbet Ness. The drag lasted for one hour and forty-five minutes, and it was found that the net was considerably torn. The catch was small, amounting to 543 fishes, of which 431 were marketable and 112 unmarketable. The number of haddocks taken was 338, of which 315 were marketable; there were seventy plaice, fifty-two being marketable, thirteen marketable codlings, five coal-fish, forty-two whitings, twenty-seven marketable, as well as six lemon dabs and sixty-three common dabs.

Two or three hauls were then made in the Dornoch Firth, in from seven to twelve fathoms, but the work was difficult owing to the thick fog, and in one of the drags the net was foul and came up without any fish. In a recorded haul, which lasted for four hours, the number of fishes caught was 1095, of which the marketable amounted to 933 and the unmarketable to 162. The catch included 825 haddocks, all but 55 being marketable, as well as eight cod, two turbot, four brill, 148 plaice, and some dabs. On the 27th a haul was made for sixty-five minutes, in from eight to ten fathoms, with the small-meshed net, around the cod-end. The total number of fishes taken in the two nets was 880, belonging to sixteen species. On the following day another similar drag was taken with the small-meshed net for an hour, and they may be both considered together. The following is a list of the numbers of each kind of fish caught in the two drags, nineteen species being represented, and the total being 3657 fishes:—

Plaice, ...	122	Gurnard, ...	10
Lemon Dab, ...	4	Sprat, ...	808
Common Dab, ...	845	Herring, ...	4
Long Rough Dab, ...	24	Pogge, ...	8
Little Sole, ...	18	*Gobius minutus*, ...	2
Brill, ...	4	Dragonet, ...	4
Witch, ...	1	Common Pipe-fish, ...	3
Cod, ...	20	Angler, ...	8
Haddock, ...	·57	Thornback, ...	7
Whiting, ...	1,708		

From the Dornoch the vessel steamed to the grounds off Lybster, where a drag was made for four hours and a quarter in from eighteen to twenty-two fathoms. The net was found to have been badly split on coming up, and the catch was very small, amounting to only sixty-two fishes, all marketable. The catch included two cod, forty-four haddocks, and a few plaice and whitings.

The next place visited was Smith Bank, where a haul was made in twenty-seven and twenty-eight fathoms, on the edge of the bank, for sixty-five minutes, the small-meshed net being around the cod-end. The total number of fishes taken was considerable, viz. 1673, and they belonged to twenty-one species; some of them, as the young conger (*Leptocephalus*) and the thick-back sole, were of much scientific interest.

Plaice, ...	19	Sprat, ...	6
Lemon Dab, ...	20	Gurnard, ...	8
Common Dab, ...	1,124	Goby (sp.), ...	6
Little Sole, ...	47	Pogge, ...	8
Thickback, ...	1	Gemmeous Dragonet, ...	14
Long Rough Dab, ...	3	Spotted Dragonet, ...	2
Haddock, ...	25	Sand-eel, ...	54
Whiting, ...	141	*Leptocephalus*, ...	1
Cod, ...	38	Piked Dog-fish, ...	1
Norway Pout, ...	153	Starry Ray, ...	1
Poor Cod, ...	1		

From the commercial point of view, however, the fishing on Smith Bank was not of a profitable kind, and the vessel returned to Burghead Bay on the 28th, where a number of hauls were taken, three of which were completely recorded. In the first, which was for five hours and a quarter, in from five to thirteen fathoms, 1198 fishes were taken, of which 567 were marketable and 631 unmarketable. The catch included nine cod, thirty-two codlings, all but seven marketable, 713 haddocks, the majority being again very small and 540 of them unmarketable, three turbot, thirty-seven brill, 306 plaice, all marketable, and a few others.

The second drag, for five hours, yielded only 269 fishes, of which 110 were marketable. Of 120 haddocks caught only three were marketable, and the other marketable fishes comprised one turbot, nine brill, sixty-three plaice, and twenty-seven common dabs. The third haul, in from four and a half to ten fathoms, was even less productive, only 193 fishes being caught, of which 111 were marketable and 82 unmarketable. None of the fifty-six haddocks taken were marketable, but there were seven brill and ninety-nine plaice, a cat-fish, two cod, and a thornback ray.

In the three hauls, occupying altogether fourteen hours and a quarter of actual fishing, only 1660 fishes were taken, 788 being marketable and 872 unmarketable. The general average per hour's fishing is thus a very low one, viz. 116·5, while the average for the marketable alone is 55·3. The particulars regarding the different kinds of fish are given in the following Table:—

	Cod.	Codling.	Haddock.	Whiting.	Plaice.	Turbot.	Brill.
I.	18	25	176	-	468	4	53
II.	-	16	713	40	-	-	-
Total	18	41	889	40	468	4	53

	Common Dab.	Lemon Dab.	Gurnard.	Cat-fish.	Long Rough Dab.	Thorn-back.
I.	37	3	-	2	-	2
II.	79	-	22	-	2	-
Total	116	3	22	2	2	2

A haul with the small-meshed net was also taken in Burghead Bay for seventy-five minutes, in from five to twelve fathoms, and the total number of fish caught was only 173, as follows:—

Plaice, ...	45	Whiting, ...	59
Common Dab, ...	11	Sprat, ...	7
Brill, ...	4	Herring, ...	3
Turbot, ...	1	Long Rough Dab, ...	1
Cod, ...	6	Sand-eel, ...	2
Haddock, ...	34		

Another drag with the small-meshed net was taken on the so-called "witch ground" between Burghead Bay and the Suters of Cromarty, in thirty and thirty-one fathoms, and it lasted for an hour. The total number of fishes caught was 2112, belonging to twenty species. The numbers of each kind are as follows:—

Halibut, ...	1	Norway Pout, ...	307
Witch, ...	73	Hake, ...	2
Plaice, ...	6	Herring, ...	31
Common Dab, ...	151	Sprat, ...	356
Long Rough Dab, ...	696	Sand-eel, ...	1
Thickback Sole, ...	1	*Lumpenus*, ...	6
Cod, ...	3	Goby (sp.)	1
Haddock, ...	1	Angler, ...	1
Whiting, ...	470	Starry Ray, ...	3
Gurnard, ...	1	Thornback, ...	1

Before the vessel left the Moray Firth a few hauls were taken at night off Lossiemouth in twenty and twenty-one fathoms, but the net suffered much and was usually found split when it was hauled. The particulars of these hauls were not recorded; but in the first the catch included two baskets of large haddocks, one basket of mediums, and three baskets of thirds, as well as two cod, twenty lemon dabs, half a basket of plaice, and half a basket of whitings. The offal thrown overboard consisted of seven basketfuls, mostly of small haddocks.

On the way to port a small-meshed drag was taken in Aberdeen Bay on 29th December. It was made in from eight to seventeen fathoms, and lasted for an hour. The total number of fishes caught was 4270, the great bulk consisting of small whitings. The numbers of the various species are as follows:—

Plaice, ...	10	Herring, ...	16
Common Dab, ...	5	Sprat, ...	39
Long Rough Dab, ...	5	Gurnard, ...	1
Haddock, ...	173	Pogge, ...	2
Cod, ...	9	Liparis, ...	2
Whiting, ...	4,007	Sand-eel, ...	1

The total quantity of fish, in cwts., landed from this trip was recorded by the Fishery Officer as follows:—

Cod.	Codling.	Coal-fish.	Haddock.	Whiting.	Turbot.	Halibut.
$13\frac{1}{2}$	2	$\frac{1}{2}$	$27\frac{3}{4}$	$3\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{8}$
Brill.	**Lemon Dab.**	**Plaice.**	**Dabs.**	**Witches.**	**Cat-fish.**	**Skate.**
$1\frac{1}{4}$	1	$28\frac{1}{4}$	$1\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	1

The quantity was small, considering the duration of fishing, but the foggy weather which prevailed for a large part of the time somewhat hampered the operations. It was noticed also that young herrings and sprats did not form so large a proportion of the small fishes caught in the small-meshed net as was usually the case. Foreign trawlers, moreover, were observed to be fishing in some numbers in the Firth at the time, and three of them were working along with us on Smith Bank.

IX.

In August a record was kept of the hauls made by the steam-trawler "Glenogil" on the fishing grounds lying off the mouth of the Firth of Forth. The vessel left Aberdeen on the 17th August, and ran for about sixty miles on a course S. ½ E. from Girdleness, and continued fishing southwards for several days, landing the catches at Granton, to about thirty-four miles S.E. of the Isle of May. The weather was good and the sea calm. The grounds visited on this trip, as may be seen from a chart, lie off St. Abb's Head and the coast of Berwickshire and Northumberland, and are much fished by the trawlers belonging to Granton.

The first drag was made in thirty-four and thirty-five fathoms, about thirty miles E. ½ S. of the Isle of May, and it lasted for three hours. The catch was a moderate one, the number of fishes taken being 608, of which only 381 were marketable. They consisted almost entirely of haddocks, which numbered 519, the marketable numbering 360; the other marketable fishes were seven codlings, nine whitings, and five lemon dabs. The unmarketable were made up of haddocks, whitings, and gurnards. The next three shots were much the same both in regard to species and amount, the bulk of the catches being composed of haddocks, but there were in addition a few cod, coal-fish, plaice, and ling. Afterwards the catches improved. In the sixth haul, which was for three hours and five minutes, 2145 fishes were captured, 1713 being marketable. The haddocks numbered 1755, of which 1535 were marketable; there were also 130 marketable whitings, one cod, nineteen codlings, twelve plaice, and sixteen lemon dabs. The unmarketable consisted entirely of haddocks, whitings, and gurnards.

Succeeding hauls were nearly as productive, the totals varying from 1243 to 2991, the duration of the drags being generally a little over three hours. In all of them haddocks formed the great bulk of the catch, the rest of the marketable fishes being made up of whitings, codlings, a few cod, ling, and coal-fishes; the flat-fishes were represented by small numbers of lemon dabs, plaice, and common dabs.

Altogether, in twelve hauls, up to the afternoon of the 19th August, the time of actual fishing being thirty-nine hours and twenty minutes, the number of fishes caught was 17,569, of which 13,874 were marketable and 3695 unmarketable. The average number taken per hour's fishing was 353·0 for the marketable, 94·0 for the unmarketable, and 447·1 for both combined.

The totals of each kind are given in the following Table, the marketable (I.) being distinguished from the unmarketable (II.):—

	Cod.	Codling.	Haddock.	Whiting.	Coal-fish.	Ling.	Hake.
I.	27	373	12,464	711	19	8	1
II.	-	89	2,264	695	-	-	-
Total	27	462	14,728	1,406	19	8	1

	Plaice.	Lemon Dab.	Common. Dab.	Long Rough Dab.	Gurnard.	Angler.
I.	92	176	3	-	-	-
II.	-	-	35	85	514	13
Total	92	176	38	85	514	13

The haddocks were by far the most important part of the catch, the average number taken per hour being 374·7 ; the rate for the marketable was 317·1 and for the unmarketable 57·6. The particulars for the majority of the fishes, showing the rate per hour, are as follows :—

	Marketable.	Unmarketable.	Total.
Haddock, ...	317·1	57·6	374·7
Whiting, ...	18·1	17·6	35·8
Codling, ...	9·5	2·2	11·7
Lemon Dab, ...	4·5	–	4·5
Plaice, ...	2·3	–	2·3
Gurnard, ...	–	13·1	13·1

On the 20th and 21st August a number of other hauls were made about fifty miles E. by S. from the Isle of May, off the coast of Northumberland, in from thirty-four to thirty-six fathoms. The catch was of much the same character, consisting mostly of haddocks, with some whitings, codlings, plaice, lemon dabs, common dabs, gurnards, and an occasional cod.

The record of one of the hauls was not completely taken, the unmarketable fishes being omitted, but in the other four, the time of actual fishing being thirteen hours and twenty minutes, 7257 fishes were taken, the number of marketable being 6342 and of unmarketable 915. The average per hour's fishing was thus 476·8 for the marketable and 68·8 for the unmarketable, the general average being 545 6. The total number of haddocks caught was 6292, of which 5811 were marketable; 443 whitings were taken, 294 being marketable, 140 codlings, forty plaice, eighty-one lemon dabs, and some others.

The averages per hour's fishing agree very well with those of the previous hauls above referred to :—

	Marketable.	Unmarketable.	Total.
Haddock, ...	436·9	36·1	473·1
Whiting, ...	22·1	12·2	33·3
Codling, ...	8·1	2·4	10·5
Lemon Dab, ...	6·0	–	6·0
Plaice, ...	3·0	–	3·0
Gurnard, ...	–	12·4	12·4

[TABLES.

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Surface.	Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Over-board.	Total No.	Remarks.
1. Burghead Bay. Burghead Pier light bearing S.S.E. 4 miles.	1903. Feb. 7.	..	..	..	17 to 20	7.30 p.m.	11.45 p.m.	Cod, ...	8	..	8	Strong N.N.W. breeze. Sea moderate.
								Codling, ...	7	..	7	
								Haddock, ...	5	..	5	
								Whiting, ...	..	7	7	
								Brill, ...	1	..	1	
								Plaice, ...	50	..	50	
								Witch, ...	86	8	94	
								Com. Dab,.. ..	12	14	26	
								Grey Skate, ..	..	6	6	
								Starry Ray, ..	..	1	1	
								Angler, ...	4	18	22	
								Dragonet, ...	..	1	1	
									173	55	228	
2. Burghead Bay. Burghead Pier light bearing S.S.E. 4 miles.	Feb. 8.	..	..	..	17 to 20	12.0 p.m.	4.0 a.m.	Cod, ...	14	..	14	
								Codling, ...	4	..	4	
								Haddock, ...	42	..	42	
								Whiting, ...	19	..	19	
								Halibut, ...	1	..	1	
								Turbot, ...	1	..	1	
								Brill, ...	3	..	3	
								Plaice, ...	128	..	128	
								Lemon Dab, ..	14	..	14	
								Witch, ...	191	..	191	
								Com. Dab,.. ..	31	105	136	
								Long Rough Dab,	..	84	84	
								Cat-fish, ...	2	..	2	
								Thornback, ..	3	2	5	
								Starry Ray, ..	2	2	4	
								Angler, ...	8	36	44	
									463	229	692	
3. Burghead Bay. Burghead Pier light bearing S S.E. 4–5 miles.	,,	..	..	..	18 to 25	4.30 a.m.	8.35 a.m.	Cod, ...	23	..	23	Net had small split.
								Codling, ...	55	5	60	
								Ling, ...	2	..	2	
								Coal-fish, ...	1	..	1	
								Haddock, ...	88	7	95	
								Whiting, ...	23	..	23	
								Plaice, ...	21	..	21	
								Lemon Dab, ..	38	..	38	
								Witch, ...	197	52	249	
								Com. Dab,.. ..	5	97	102	
								Long Rough Dab,	..	53	53	
								Cat-fish, ...	2	..	2	
								Thornback, ..	4	..	4	
								Starry Ray, ..	3	..	3	
								Angler, ...	14	33	47	
								Herring, ...	..	2	2	
									476	249	725	
4. Burghead Bay. Burghead Pier light bearing S.E. and by E. 5–6 miles.	,,	..	..	..	20 to 30	10.10 a.m.	2.30 p.m.	Cod, ...	59	..	59	Light wind W. and by S.
								Codling, ...	25	2	27	
								Ling, ...	1	..	1	
								Coal-fish, ...	11	..	11	
								Haddock, ...	89	..	89	
								Whiting, ...	7	87	94	
								Brill, ...	1	..	1	
								Plaice, ...	88	..	88	
								Lemon Dab, ..	6	..	6	
								Witch.	273	..	273	
								Com. Dab,.. ..	22	172	194	
								Long Rough Dab,	..	101	101	
								Thornback, ..	1	..	1	
								Angler, ...	3	7	10	
								Herring, ...	..	74	74	
									586	443	1029	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Over-board.	Total No.	Remarks.
5. Burghead Bay.	1903. Feb. 8.	..	..	..	20 to 30	3.25 p.m.	4.55 p.m.	Cod,	12	..	12	Gear fouled.
								Codling,	5	..	5	
								Haddock,	5	..	5	
								Whiting,	..	5	5	
								Plaice,	6	..	6	
								Witch,	72	..	72	
								Com. Dab,	2	2	4	
									102	7	109	
6. Same Place.	,,	..	..	..	,,	5.25 p.m.	9.30 p.m.	Cod,	28	..	28	
								Codling,	8	..	8	
								Coal-fish,	6	..	6	
								Haddock,	46	4	50	
								Whiting,	..	7	7	
								Plaice,	81	..	81	
								Lemon Dab,	2	..	2	
								Witch,	422	..	422	
								Com. Dab,	19	162	181	
								Long Rough Dab,	..	109	109	
								Thornback,	3	..	3	
								Angler	18	26	44	
								Red Gurnard	..	1	1	
									633	309	942	
7. Same Place.	Feb. 8 & 9.	..	..	..	,,	10.0 p.m.	2.45 a.m.	Cod,	12	..	12	
								Codling,	6	..	6	
								Coal-fish,	1	1	2	
								Haddock,	85	..	85	
								Gurnard	..	1	1	
								Plaice,	44	..	44	
								Lemon Dab,	3	..	3	
								Witch,	326	11	337	
								Com. Dab,	21	176	197	
								Long Rough Dab,	..	132	132	
								Starry Ray,	4	2	6	
								Angler,	19	31	50	
								Red Gurnard,	..	1	1	
								Herring,	..	1	1	
									521	356	877	
8. Same Place.	Feb. 9.	..	..	..	..	3.0 a.m.	7.30 a.m.	Cod,	10	..	10	Strong E.S.E. wind freshening. Heavy showers of rain and sleet.
								Codling,	12	4	16	
								Coal-fish,	1	..	1	
								Haddock,	38	..	38	
								Whiting,	.	49	49	
								Plaice,	83	..	83	
								Lemon Dab,	10	..	10	
								Witch,	204	118	322	
								Com. Dab,	15	135	150	
								Long Rough Dab,	..	174	174	
								Thornback,	3	..	3	
								Starry Ray,	2	4	6	
								Angler,	39	51	90	
									417	535	952	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Surface.	Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Over-board.	Total No.	Remarks.
9. Six miles East of Cromarty.	1903. Feb. 9.	..	..	..	25 to 30	2.25 p.m.	6.30 p.m.	Cod,	27	..	27	Muddy bottom.
								Codling,	10	..	10	
								Haddock,	198	..	198	
								Whiting,	..	1	1	
								Plaice,	4	..	4	
								Lemon Dab,	2	..	2	
								Witch,	826	67	893	
								Com. Dab,	..	272	272	
								Flounder,	1	..	1	
								Long Rough Dab,	..	367	367	
								Thornback,	25	..	25	
								Starry Ray,	29	..	29	
								Angler,	3	6	9	
								Sprat,	..	2	2	
									1125	715	1840	
10. Same Place.	,,	..	..	..	..	6.55 p.m.	11.10 p.m.	Cod,	5	..	5	Net badly split.
								Codling,	3	..	3	
								Ling,	1	..	1	
								Haddock,	21	..	21	
								Whiting,	1	2	3	
								Plaice,	1	..	1	
								Lemon Dab,	5	..	5	
								Witch,	162	117	279	
								Com. Dab,	..	17	17	
								Long Rough Dab,	..	11	11	
								Cat-fish,	1	..	1	
								Starry Ray.	6	..	6	
								Thornback,	2	..	2	
									208	147	355	
11. Same Place.	Feb. 10.	..	..	..	..	12.25 a.m.	5.15 a.m.	Cod,	22	..	22	Fresh S.W. breeze.
								Codling,	9	..	9	
								Haddock,	159	..	159	
								Whiting,	..	14	14	
								Brill,	1	..	1	
								Plaice,	7	..	7	
								Lemon Dab,	4	..	4	
								Witch,	414	76	490	
								Com. Dab,	..	263	263	
								Long Rough Dab,	..	112	112	
								Starry Ray,	48	4	52	
								Thornback,	23	..	23	
								Cat-fish,	1	..	1	
								Angler,	..	3	3	
									688	472	1160	
12. Five miles East of Cromarty	,,	..	..	..	..	5.45 a.m.	10.30 a.m.	Cod,	54	..	54	S. W. gale.
								Codling,	5	..	5	
								Coal-fish,	1	.	1	
								Haddock,	86	..	86	
								Whiting,	..	11	11	
								Brill,	1	..	1	
								Sole,	1	..	1	
								Plaice,	6	..	6	
								Lemon Dab,	2	..	2	
								Witch,	958	121	1,079	
								Com. Dab,	10	543	553	
								Flounder,	1	..	1	
								Long Rough Dab,	..	267	267	
								Starry Ray,	18	..	18	
								Thornback,	10	..	10	
								Sandy Ray,	3	..	3	
								Angler,	2	6	8	
								Herring,	..	1	1	
								Sprat,	..	10	10	
									1158	959	2117	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
13. Off Burghead Bay.	1903. Feb. 12 & 13.	..	..	..	10 to 20	11.40 p.m.	3.50 a.m.	Cod, ...	17	..	17	
								Codling, ...	19	..	19	
								Coal-fish, ...	1	..	1	
								Hake, ...	1	..	1	
								Haddock, ...	54	..	54	
								Whiting, ...	5	3	8	
								Gurnard, ...	..	1	1	
								Brill, ...	4	..	4	
								Plaice, ...	80	..	80	
								Lemon Dab, ..	3	..	3	
								Witch, ...	709	125	834	
								Com. Dab, ...	12	307	319	
								Long Rough Dab,	..	118	118	
								Cat-fish, ...	1	..	1	
								Starry Ray, ..	1	1	2	
								Thornback, ..	..	1	1	
								Sandy Ray ..	1	..	1	
								Angler, ...	19	32	51	
									927	588	1515	
14. Same Place.	Feb. 12.	..	..	..	10 to 20	4 a.m.	8.10 a.m.	Cod, ...	12	..	12	
								Codling, ...	23	14	37	
								Coal-fish, ...	6	..	6	
								Haddock, ...	32	..	32	
								Whiting, ...	4	26	30	
								Turbot, ...	1	..	1	
								Brill, ...	3	..	3	
								Plaice, ...	115	..	115	
								Lemon Dab, ..	3	..	3	
								Witch, ...	381	254	635	
								Com. Dab, ...	56	542	598	
								Flounder, ...	2	..	2	
								Long Rough Dab,	..	471	471	
								Cat-fish, ...	1	..	1	
								Thornback, ..	1	..	1	
								Starry Ray, ..	..	3	3	
								Sandy Ray, ..	1	..	1	
								Angler, ...	21	32	53	
								Herring, ...	..	5	5	
									662	1347	2009	
15. Dornoch Firth.	Feb. 12.	..	..	..	6 to 12	10.15 a.m.	2.15 p.m.	Cod, ...	2	..	2	
								Codling, ...	7	..	7	
								Haddock	2	..	2	
								Whiting, ...	..	2	2	
								Plaice	254	2	256	
								Witch, ...	2	19	21	
								Com. Dab, ...	24	74	98	
								Flounder, ...	27	..	27	
								Long Rough Dab,	..	28	28	
								Cat-fish, ...	1	..	1	
								Sandy Ray, ..	1	..	1	
								Thornback, ..	1	..	1	
								Angler, ...	1	..	1	
									322	125	447	
16. Same Place.	,,	..	..	..	6 to 12	3.20 p.m.	7.20 p.m.	Cod, ...	4	.	4	
								Codling, ...	2	..	2	
								Brill, ...	4	..	4	
								Plaice	209	..	209	
								Com. Dab, ..	10	116	126	
								Witch, ...	1	2	3	
								Flounder, ...	66	..	66	
								Long Rough Dab,	..	16	16	
								Thornback, ..	5	..	5	
								Grey Skate ..	..	1	1	
									301	135	436	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Over-board.	Total No.	Remarks.
17. Same Place.	1903. Feb. 12 & 13.	..	..	..	..	8.20 p.m.	12.30 a.m.	Cod, ...	7	..	7	
								Coal-fish, ...	1	..	1	
								Haddock, ...	2	..	2	
								Turbot, ...	1	..	1	
								Brill, ...	1	..	1	
								Plaice	223	20	243	
								Com. Dab, ...	28	47	75	
								Flounder, ...	30	..	30	
								Long Rough Dab,	..	63	63	
								Starry Ray, ..	2	..	2	
								Thornback, ..	8	..	8	
								Grey Skate, ..	..	1	1	
									303	131	434	
18. Same Place.	Feb 13.	..	..	..	..	1 a.m.	6 a.m.	Cod, ...	7	..	7	
								Codling, ...	60	..	60	
								Ling, ...	2	..	2	
								Haddock, ...	98	..	98	
								Whiting, ...	1	3	4	
								Plaice, ...	237	..	237	
								Com. Dab, ..	46	155	201	
								Witch, ...	1	..	1	
								Flounder, ...	92	..	92	
								Cat-fish	2	..	2	
								Thornback, ..	4	..	4	
								Red Gurnard, ..	..	1	1	
								Herring, ...	..	1	1	
									550	160	710	
19. Aberdeen Bay, off Newburgh.	,,	..	..	..	8 to 10	7.5 p.m.	11.5 p.m.	Cod, ...	1	..	1	
								Codling, ...	13	..	13	
								Haddock, ...	15	..	15	
								Whiting, ...	..	52	52	
								Plaice, ...	3	..	3	
								Lemon Dab, ..	2	..	2	
								Com Dab, ..	..	23	23	
								Flounder, ...	1	..	1	
								Witch, ...	..	14	14	
								Thornback, ..	..	24	24	
								Grey Skate, ..	..	6	6	
								Angler, ...	..	1	1	
									35	120	155	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
1. Aberdeen Bay, off Newburgh.	1903. Mar. 16.	..	..	..	13 to 19	2.50 a.m.	6.50 a.m	Cod,	123	..	123	Wind S.S.E.
								Codling,	195	..	195	
								Haddock,	4	..	4	
								Gurnard,	..	1	1	
								Plaice,	156	28	184	
								Flounder,	..	2	2	
								Thornback,	..	5	5	
									478	36	514	
2. Same Place.	,,	..	..	..	12 to 18	7.20 a.m.	11.40 a.m.	Cod,	8	..	8	Heavy Sea.
								Codling,	4	..	4	
								Coal-fish,	1	..	1	
								Haddock,	84	8	92	
								Whiting,	..	7	7	
								Plaice	20	2	22	
								Lemon Dab,	4	..	4	
								Witch,	..	2	2	
								Com. Dab,	..	3	3	
								Starry Ray,	..	1	1	
								Grey Skate,	..	16	16	
								Thornback,	..	45	45	
									121	84	205	
3. Aberdeen Bay. Newburgh to Donmouth.	,,	..	..	..	8 to 16	12.15 p.m.	4.20 p.m.	Cod,	47	..	47	
								Codling,	126	..	126	
								Coal-fish,	1	..	1	
								Haddock,	3	..	3	
								Plaice,	92	53	145	
								Witch,	..	2	2	
								Com. Dab,	..	30	30	
								Flounder,	..	12	12	
								Grey Skate,	..	1	1	
								Thornback,	..	7	7	
								Lumpsucker,	..	1	1	
									269	106	375	
4. Moray Firth. Burghead. Bay.	Mar. 17.	..	..	..	7 to 12	4.35 p.m	8.25 p.m.	Cod,	4	..	4	
								Codling,	3	1	4	
								Haddock,	2	..	2	
								Turbot,	1	..	1	
								Brill,	11	..	11	
								Plaice	329	..	329	
								Com. Dab,	70	204	274	
								Flounder,	14	..	14	
								Cat-fish,	3	..	3	
								Gurnard,	..	1	1	
								Thornback,	..	4	4	
								Starry Ray,	..	2	2	
								Angler,	2	1	3	
									439	213	652	
5. Same Place.	Mar. 17 & 18.	..	..	..	..	9 p.m.	1.15 a.m.	Cod,	2	..	2	
								Codling,	4	3	7	
								Haddock,	..	44	44	
								Whiting,	..	32	32	
								Brill,	5	1	6	
								Plaice,	226	..	226	
								Lemon Dab,	1	..	1	
								Com. Dab,	56	264	220	
								Flounder,	8	..	8	
								Cat-fish,	4	..	4	
								Thornback,	3	12	15	
								Starry Ray,	4	2	6	
								Sandy Ray,	3	4	7	
								Angler,	..	24	24	
								Herring,	..	3	3	
									316	389	705	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Surface.	Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No thrown Overboard.	Total No.	Remarks.
6. Same Place.	1903 Mar. 18.	..	..	..	..	2 a.m.	6 a.m.	Cod, ..	1	..	1	
								Codling, ..	6	..	6	
								Haddock ..	..	1	1	
								Whiting, ..	..	8	8	
								Brill, ..	4	..	4	
								Plaice, ..	426	43	469	
								Com. Dab, ..	137	261	398	
								Lemon Dab, ..	9	..	9	
								Flounder, ..	17	..	17	
								Cat-fish, ..	2	..	2	
								Thornback, ..	4	..	4	
								Starry Ray, ..	1	10	11	
								Sandy Ray, ..	..	1	1	
								Angler, ..	..	12	12	
								Lumpsucker, ..	..	1	1	
								Herring, ..	..	4	4	
									607	341	948	
7. Dornoch Firth, off Golspie.	,,	..	..	..	8 to 16	8.15 a.m.	12.20 p.m.	Cod, ..	24	..	24	
								Codling, ..	5	..	5	
								Haddock, ..	2	..	2	
								Whiting, ..	1	..	1	
								Brill, ..	2	..	2	
								Plaice, ..	369	5	374	
								Lemon Dab, ..	3	..	3	
								Com. Dab, ..	71	143	214	
								Flounder, ..	317	25	342	
								Cat-fish, ..	10	..	10	
								Thornback, ..	14	..	14	
								Starry Ray, ..	3	2	5	
								Sandy Ray, ..	1	..	1	
								Angler, ..	..	1	1	
								Lumpsucker, ..	..	1	1	
									822	177	999	
8. ,,	,,	.	..	..	,,	12.40 p.m.	4.40 p.m.	Cod, ..	16	..	16	
								Haddock, ..	5	..	5	
								Plaice, ..	57	..	57	
								Lemon Dab, ..	2	..	2	
								Com. Dab, ..	12	51	63	
								Flounder, ..	52	4	56	
								Cat-fish, ..	1	..	1	
								Thornback, ..	3	..	3	
								Lumpsucker, ..	..	1	1	
								Herring, ..	..	3	3	
								Sprat, ..	..	22	22	
									148	81	229	
9. ,,	..	..	..	..	,,	4.50 p.m.	9 p.m.	Cod, ..	100	..	100	
								Codling, ..	110	..	110	
								Plaice, ..	174	3	177	
								Lemon Dab, ..	11	..	11	
								Com. Dab, ..	45	315	360	
								Flounder, ..	51	19	70	
								Cat-fish, ..	3	..	3	
								Thornback, ..	5	..	5	
								Grey Skate, ..	1	..	1	
								Angler ..	..	1	1	
									500	338	838	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
10. Dornoch Firth. Off Golspie.	1903. Mar. 18-19.	..	..	..	..	9.30 p.m.	1.50 a.m.	Cod, ...	38	..	38	Net badly split.
								Codling, ...	1	..	1	
								Coal-fish, ...	1	..	1	
								Haddock, ...	1	..	1	
								Plaice, ...	47	3	50	
								Com. Dab,.. ..	5	39	44	
								Flounder, ...	16	6	22	
								Thornback, ..	1	1	2	
								Starry Ray, ..	1	..	1	
									111	49	160	
11. Smith Bank.	Mar. 19.	..	..	..	19 to 28	7.15 a.m.	11.15 a.m.	Cod, ...	11	..	11	
								Codling, ...	2	..	2	
								Hake, ...	..	1	1	
								Haddock, ...	141	82	223	
								Whiting, ...	27	..	27	
								Halibut, ...	1	..	1	
								Plaice, ...	40	..	40	
								Lemon Dab, ..	14	1	15	
								Witch, ...	16	28	44	
								Megrim, ...	2	..	2	
								Com. Dab,.. ..	..	221	221	
								Cat-fish, ...	2	..	2	
								Gurnard, ...	..	117	117	
								Grey Skate, ..	6	2	8	
								Thornback, ..	..	7	7	
								Angler, ...	..	5	5	
									262	464	726	
12. Same Place.	„	..	..	..	..	11.45 a.m.	3.45 p.m.	Cod, ...	30	..	30	
								Codling, ...	6	11	17	
								Coal-fish, .. :	1	..	1	
								Haddock, ...	499	75	574	
								Whiting, ...	2	..	2	
								Plaice, ...	69	..	69	
								Lemon Dab, ..	54	4	58	
								Com. Dab, ..	1	122	123	
								Witch, ...	1	16	17	
								Long Rough Dab,	..	89	89	
								Cat-fish, ...	7	..	7	
								Gurnard, ...	..	24	24	
								Red Gurnard, ..	..	2	2	
								Grey Skate, ..	..	2	2	
								Angler, ...	..	1	1	
									670	346	1016	
13. Same Place.	Mar. 19.	..	..	..	..	4 p.m.	8 p.m.	Cod, ...	28	..	28	
								Codling, ...	6	11	17	
								Coal-fish, ...	1	..	1	
								Haddock, ...	406	973	1,379	
								Whiting, ...	..	27	27	
								Halibut, ...	1	..	1	
								Plaice, ...	90	..	90	
								Lemon Dab, ..	108	3	111	
								Com. Dab. ..	2	214	216	
								Witch, ...	1	..	1	
								Flounder, ...	2	..	2	
								Long Rough Dab,	..	50	50	
								Cat-fish, ...	3	..	3	
								Thornback, ..	..	7	7	
								Angler, ..	..	1	1	
									648	1286	1934	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
14. Smith Bank.	1903. Mar. 19-20.	..	..	..	..	8.15 p.m.	12.30 a.m.	Cod, ...	62	..	62	
								Haddock, ...	..	333	333	
								Whiting, ...	1	125	126	
								Plaice, ...	44	..	44	
								Lemon Dab, ..	52	2	56	
								Com. Dab, ...	..	139	139	
								Witch, ...	1	..	1	
								Megrim, ...	1	..	1	
								Long Rough Dab,	..	118	118	
								Cat-fish, ...	5	..	5	
								Gurnard, ...	..	4	4	
								Red Gurnard, ..	..	2	2	
								Dragonet, ...	..	1	1	
								Grey Skate, ..	..	2	2	
								Thornback, ..	..	3	3	
								Angler, ...	..	6	6	
									166	735	901	
15. Same Place.	Mar. 20.	..	..	..	..	1 a.m.	5.10 a.m.	Cod, ...	23	..	23	
								Coal-fish, ...	2	..	2	
								Haddock, ...	3	124	127	
								Whiting, ...	..	216	216	
								Brill, ...	1	..	1	
								Plaice, ...	54	..	54	
								Lemon Dab, ..	11	..	11	
								Com. Dab, ...	..	130	130	
								Witch, .. .	3	..	3	
								Long Rough Dab,	..	71	71	
								Thornback, ..	1	9	10	
								Grey Skate, ..	2	..	2	
								Gurnard, ...	..	4	4	
								Red Gurnard, ..	..	5	5	
								Angler, ...	..	5	5	
									100	564	664	
16. Off Lossiemouth.	,,	..	..	..	7 to 14	2 p.m.	4 p.m.	Haddock, . ..	3	2	5	Net badly split.
								Whiting, ...	..	5	5	
								Plaice, ...	45	3	48	
								Com. Dab, ..	5	8	13	
								Flounder, ...	2	2	4	
								Cat-fish, ...	1	..	1	
								Gurnard, ...	..	1	1	
									56	21	77	
17. Same Place.	,,	..	..	..	..	7 p.m.	11 p.m.	Cod, ...	50	..	50	
								Codling, ...	25	..	25	
								Coal-fish, ...	3	..	3	
								Haddock, ...	3	..	3	
								Whiting, ...	2	..	2	
								Brill, ...	3	..	3	
								Plaice, ...	325	9	334	
								Lemon Dab, ..	6	..	6	
								Com. Dab, ..	24	185	209	
								Flounder, ...	103	32	135	
								Cat-fish, ...	4	..	4	
								Thornback, ..	8	..	8	
								Grey Skate, ..	..	2	2	
									556	229	785	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
18. Off Lossiemouth.	1903. Mar. 20.	..	..	..	..	11.15 p.m.	3.30 a.m.	Cod, ...	77	..	77	
								Codling, ...	147	..	147	
								Coal-fish, ...	2	..	2	
								Haddock, ..	6	..	6	
								Halibut, ...	1	..	1	
								Brill, ...	1	..	1	
								Plaice, ...	190	..	190	
								Lemon Dab, ..	5	1	6	
								Com. Dab, ..	24	117	141	
								Flounder, ...	108	..	108	
								Cat-fish, ...	8	..	8	
								Thornback, ..	1	..	1	
								Grey Skate, ..	..	1	1	
								Angler, ...	..	1	1	
									570	120	690	
19. Same Place.	Mar. 21.	..	..	..	..	4 a.m.	9 a.m.	Cod, ...	27	..	27	Net badly split.
								Codling, ...	36	..	36	
								Brill, ...	1	..	1	
								Plaice, ...	69	5	74	
								Lemon Dab, ..	2	1	3	
								Com. Dab,.. ..	10	142	152	
								Flounder, ...	6	2	8	
								Thornback, ..	4	..	4	
								Grey Skate, ..	..	3	3	
									155	153	308	
20. Off Tarbet Ness.	,,	..	..	..	20 to 26	10.25 a.m.	3 p.m.	Cod, ...	18	..	18	Net slightly split.
								Haddock, ...	87	4	91	
								Whiting, ...	9	..	9	
								Plaice, ...	53	2	55	
								Lemon Dab, ..	1	..	1	
								Com. Dab, ..	4	41	45	
								Gurnard, ...	..	1	1	
								Conger, ...	1	..	1	
								Starry Ray, ..	1	..	1	
									174	48	222	
21. Same Place.	..	..	..	..	..	4.15 p.m.	8.25 p.m.	Cod, ...	48	..	48	
								Haddock, ...	12	149	161	
								Whiting, ...	..	54	54	
								Plaice, ...	66	3	69	
								Lemon Dab, ..	1	2	3	
								Com. Dab,.. ..	2	57	59	
								Long Rough Dab,	..	45	45	
								Cat-fish, ...	1	..	1	
								Gurnard, ...	..	4	4	
								Red Gurnard, ..	..	1	1	
								Grey Skate, ..	..	2	2	
								Angler, ...	..	1	1	
								Herring, ...	..	1	1	
									130	319	449	
22. Same Place.	Mar. 21-22.	..	..	..	..	9 p.m.	1 a.m.	Cod, ...	76	..	76	
								Coal-fish, ...	1	..	1	
								Haddock, ...	4	36	40	
								Whiting, ...	..	15	15	
								Plaice, ...	68	..	68	
								Com. Dab,.. ..	12	15	27	
								Long Rough Dab,	..	26	26	
								Grey Skate, ..	..	3	3	
								Angler, ...	..	3	3	
									161	98	259	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
1. Moray Firth. Burghead Bay.	1903. June 8.	10·8	12·8	9.4	5 to 8	7.30 p.m.	9.30 p.m.	Cod, ...	1	..	1	Sea smooth; wind, S.W., light; net slightly split.
								Haddock, ..	1	..	1	
								Plaice (1), ...	17	..	..	
								,, (2), ...	23	..	..	
									— 40	9	49	
								Com. Dab, ..	21	42	63	
								Black Sole, ..	1	..	1	
								Gurnard, ...	17	41	58	
								Angler, ...	..	2	2	
									81	94	175	
2. Same Locality.	June 8 & 9.	..	..	..	5 to 9	10.20 p.m.	12.30 a.m.	Codling, ...	1	..	1	A great deal of weed in the net, which was difficult to get clean.
								Plaice (1), ...	14	..	..	
								,, (2), ...	39	..	..	
									— 53	12	65	
								Com. Dab, ..	..	79	79	
								Gurnard, ...	7	23	30	
									61	114	175	
3. Same Locality.	June 9.	10·0	10·8	8·9	4 to 9	7 a.m.	9.30 a.m.	Codling, ...	1	..	1	Calm, foggy
								Whiting, ...	3	..	3	
								Plaice (1), ...	5	..	..	
								,, (2), ...	50	..	..	
									— 55	..	55	
								Com. Dab, ..	..	104	104	
								Cat-fish, ...	2	..	2	
								Gurnard, ...	..	47	47	
								Angler, ...	3	..	3	
									64	151	215	
4. Off Lossiemouth about 3 miles.	,,	10·0	10·3	9·2	11 to 14	1.35 p.m.	2.25 p.m.	Plaice (1), ...	4	..	..	Sea calm, no wind, slight fog; weed in net.
								,, (2), ...	36	..	..	
									— 40	38	78	
								Black Sole, ..	1	..	1	
								Com. Dab, ..	..	87	87	
								Gurnard, ...	..	110	110	
								Angler, ...	..	1	1	
								Sandy Ray, ..	..	1	1	
									41	237	278	
5. Dornoch Firth, off Golspie.	,,	9·6	12·2	9·3	8 to 11	6.10 p.m.	6.38 p.m.	Codling, ...	5	2	7	Small meshed net around cod end.
								Haddock, ...	1	..	1	
								Plaice (1), ...	12	..	..	
								,, (2), ...	9	..	..	
								,, (3), ...	11	..	..	
									— 32	19	51	
								Lemon Dab, ..	2	..	2	
								Com. Dab, ..	..	22	22	
								Cat-fish, ...	1	..	1	
								Gurnard, ...	..	11	11	
									41	54	95	

TRAWLING INVESTIGATIONS—TABLE I.

Place	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Over-board.	Total No.	Remarks.
6. Same Locality.	1903. June 9.	..	..	..	5 to 11	7.25 p.m.	10.7 p.m.	Plaice (1), ...	11	..	..	Calm, slight fog; trawling round Dan.
								,, (2),.. ..	205	..	..	
								,, (3),.. ..	370	..	..	
								,, (4),.. ..	939	..	..	
									—1525	3113	4638	
								Brill, ...	4	..	4	
								Flounder, ...	6	..	6	
								Com. Dab, ..	..	206	206	
								Thornback, ..	20	4	24	
								Gurnard, ...	..	50	50	
									1555	3373	4928	
7. Same Locality.	June 10.	..	..	..	6 to 9	3.0 a.m.	7.0 a.m.	Turbot, ...	1	..	1	8½ baskets of plaice.
								Brill, .. .	1	..	1	
								Plaice (1),.. ..	16	..	..	
								,, (2),.. ..	124	..	..	
								,, (3),.. ..	311	..	..	
								,, (4),.. ..	760	..	..	
									—1211	3306	4517	
								Com. Dab,. ..	85	185	270	
								Lemon Dab, ..	1	..	1	
								Flounder, ...	..	2	2	
								Gurnard, ...	..	43	43	
								Thornback, ..	19	..	19	
								Angler, ...	..	5	5	
									1318	3541	4859	
8. Same Locality.	,,	..	..	..	9 to 13	7.30 a.m.	11.32 a.m.	Cod, ...	2	..	2	
								Codling, ...	..	2	2	
								Plaice (1),.. ..	28	..	..	
								,, (2),.. ..	58	..	..	
								,, (3),.. ..	110	..	..	
								,, (4),.. ..	216	..	..	
									— 412	693	1105	
								Com. Dab, ..	10	..	10	
								Flounder, ...	2	..	2	
								Gurnard, ...	..	17	17	
								Cat-fish, ...	1	..	1	
								Thornback, ..	5	..	5	
									432	712	1144	
9. Same Locality.	,,	11·7	12·0	8·9	9 to 11	12.25 p.m.	1.25 p.m.	Plaice (1),.. ..	3	..	..	Small meshed net; slight breeze from eastwards; sea becoming choppy.
								,, (2),.. ..	24	..	..	
								,, (3),.. ..	46	..	..	
								,, (4),.. ..	9	..	..	
									— 76	22	98	
								Com. Dab,.. ..	.	13	13	
								Gurnard, ...	..	6	6	
								Angler, ...	..	2	2	
									76	43	119	
10. Same Locality.	..		..	..	..	3.15 p.m.	7.15 p.m.	Plaice (1),.. ..	21	..	..	
								,, (2),.. ..	18	..		
								,, (3),.. ..	20	..	.	
								,, (4),.. ..	14	..	.	
									— 73	25	98	
								Com. Dab,.. ..	..	14	14	
								Flounder, ...	1	..	1	
								Gurnard, ...	..	54	54	
									74	93	167	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Over-board.	Total No.	Remarks.
11. Same Locality.	..	..	..	..	8 to 11	7.45 p.m.	11.45 p.m.	Cod, ...	1	..	1	
								Haddock (1), ..	1	..	1	
								Brill, ..	1	..	1	
								Plaice (1), ...	35	..	..	
								,, (2), ...	155	..	..	
								,, (3), ...	194	..	..	
								,, (4), ...	36	..	..	
									— 420	406	826	
								Com. Dab, ..	..	53	53	
								Thornback, ..	1	..	1	
								Gurnard, ...	..	40	40	
								Angler, ...	..	1	1	
									424	500	924	
12. Same Locality.	June 11.	..	..	..	,,	12.30 a.m.	5 a.m.	Haddock, ...	1	..	1	
								Plaice (1), ...	20	..	..	
								,, (2), ...	156	..	..	
								,, (3), ...	150	..	..	
								,, (4), ...	102	..	..	
									— 428	235	663	
								Com. Dab, ...	..	4	4	
								Thornback, ..	..	3	3	
									429	242	671	
13. Same Locality.	,,	..	..	..	,,	5.30 a.m.	7.30 a.m.	Cod, ...	1	..	1	
								Brill, ...	1	..	1	
								Plaice (1), ...	9	..	..	
								,, (2), ...	44	..	..	
								,, (3), ...	46	..	..	
								,, (4), ...	30	..	..	
									— 129	40	169	
								Com. Dab, ...	..	23	23	
								Sprat, ...	..	1	1	
									131	64	195	
14. Same Locality.	,,	10·9	11·8	8·9	,,	8.40 a.m.	12.40 p.m.	Plaice (1), ...	18	...	..	
								,, (2), ...	69	..	..	
								,, (3), ...	134	..	..	
								,, (4), ...	274	..	..	
									— 495	547	1042	
								Com. Dab, ...	32	109	141	
								Gurnard, ...	..	23	23	
								Thornback, ..	1	..	1	
									528	679	1207	
15. Same Locality.	,,	..	..	..	,,	1.30 p.m.	6.30 p.m.	Haddock (1), ..	2	..	2	
								Plaice (1), ...	14	..	..	
								,, (2), ...	100	..	.	
								,, (3), ..	121	..	..	
								,, (4), ...	86	..	..	
									— 321	210	531	
								Com. Dab, ..	2	96	98	
								Cat-fish, ...	1	..	1	
								Gurnard, ...	..	4	4	
									326	310	636	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over-board.	Total No.	
16. Same Locality.	1903. June 11 & 12.	..	..	..	8 to 11	7.30 p.m.	12.30 a.m.	Haddock (1), ..	12	..	12	
								Plaice (1), ...	11	..	..	
								„ (2), ...	64	..	..	
								„ (3), ...	190	..	..	
								„ (4), ...	360	..	..	
									— 625	700	1325	
								Com. Dab, ..	..	156	156	
								Gurnard, ...	..	30	30	
									637	886	1523	
17. Same Locality.	„	..	..	..	..	1 a.m.	6 a.m.	Cod, ...	1	..	1	
								Haddock (1), ..	14	..	..	
								„ (2), ..	2	..	..	
									— 16	..	16	
								Hake, ...	1	..	1	
								Plaice (1), ...	15	..	..	
								„ (2), ...	87	...	..	
								„ (3), ...	174	..	..	
								„ (4), ...	195	..	..	
									— 471	352	823	
								Com. Dab, ...	12	104	116	
								Flounder, ...	2	1	3	
								Thornback, ..	4	..	4	
								Cat-fish, ...	3	..	3	
								Gurnard, ...	..	60	60	
									510	517	1027	
18. Lybster Bay, Caithness.	„	11·4	10·8	9·4	23	10.45 a.m.	12.45 p.m.	Cod, ...	2	..	2	
								Hake, ...	1	..	1	
								Haddock (1), ..	2	..	..	
								„ (3), ..	306	..	..	
									— 308	102	410	
								Whiting, ...	19	25	44	
								Plaice (2), ...	6	..	6	
								Lemon Dab, ..	46	..	46	
								Com. Dab, ..	..	40	40	
								Cat-fish, ...	1	..	1	
								Gurnard, ...	..	34	34	
									383	201	584	
19. Smith Bank.	„	..	..	..	19 to 22	2.55 p.m.	5 p.m.	Cod, ...	1	..	1	
								Codling, ...	12	..	12	
								Haddock (1), ..	2	..	..	
								„ (3), ..	314	..	..	
									— 316	165	481	
								Turbot, ...	2	..	2	
								Lemon Dab, ..	22	7	29	
								Com. Dab, ...	20	200	220	
								Cat-fish, ...	2	..	2	
								Angler, ...	3	..	3	
								Gurnard, ...	..	23	23	
									378	395	773	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Surface.	Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
20. Aberdeen Bay, off Black Dog.	1903. June 13.	..	..	..	8 to 10	2.30 a.m.	6.30 a.m.	Cod, ...	1	..	1	
								Codling, ...	3	14	17	
								Haddock(3), ..	707	210	917	
								Whiting, ...	..	40	40	
								Plaice (1),.. ..	25	..	..	
								,, (2),.. ..	363	..	..	
								,, (3),.. ..	189	..	..	
									— 577	20	597	
								Com. Dab,.. ..	94	56	150	
								Gurnard, ...	..	25	25	
								Angler, ...	2	..	2	
									1384	365	1749	
21. Same Locality.	,,	..	..	..	,,	7.15 a.m.	11.15 a.m.	Codling, ...	.	25	25	
								Haddock(3), ..	763	250	1013	
								Whiting, ...	40	16	56	
								Brill, ...	2	..	2	
								Plaice (1),.. ..	15	..	..	
								,, (2),.. ..	162	..	..	
								,, (3),.. ..	330	..	..	
									— 507	..	507	
								Com. Dab,.. ..	..	120	120	
								Gurnard, ...	..	20	20	
								Angler, ...	..	2	2	
									1312	433	1745	
22. Aberdeen Bay, off Slains Castle.	,,	..	..	..	12 to 14	11.30 a.m.	3.30 p.m.	Haddock(2), ..	196	..	..	
								,, (3), ..	1492	..	..	
									——1688	109	1797	
								Turbot, ...	2	..	2	
								Brill, ...	5	..	5	
								Plaice (2),.. ..	60	..	..	
								,, (3),.. ..	100	..	..	
									— 160	..	160	
								Com. Dab,.. ..	..	87	87	
								Gurnard, ...	..	16	16	
								Angler, ...	..	1	1	
									1855	213	2068	
23. Same Locality.	,,	..	..	..	12 to 15	4.15 p.m.	7.15 p.m.	Haddock(1), ..				Unmarketable not enumerated; consisted of six basketfuls, mostly small haddocks.
								,, (2), ..	303	..	..	
								,, (3). ..	3193	..	..	
								,, (4), ..	630	..	..	
									——4126	..	4126	
								Plaice (2),.. ..	87	..	87	
								Com. Dab,.. ..	70	..	70	
									4283	..	4283	
24. Same Locality.	,,	..	..	..	12 to 14	7.45 p.m.	11.45 p.m.	Cod, ...	2	..	2	Unmarketable not enumerated.
								Codling, ...	5	..	5	
								Haddock (3), ..	993	..	..	
								,, (4), ..	878	..	..	
									——1871	..	1871	
								Plaice (1),.. ..				
								,, (2),.. ..	51	..	..	
								,, (3),.. ..	36	..	..	
								,, (4),.. ..	20	..	..	
									— 107	..	107	
									1985	..	1985	

TRAWLING INVESTIGATIONS—TABLE I

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
1. About 60 miles S. ½ E. from Aberdeen, and about 30 miles E. ½ S. from Isle of May.	1903. Aug. 17.	16·8	12·8	8·9	34 & 35	11 a.m.	2 p.m.	Codling, ...	7	4	11	Course run — 60 miles S. ½ E. from Aberdeen, and worked southwards to about 34 miles S.E. of Isle of May. Sea calm.
								Haddock (1), ..	13	..	..	
								,, (2), ..	84	..	..	
								,, (3), ..	167	..	..	
								,, (4), ..	96	..	..	
									—360	159	519	
								Whiting, ...	9	52	61	
								Lemon Dab, ..	5	..	5	
								Gurnard, ...	..	7	7	
								Angler, ...	..	5	5	
									381	227	608	
2. Same Locality.	,,	..	..	..	35 & 36	2.30 p.m.	5.30 p.m.	Codling, ...	..	1	1	
								Haddock (1), ..	24	..	..	
								,, (2), ..	96	..	..	
								,, (3), ..	104	..	..	
								,, (4), ..	120	..	..	
									—344	246	590	
								Whiting, ...	..	26	26	
								Plaice, ...	2	..	2	
								Lemon Dab, ..	2	..	2	
								Gurnard, ...	..	14	14	
									348	287	635	
3. Same Locality, working southwards.	,,	..	..	..	..	6.10 p.m.	9.40 p.m.	Cod, ...	9	..	9	
								Codling, ...	11	4	15	
								Coal-fish, ...	11	..	11	
								Haddock (1), ..	18	..	..	
								,, (2), ..	50	..	..	
								,, (3), ..	254	..	..	
								,, (4), ..	187	..	..	
									—509	116	625	
								Whiting, ...	..	12	12	
								Plaice, ...	12	..	12	
								Lemon Dab, ..	4	..	4	
								Com. Dab,.. ..	3	..	3	
								Gurnard, ...	..	12	12	
								Angler, ...	..	2	2	
									559	146	705	
4. Same Locality.	,,	..	..	..	34 to 36	5.15 a.m.	9 a.m.	Cod, ...	9	..	9	
								Codling, ...	..	7	7	
								Coal-fish, ...	4	..	4	
								Haddock (1), ..	17	..	..	
								,, (2), ..	120	..	..	
								,, (3), ..	167	..	..	
								,, (4), ..	110	..	..	
									—414	86	500	
								Whiting, ...	..	32	32	
								Plaice, ...	6	..	6	
								Lemon Dab, ..	26	..	26	
								Gurnard, ...	..	30	30	
									459	155	614	
5. Same Locality.	,,	19·2	13·2	8·9	..	9.45 a.m.	1 p.m.	Codling, ...	40	28	68	Sea smooth; calm.
								Ling, ...	5	..	5	
								Haddock (1), ..	40	..	..	
								,, (2), ..	78	..	..	
								,, (3). ..	122	..	..	
								,, (4), ..	120	..	..	
									—360	210	570	
								Whiting, ...	46	96	142	
								Plaice, ...	13	..	13	
								Lemon Dab, ..	22	..	22	
								Com. Dab,.. ..	..	2	2	
								Long Rough Dab,	..	3	3	
									486	339	825	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Over-board.	Total No.	Remarks.
6. Same Locality.	1903. Aug. 18	..	..	..	34 to 36	2.5 p.m.	5.10 p.m.	Cod, ...	1	..	1	
								Codling, ...	19	..	19	
								Haddock (1), ..	62	..	..	
								,, (2), ..	314	..	..	
								,, (3), ..	621	..	..	
								,, (4), ..	538	..	..	
									—1535	220	1,755	
								Whiting, ...	130	120	250	
								Plaice, ...	12	..	12	
								Lemon Dab, ..	16	..	16	
								Gurnard, ...	..	92	92	
									1713	432	2145	
7. Same Locality.	,,	..	..	..	,,	5.35 p.m.	9.15 p.m.	Cod, ...	1	..	1	
								Codling, ...	58	..	58	
								Hake, ...	1	..	1	
								Haddock (1), ..	123	..	..	
								,, (2), ..	315	..	..	
								,, (3), ..	643	..	..	
								,, (4), ..	435	..	..	
									—1516	209	1725	
								Whiting, ...	46	100	146	
								Plaice, ...	6	..	6	
								Lemon Dab, ..	5	..	5	
								Com. Dab, ...	..	8	8	
								Long Rough Dab,	..	5	5	
								Gurnard, ...	..	38	38	
									1633	360	1993	
8. Same Locality.	Aug. 18-19.	..	..	..	,,	9.50 p.m.	1 a.m.	Cod, ...	3	..	3	
								Codling, ...	12	..	12	
								Haddock (1), ..	58	..	..	
								,, (2), ..	311	..	..	
								,, (3), ..	385	..	..	
								,, (4), ..	439	..	..	
									—1193	105	1298	
								Whiting, ...	32	63	95	
								Plaice, ...	3	..	3	
								Lemon Dab, ..	8	..	8	
								Com. Dab, ...	..	3	3	
								Long Rough Dab,	..	7	7	
								Gurnard, ...	..	24	24	
									1251	202	1453	
9. Same Locality.	,,	.	..	..	,,	1.30 a.m.	5 a.m.	Cod, ...	1	..	1	
								Codling, ...	23	..	23	
								Haddock (1), ..	126	..	..	
								,, (2), ..	105	..	..	
								,, (3), ..	383	..	..	
								,, (4), ..	210	..	..	
									—824	180	1004	
								Whiting, ...	20	64	84	
								Plaice, ...	9	..	9	
								Lemon Dab, ..	49	..	49	
								Com. Dab, ...	..	4	4	
								Long Rough Dab,	..	18	18	
								Gurnard, ...	..	48	48	
								Angler, ...	..	3	3	
									926	317	1243	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over-board	Total No.	
10. Same Locality.	1903. Aug. 19.	..	..	..	35	5.30 a.m.	8.30 a.m.	Cod, ...	2	..	2	
								Codling, ...	120	10	130	
								Haddock (1), ..	62	..	..	
								,, (2), ..	312	..	..	
								,, (3), ..	625	..	..	
								,, (4), ..	235	..	..	
									—1234	96	1330	
								Whiting, ...	..	28	28	
								Plaice, ...	6	..	6	
								Lemon Dab, ..	8	..	8	
								Com. Dab, ..	..	4	4	
								Long Rough Dab,	..	14	14	
								Gurnard, ...	..	40	40	
								Angler, ...	..	1	1	
									1370	193	1563	
11. Same Locality.	,,	..	..	..	35 to 36	9 a.m.	12.15 p.m.	Codling, ...	40	15	55	
								Coal-fish, ...	2	..	2	
								Haddock (1), ..	126	..	..	
								,, (2), ..	524	..	..	
								,, (3), ..	1087	..	..	
								,, (4), ..	435	..	..	
									—2172	209	2381	
								Whiting, ...	140	56	196	
								Plaice, ...	13	..	13	
								Lemon Dab, ..	21	..	21	
								Com. Dab, ..	..	8	8	
								Long Rough Dab,	..	18	18	
								Gurnard, ...	..	100	100	
									2388	406	2794	
12. Same Locality.	,,	15·2	12·8	9·4	,,	12.35 p.m.	3.45 p.m.	Cod, ...	1	..	1	Calm. Sea smooth.
								Codling, ...	43	20	63	
								Ling, ...	3	..	3	
								Coal-fish, ...	2	..	2	
								Haddock (1), ..	127	..	..	
								,, (2), ..	418	..	..	
								,, (3), ..	998	..	..	
								,, (4), ..	460	..	..	
									—2003	428	2431	
								Whiting, ...	288	46	334	
								Plaice, ...	10	..	10	
								Lemon Dab, ..	10	..	10	
								Com. Dab,.. ..	..	6	6	
								Long Rough Dab,	..	20	20	
								Gurnard, ...	..	109	109	
								Angler, ...	..	2	2	
									2360	631	2991	
13. Same Locality.	,,	..	..	..	,,	4.30 p.m.	7.15 p.m.	Codling, ...	36	4	40	At end of haul, left for Granton
								Haddock (1), ..	62	..	..	
								,, (2), ..	455	..	..	
								,, (3), ..	671	..	..	
								,, (4), ..	455	..	..	
									—1643	312	1955	
								Whiting, ...	135	109	244	
								Plaice, ...	12	..	12	
								Lemon Dab, ..	9	..	9	
								Com. Dab, ..	..	5	5	
								Long Rough Dab,	..	17	17	
								Gurnard, ...	..	47	47	
								Angler, ...	..	1	1	
									1835	495	2330	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Over-board.	Total No.	Remarks.
14. About 50 miles E. by S. from Isle of May.	1903. Aug. 20.	..	..	..	36	6.15 p.m.	10.15 p.m.	Codling, ...	18	17	35	
								Haddock (1), ..	128	..	..	
								,, (2), ..	522	..	..	
								,, (3), ..	1044	..	..	
								,, (4), ..	428	..	..	
									—2122	108	2230	
								Whiting, ...	130	40	170	
								Plaice, ...	20	..	20	
								Lemon Dab, ..	31	..	31	
								Com. Dab, ...	..	9	9	
								Long Rough Dab,	..	23	23	
								Gurnard, ...	..	47	47	
								Grey Skate, ..	..	3	3	
									2321	247	2568	
15. Same Locality.	Aug. 20-21.	..	..	..	34 to 35	10.35 p.m.	2.45 a.m.	Cod, ...	5	..	5	
								Codling, ...	48	8	56	
								Haddock (1), ..	128	..	..	
								,, (2), ..	416	..	..	
								,, (3), ..	507	..	..	
								,, (4), ..	220	..	..	
									—1271	96	1367	
								Whiting, ...	60	32	92	
								Lemon Dab, ..	23	..	23	
								Com. Dab, ..	..	8	8	
								Long Rough Dab,	..	15	15	
								Gurnard, ...	..	52	52	
								Grey Skate, ..	..	1	1	
								Angler, ...	..	2	2	
									1407	214	1621	
16. Same Locality.	Aug. 21	..	..	..	,,	8.10 a.m.	12.20 p.m.	Cod, ...	2	..	2	
								Codling, ...	42	7	49	
								Coal-fish, ...	1	..	1	
								Haddock (1), ..	125	..	..	
								,, (2), ..	623	..	..	
								,, (3), ..	882	..	..	
								,, (4), ..	215	..	..	
									—1845	209	2054	
								Whiting, ...	104	46	150	
								Plaice, ...	10	..	10	
								Lemon Dab, ..	20	..	20	
								Com. Dab, ..	..	4	4	
								Long Rough Dab,	..	7	7	
								Gurnard, ...	..	43	43	
								Grey Skate, ..	..	2	2	
								Angler, ...	..	3	3	
									2024	321	2345	
17. Same Locality.	,,	..	..	..	34	1.5 p.m.	2.5 p.m.	Haddock (1), ..	20	..	..	
								,, (2), ..	105	..	..	
								,, (3), ..	268	..	..	
								,, (4), ..	180	..	..	
									—573	68	641	
								Whiting, ...	..	31	31	
								Plaice, ...	10	..	10	
								Lemon Dab, ..	7	..	7	
								Com. Dab, ..	..	4	4	
								Long Rough Dab,	..	7	7	
								Gurnard, ...	..	23	23	
									590	133	723	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over board.	Total No.	
18. Same Locality.	1903. Aug. 21.	..	..	..	34	2.30 p.m.	6.30 p.m.	Cod, ...	5	..	5	Unmarketable, amounting to 1½ baskets, not counted; mostly haddocks.
								Codling, ...	13	..	13	
								Hake, ...	1	..	1	
								Haddock (1), ..	186	..	..	
								,, (2), ..	717	..	..	
								,, (3), ..	1131	..	..	
								,, (4), ..	448	..	..	
									——2482	..	2482	
								Whiting, ...	217	..	217	
								Plaice, ...	28	..	28	
								Lemon Dab, ..	42	..	42	
								Cat-fish, ...	1	..	1	
									2789	..	2789	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over-board.	Total No.	
1. Aber-deen Bay, off Black Dog.	1903. Oct. 16.	..	..	..	8 to 12	10.50 a.m.	2.50 p.m.	Cod, ...	13	..	13	Wind S.W., strong breeze; sea rough.
								Codling, ...	118	3	121	
								Haddock (1), ..	749	..	..	
								,, (2), ..	232	..	..	
								,, (3), ..	536	..	..	
									—1517	..	1517	
								Whiting, ...	259	5	264	
								Brill, ...	1	..	1	
								Plaice (1), ...	13	..	..	
								,, (2), ...	9	..	..	
									— 22	..	22	
								Lemon Dab, ..	1	..	1	
								Com. Dab,.. ..	5	23	28	
								Grey Skate, ..	2	..	2	
								Gurnard, ...	..	8	8	
								Angler, ...	..	1	1	
									1938	40	1978	
2. Aberdeen Bay, off Old Castle.	,,	10·1	10·8	6·1	9 to 12	3.20 p.m.	7.10 p.m.	Cod, ...	4	..	4	
								Codling, ...	273	9	282	
								Haddock (1), ..	395	..	..	
								,, (2), ..	164	..	..	
								,, (3), ..	540	..	..	
									—1099	..	1099	
								Whiting, ...	261	14	275	
								Brill, ...	10	..	10	
								Plaice (1), ...	12	..	..	
								,, (2), ...	169	..	..	
								,, (3), ...	13	..	..	
									—194	..	194	
								Lemon Dab, ..	12	..	12	
								Com. Dab,.. ..	28	45	73	
								Starry Ray, ..	3	2	5	
								Grey Skate, ..	5	1	6	
								Gurnard, ...	..	4	4	
									1889	75	1964	
3. Same Locality.	,,	..	..	..	8 to 11	7.30 p.m.	11.30 p.m.	Cod, ...	26	..	26	
								Codling, ...	179	11	190	
								Haddock (1), ..	241	..	..	
								,, (2), ..	254	..	..	
								,, (3), ..	170	..	..	
									—665	..	665	
								Whiting, ...	96	16	112	
								Brill, ...	8	..	8	
								Plaice (1), ...	10	..	..	
								,, (2), ...	171	..	..	
								,, (3), ...	14	..	..	
									—195	..	195	
								Lemon Dab, ..	14	..	14	
								Com. Dab,.. ..	24	37	61	
								Gurnard, ...	..	5	5	
								Thornback, ..	4	..	4	
								Grey Skate, ..	5	1	6	
								Angler, ...	..	1	1	
									1216	71	1287	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
4. Same Locality. Towed up to Cruden Scars.	1903. Oct. 17.	..	..	..	12 to 20	12.50 a.m.	4.5 a.m.	Cod, ...	9	..	9	
								Codling, ...	382	5	387	
								Haddock (1), ..	237	..	..	
								,, (2), ..	156	..	..	
								,, (3), ..	397	..	..	
									—790	..	790	
								Whiting, ...	214	14	228	
								Turbot, ...	3	..	3	
								Brill, ...	4	..	4	
								Plaice (1), ...	12	..	..	
								,, (2), ...	181	..	..	
								,, (3), ...	11	..	..	
									—204	..	204	
								Lemon Dab, ..	3	..	3	
								Com. Dab, ...	14	21	35	
								Gurnard, ...	..	4	4	
								Thornback, ..	4	2	6	
								Grey Skate, ..	4	1	5	
								Starry Ray, ..	2	4	6	
								Angler, ...	1	..	1	
									1634	51	1685	
5. Same Locality. Shot at Cruden Skerries and towed towards Aberdeen.	,,	..	..	.	10 to 15	4.20 a.m.	5.20 a.m.	Codling, ...	14	5	19	Small-meshed net.
								Haddock (1), ..	20	..	..	
								,, (2), ..	46	..	..	
									— 66	4	70	
								Whiting, ...	32	19	51	
								Plaice (1), ...	..	..	..	
								,, (2), ...	42	..	..	
									— 42	..	42	
								Com. Dab, ...	12	14	26	
									166	42	208	
6. Moray Firth; Burghead Bay.	Oct. 19.	..	..	..	12 to 20; mostly in 10	1.30 p.m.	5.30 p.m.	Codling, ...	12	..	12	Weather calm. Catch included 31½ baskets of haddocks, mostly small, and six of plaice.
								Haddock (1), ..	35	..	..	
								,, (2), ..	190	..	..	
								,, (3), ..	6214	..	..	
									—6439	30	6469	
								Whiting, ...	60	150	210	
								Halibut, ...	1	..	1	
								Brill, ...	2	..	2	
								Plaice (1), ...	2	..	..	
								,, (2), ...	178	..	..	
								,, (3), ...	277	..	..	
								,, (4), ...	165	..	..	
									—622	56	678	
								Witch, ...	30	..	30	
								Com. Dab, ...	20	794	814	
								Gurnard, ...	96	60	156	
								Thornback, ..	4	..	4	
								Angler, ...	..	6	6	
									7286	1096	8382	
7. Same Locality.	,,	..	..	..	8 to 12	6.15 p.m.	10.15 p.m.	Cod, ...	1	..	1	
								Codling, ...	9	..	9	
								Haddock (1), ..	1	..	..	
								,, (2), ..	180	..	..	
								,, (3), ..	1282	..	..	
									—1463	38	1501	
								Whiting, ...	255	102	357	
								Turbot	1	..	1	
								Brill, ...	3	..		
								Plaice (1), ...	4	..	..	
								,, (2, ...	314	..	..	
								,, (3), ...	134	..	..	
								,, (4), ...	194	..	..	
									—646	20	666	
								Witch, ...	2	..	2	
								Com. Dab, ...	120	653	773	
								Gurnard, ...	80	31	111	
								Thornback, ..	1	..	1	
								Angler, ...	..	21	21	
									2581	865	3446	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks
8. Same Locality.	1903. Oct 19-20.	11·2	10·3	10	8 to 12	10·45 p.m.	2.45 a m.	Cod, ...	2	..	2	
								Codling, ...	5	..	5	
								Haddock (1), ..	16	..	..	
								,, (2), ..	12	..	..	
								,, (3), ..	352	..	..	
								,, (4), ..	182	..	..	
									—562	20	582	
								Whiting, ...	290	94	384	
								Plaice, (1), ...	7	..	..	
								,, (2), ...	89	..	..	
								,, (3), ...	214	..	..	
								,, (4), ...	324	..	..	
									—634	32	666	
								Lemon Dab, ..	2	..	2	
								Witch, ...	18	..	18	
								Com. Dab, ..	..	786	786	
								Gurnard, ...	80	18	98	
								Thornback, ..	3	..	3	
								Angler, ...	..	10	10	
									1596	960	2556	
9. Same Locality.	Oct. 20.	10·8	12·3	10	8 to 13	3.35 a.m	7.35 a.m.	Codling, ...	11	..	11	
								Haddock (1), ..	8	..	..	
								,, (2), ..	112	..	..	
								,, (3), ..	1956	..	..	
									—2076	43	2119	
								Whiting, ...	250	103	353	
								Turbot, ...	1	..	1	
								Plaice (1), ...	5	..	..	
								,, (2), ...	78	..	..	
								,, (3), ...	120	..	..	
								,, (4), ...	288	..	..	
									—491	..	491	
								Lemon Dab, ..	4	..	4	
								Witch, ...	5	..	5	
								Com. Dab, ...	78	860	938	
								Gurnard, ...	87	21	108	
								Thornback, ..	2	..	2	
								Angler, ...	..	5	5	
									3005	1032	4037	
10. Same Locality.	,,	..	..	..	8 to 12	9.0 a.m.	10.0 a.m.	Hake, ...	1	..	1	Small-meshed net.
								Codling, ...	12	3	15	
								Haddock (1), ..	2	..	..	
								,, (2), ..	27	..	..	
								,, (3), ..	184	..	..	
									—213	26	239	
								Whiting, ...	10	46	56	
								Plaice (1), ...	4	..	..	
								,, (2), ...	18	..	..	
								,, (3), ...	50	..	..	
								,, (4), ...	157	..	..	
									—229	..	229	
								Com. Dab, ..	..	307	307	
								Witch, ...	13	..	13	
								Gurnard, ...	36	14	50	
								Thornback, ..	1	..	1	
								Angler, ...	..	1	1	
									515	397	912	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over-board.	Total No.	
11. Dornoch Firth, off Dunrobin and Golspie.	1903. Oct. 20.	..	..	..	8 to 14	2.45 p.m.	4.45 p.m.	Cod, ...	42	..	42	
								Codling, ...	26	7	33	
								Coal-fish, ...	..	2	2	
								Haddock (1), ..	51	..	..	
								,, (2), ..	83	..	..	
								,, (3), ..	444	..	..	
									—578	14	592	
								Whiting, ...	..	27	27	
								Brill, ...	2	..	2	
								Plaice (1), ...	10	..	..	
								,, (2), ...	5	..	..	
								,, (3), ...	7	..	..	
									— 22	..	22	
								Lemon Dab, ..	3	..	3	
								Com. Dab, ...	..	61	61	
								Cat-fish, ...	1	..	1	
								Gurnard, ...	3	5	8	
									677	116	793	
12. Same Locality.	,,	..	..	..	,,	5.10 p.m.	7.10 p.m.	Cod, ...	3	..	3	Weather fine; light S.W. wind.
								Codling, ...	12	..	12	
								Haddock (1), ..	177	..	..	
								,, (2), ..	43	..	..	
								,, (3), ..	425	..	..	
									—645	7	652	
								Whiting, ...	4	12	16	
								Plaice (1), ...	5	..	..	
								,, (2), ...	39	..	..	
								,, (3), ...	54	..	..	
									— 98	2	100	
								Lemon Dab, ..	8	..	8	
								Com. Dab, ...	..	43	43	
								Gurnard, ...	..	4	4	
								Thornback, ..	1	..	1	
								Angler, ...	..	3	3	
									771	71	842	
13. Same Locality.	,,	..	..	..	,,	7.45 p.m.	11.45 p.m.	Codling, ...	26	3	29	
								Haddock (1), ..	78	..	..	
								,, (2), ..	24	..	..	
									—102	2	104	
								Whiting, ...	4	6	10	
								Brill, ...	2	..	2	
								Plaice (1), ...	21	..	..	
								,, (2), ...	36	..	..	
									— 57	..	57	
								Lemon Dab, ..	4	..	4	
								Com. Dab, ..	..	60	60	
								Gurnard, ...	..	8	8	
								Thornback, ..	2	..	2	
									197	79	276	
14. Same Locality.	Oct. 21.	..	..	..	,,	12.20 a.m.	3.20 a.m.	Codling, ...	10	9	19	Weather fine net split.
								Haddock (1), ..	2	..	..	
								,, (2), ..	10	..	..	
									— 12	4	16	
								Whiting, ...	..	3	3	
								Plaice (1), ...	5	..	..	
								,, (2), ...	20	..	..	
									— 25	6	31	
								Lemon Dab, ..	12	..	12	
								Com. Dab, ...	..	24	24	
								Gurnard, ...	8	11	19	
								Thornback, ..	4	..	4	
									71	57	128	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over-board.	Total No.	
15. Same Locality.	1903. Oct. 21.	12·0	10·1	10·6	8 to 14	3.50 a.m.	7.50 a.m.	Cod, ...	3	..	3	
								Codling, ...	8	..	8	
								Haddock (1), ..	21	..	..	
								,, (2), ..	10	..	..	
								,, (3), ..	637	..	..	
									—668	2	670	
								Whiting, ...	15	25	40	
								Plaice (1), ...	16	..	..	
								,, (2), ...	24	..	..	
								,, (3), ...	17	..	..	
								,, (4), ...	25	..	..	
									— 82	..	82	
								Lemon Dab, ..	2	..	2	
								Com. Dab, ..	..	233	233	
								Witch, ...	2	..	2	
								Gurnard, ...	7	18	25	
								Conger, ...	1	..	1	
								Thornback, ..	2	..	2	
								Angler, ...	..	2	2	
								Piked Dog-fish, ..	..	2	2	
								Sprat, ...	..	3	3	
									790	285	1075	
16. Same Locality.	,,	..	..	,,	10 to 15	8 a.m.	12 p.m.	Cod, ...	1	..	1	
								Codling, ...	13	5	18	
								Haddock (1), ..	149	..	..	
								,, (2), ..	123	..	..	
								,, (3), ..	1574	..	..	
									—1846	..	1846	
								Whiting, ...	9	23	32	
								Plaice (1), ...	14	..	..	
								,, (2), ...	40	..	..	
								,, (3), ...	91	..	..	
								,, (4), ...	180	..	..	
									—325	20	345	
								Lemon Dab, ..	3	..	3	
								Com. Dab, ..	30	181	211	
								Gurnard, ...	8	..	8	
								Piked Dog-fish, ..	..	2	2	
								Angler, ...	..	1	1	
								Thornback, ..	4	..	4	
								Sprat, ...	..	15	15	
									2239	247	2486	
17. Same Locality.	,,	..	..	..	8 to 12	12.15 p.m.	1.15 p.m.	Cod, ...	1	..	1	Net split.
								Codling, ...	9	..	9	
								Whiting, ...	..	2	2	
								Plaice (3), ...	1	..	1	
								Com. Dab, ..	..	6	6	
								Sprat, ...	..	8	8	
									11	16	27	
18. Same Locality.	,,	..	..	..	8 to 13	4.50 p.m.	8.50 p.m.	Cod, ...	5	..	5	
								Codling, ...	30	12	42	
								Haddock (1), ..	308	..	..	
								,, (2), ..	356	..	..	
								,, (3), ..	1243	..	..	
									—1907	19	1926	
								Whiting, ...	..	36	36	
								Plaice (1), ...	17	..	..	
								,, (2), ...	34	..	..	
								,, (3), ...	46	..	..	
								,, (4), ...	15	..	..	
									—112	21	133	
								Lemon Dab, ..	2	..	2	
								Com. Dab, ..	25	43	68	
								Gurnard, ...	..	10	10	
								Angler, ...	..	1	1	
									2031	142	2223	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over-board.	Total No.	
19. Same Locality.	1903. Oct. 21-22.	..	..	..	8 to 13	9.10 p.m.	1.10 a.m.	Codling, ...	19	8	27	
								Haddock (1), ..	166	..	..	
								,, (2), ..	150	..	..	
								,, (3), ..	717	..	..	
									—1033	15	1048	
								Whiting, ...	..	9	9	
								Plaice (1), ...	10	..	..	
								,, (2), ...	24	..	..	
								,, (3), ...	32	..	..	
								,, (4), ...	70	..	..	
									—136	24	160	
								Lemon Dab, ..	1	..	1	
								Com. Dab, ..	11	760	771	
								Gurnard, ...	..	6	6	
									1200	822	2022	
20. Same Locality.	Oct. 22.	..	..	..	,,	1.30 a.m.	5.30 a.m.	Codling, ...	..	9	9	
								Haddock (1), ..	73	..	..	
								,, (2), ..	81	..	..	
								,, (3), ..	645	..	..	
									—799	7	806	
								Whiting, ...	..	12	12	
								Plaice (1), ...	4	..	..	
								,, (2), ...	38	..	..	
								,, (3), ...	120	..	..	
								,, (4), ...	210	..	..	
									—372	18	390	
								Com. Dab, ..	..	347	347	
								Gurnard, ...	12	23	35	
								Thornback, ..	2	..	2	
									1185	416	1601	
21. Same Locality.	,,	9.2	9·7	9·4	8 to 13	5.45 a.m.	6.45 a.m.	Codling, ...	4	1	5	Small-meshed net used.
								Haddock (1), ..	10	..	..	
								,, (2), ..	9	..	..	
								,, (3), ..	69	..	..	
									— 88	4	92	
								Whiting, ...	1	40	41	
								Brill, ...	1	..	1	
								Plaice (1), ...	3	..	..	
								,, (2), ...	21	..	..	
								,, (3), ...	71	..	..	
								,, (4), ...	253	..	..	
									—348	15	363	
								Com. Dab,.. ..	23	371	394	
								Gurnard, ...	5	25	30	
								Thornback, ..	1	..	1	
								Piked Dog-fish, ..	..	1	1	
								Sting Ray, ..	..	1	1	
								Little Sole, ..	..	1	1	
								Sprat, ...	..	4	4	
								Armed Bullhead,	..	1	1	
									471	464	935	
22. Off Lybster.	,,	..	..	..	23	1 p.m.	2 p.m.	Codling, ...	..	4	4	
								Haddock (1), ..	352	..	..	
								,, (2), ..	190	..	..	
								,, (3), ..	358	..	..	
									—900	4	904	
								Whiting, ...	37	14	51	
								Plaice (1), ...	4	..	..	
								,, (2), ...	10	..	..	
									— 14	..	14	
								Lemon Dab, ..	5	..	5	
								Com. Dab.. ..	..	30	30	
									956	52	1008	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Surface.	Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
23. Same Locality.	1903. Oct. 22.	..	..	..	23 to 24	2.30 p.m.	4.30 p.m.	Codling, ...	..	13	13	20 baskets of haddocks.
								Haddock (1), ..	731	..	..	
								,, (2), ..	446	..	..	
								,, (3), ..	1277	..	..	
									—2454	9	2463	
								Whiting, ...	200	24	224	
								Plaice (3), ...	11	..	11	
								Lemon Dab, ..	5	..	5	
								Com. Dab, ...	..	20	20	
								Gurnard, ...	4	..	4	
									2674	66	2740	
24. Same Locality.	,,	..	..	..	23	4.50 p.m.	7.50 p.m.	Codling, ...	12	7	19	
								Haddock (1), ..	449	..	..	
								,, (2), ..	471	..	..	
								,, (3), ..	1075	..	..	
									—1995	13	2008	
								Whiting, ...	628	36	664	
								Plaice (1), ...	3	..	..	
								,, (2), ...	23	..	..	
									— 26	..	26	
								Lemon Dab, ..	4	..	4	
								Com. Dab, ...	..	86	86	
								Gurnard, ...	..	3	3	
									2665	145	2810	
25. Same Locality.	Oct. 22 & 23.	..	..	..	,,	8.15 p.m.	12.15 a.m.	Cod, ...	18	..	18	
								Codling, ...	19	4	23	
								Haddock (1), ..	286	..	..	
								,, (2), ..	210	..	..	
								,, (3), ..	836	..	..	
									—1332	14	1346	
								Whiting, ...	..	21	21	
								Plaice (2), ...	9	..	9	
								Lemon Dab, ..	12	..	12	
								Com. Dab, ..	..	66	66	
								Gurnard, ...	13	8	21	
								Angler, ...	..	1	1	
									1403	114	1517	
26. Same Locality.	Oct. 23.	..	..	..	,,	12.30 a.m.	3.35 a.m.	Cod, ...	7	..	7	
								Codling, ...	14	..	14	
								Haddock (1), ..	260	..	..	
								,, (2), ..	213	..	..	
								,, (3), ..	860	..	..	
									—1333	9	1342	
								Whiting, ...	450	26	476	
								Plaice (2), ...	22	..	22	
								Com. Dab, ...	..	39	39	
								Gurnard, ...	10	5	15	
								Thornback, ..	2	..	2	
									1838	79	1917	
27. Smith Bank.	,,	..	..	..	21 to 22	6.15 a.m.	7.15 a.m.	Codling, ...	5	1	6	
								Haddock (1), ..	28	..	..	
								,, (2), ..	6	..	..	
								,, (3), ..	231	..	..	
									—265	37	302	
								Whiting, ...	46	204	250	
								Plaice (1), ...	3	..	..	
								,, (2), ...	28	..	..	
									— 31	..	31	
								Com. Dab, ..	3	674	677	
								Long Rough Dab,	..	3	3	
								Lemon Dab, ..	..	14	14	
								Armed Bullhead,	..	2	2	
								Gurnard, ...	..	15	15	
									350	950	1300	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over-board.	Total No.	
28. Same Locality.	1903. Oct. 23.	..	..	..	22	8.10 a.m.	11.50 a.m.	Cod, ...	107	..	107	
								Codling, ...	27	..	27	
								Ling, ...	1	..	1	
								Haddock (1), ..	30	..	..	
								,, (2), ..	110	..	..	
								,, (3), ..	646	..	..	
									—786	10	796	
								Whiting, ...	10	31	41	
								Plaice (2), ...	34	..	34	
								Lemon Dab, ..	15	..	15	
								Com. Dab,.. ..	..	206	206	
								Gurnard	..	8	8	
								Angler, ...	..	1	1	
									980	256	1236	
29. Off Kinnaird Head at "Witch Ground."	,,	..	..	..	50	1.50 p.m.	2.50 p.m.	Hake, ...	6	..	6	Small-meshed net.
								Haddock (1), ..	21	..	..	
								,, (2), ..	..	..	..	
								,, (3), ..	400	..	..	
									—421	18	439	
								Whiting, ...	..	46	46	
								Plaice, ...	3	..	3	
								Com. Dab,.. ..	..	406	406	
								Gurnard, ...	..	12	12	
								Angler, ...	..	1	1	
									430	483	913	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over-board.	Total No.	
1. Aberdeen Bay; between Black Dog and Newburgh.	1903. Oct. 30.	..	..	..	8 to 15	9.55 a.m.	12.15 p.m.	Cod, ...	29	..	29	
								Codling, ...	43	..	43	
								Haddock (1), ..	181	..	..	
								,, (2), ..	195	..	..	
								,, (3), ..	16	..	..	
									— 392	7	399	
								Whiting, ...	195	143	338	
								Brill, ...	1	..	1	
								Plaice (3), ...	6	1	7	
								Com. Dab, ...	8	7	15	
								Black Sole, ..	1	..	1	
								Long Rough Dab,	..	2	2	
									675	160	835	
2. Same Locality.	,,	10·0	10·4	10	7½ to 12	12.45 p.m.	5.20 p.m.	Cod, ...	106	..	106	
								Codling, ...	145	6	151	
								Coal-fish, ...	4	..	4	
								Haddock (1), ..	120	..	..	
								,, (2), ..	179	..	..	
								,, (3), ..	10	..	..	
									— 309	11	320	
								Whiting, ...	54	107	161	
								Plaice (2), ...	198	..	..	
								,, (3), ...	110	..	..	
									— 308	..	308	
								Lemon Dab, ..	1	..	1	
								Com. Dab, ...	..	8	8	
								Flounder, ...	3	..	3	
								Thornback, ..	..	2	2	
								Starry Ray, ..	..	2	2	
									930	136	1066	
3. Same Locality.	,,	..	..	..	6 to 11	5.55 p.m.	10.10 p.m.	Cod, ...	25	..	25	
								Codling, ...	85	9	94	
								Haddock (1), ..	311	..	..	
								,, (2), ..	588	..	..	
								,, (3), ..	132	..	..	
									—1031	130	1161	
								Whiting, ...	188	640	828	
								Plaice (1), ...	37	..	..	
								,, (2), ...	28	..	..	
								,, (3), ...	49	..	..	
									— 114	9	123	
								Com. Dab, ..	25	13	38	
								Gurnard, ...	..	8	8	
								Thornback, ..	1	..	1	
								Starry Ray, ..	..	21	21	
									1469	830	2299	
4. Same Locality.	Oct. 30 & 31	..	..	..	5 to 11	10.45 p.m.	3 a.m.	Cod, ...	37	..	37	
								Codling, ...	49	7	56	
								Haddock (1), ..	475	..	..	
								,, (2), ..	303	..	..	
								,, (3), ..	353	..	..	
									—1131	14	1145	
								Whiting, ...	272	211	483	
								Black Sole, ..	1	..	1	
								Plaice (1), ...				
								,, (2), ...	52	..	..	
								,, (3), ...	27	..	..	
									— 79	..	79	
								Lemon Dab, ..	2	..	2	
								Com. Dab, ...	7	5	12	
								Flounder, ...	2	..	2	
								Gurnard, ...	..	1	1	
								Starry Ray, ..	..	24	24	
									1580	262	1842	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
5. Aberdeen Bay; off Collieston.	Oct. 31	9·6	10·2	10·6	8 to 12	7.10 a.m.	8 10 a.m.	Cod, ...	5	..	5	Small-meshed net.
								Codling, ...	10	9	19	
								Haddock, ...	773	157	930	
								Whiting, ...	169	75	244	
								Plaice, ...	27	..	27	
								Lemon Dab, ..	1	..	1	
								Com. Dab, .. .	..	3	3	
								Long Rough Dab,	..	2	2	
								Gurnard, ...	..	6	6	
								Grey Skate, ..	..	1	1	
									985	253	1238	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
1. Aberdeen Bay; off Black Dog to Collieston.	Nov. 6.	9·2	10·0	9·8	8 to 10	2.10 p.m.	5.10 p.m.	Cod, ...	1	..	1	Weather fine; sea smooth; gentle westerly wind.
								Codling, ...	27	..	27	
								Haddock (1), ..	135	..	..	
								,, (2), ..	69	..	..	
								,, (3), ..	334	..	..	
								,, (4), ..	439	..	..	
									— 977	36	1013	
								Whiting, ...	303	18	321	
								Plaice, ...	2	..	2	
								Com. Dab, ...	4	1	5	
								Long Rough Dab,	..	2	2	
								Gurnard, ...	..	3	3	
								Thornback Ray, ..	..	1	1	
								Herring, ...	..	6	6	
								Sprat, ...	..	2	2	
									1314	69	1383	
2. Same Locality.	,,	..	..	..	5½ to 12	6.25 p.m.	8.25 p.m.	Codling, ...	..	2	2	Nothing apparent to account for very small catch.
								Haddock (1), ..	1	..	..	
								,, (2), ..	6	..	..	
								,, (4), ..	6	..	..	
									— 13	2	15	
								Whiting, ...	24	6	30	
								Plaice, ...	1	..	1	
								Com. Dab, ...	1	..	1	
								Long Rough Dab,	..	1	1	
								Gurnard, ...	..	2	2	
								Grey Skate, ..	..	3	3	
								Starry Ray, ..	..	15	15	
								Herring, ...	..	1	1	
									39	32	71	
3. Same Locality.	Nov. 6 & 7.	..	..	..	5½ to 12	9.15 p.m.	1.20 a.m.	Cod, ...	1	..	1	
								Codling, ...	22	3	25	
								Haddock (1), ..	126	..	..	
								,, (2), ..	75	..	..	
								,, (3), ..	118	..	..	
									— 319	10	329	
								Whiting, ...	96	22	118	
								Plaice (1), ...	1	..	..	
								,, (2), ...	53	..	..	
								,, (3), ...	67	..	..	
									— 121	1	122	
								Com. Dab, ...	7	5	12	
								Long Rough Dab,	..	3	3	
								Starry Ray, ..	..	2	2	
									566	46	612	
4. Aberdeen Bay; off Newburgh.	,,	..	..	..	4½ to 12	2.55 a.m.	5.25 a.m.	Cod, ...	1	..	1	
								Codling, ...	28	8	36	
								Haddock (1), ..	13	..	..	
								,, (2), ..	14	..	..	
								,, (3), ..	81	..	..	
									— 108	20	128	
								Whiting, ...	67	37	104	
								Brill, ...	2	..	2	
								Plaice (1), ...				
								,, (2), ...	39	..	..	
								,, (3), ...	215	..	..	
									— 254	..	254	
								Com. Dab, ...	15	..	15	
								Long Rough Dab,	..	5	5	
								Gurnard, ...	..	19	19	
									475	89	564	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
5. Moray Firth; Burghead Bay.	Nov. 9.	..	..	..	5½ to 9	1 p.m.	4·10 a.m.	Cod, ...	11	..	11	Wind west; squally, rain.
								Codling, .. .	1	7	8	
								Haddock (1), ..	1	..	..	
								,, (2), ..	11	..	..	
								,, (3), ..	..	..	..	
								,, (4), ..	494	..	..	
									— 506	187	693	
								Whiting, ...	10	23	33	
								Brill, ...	9	..	9	
								Plaice (1),.. ..	21	..	..	
								,, (2), ...	109	..	..	
								,, (3), ...	660	..	..	
									— 790	8	798	
								Com. Dab,.. ..	34	8	42	
								Gurnard, ...	..	84	84	
								Thornback, ..	4	..	4	
									1365	317	1682	
6. Same Locality.	,,	..	..	..	5½ to 13 and 20	4.30 p.m.	8.45 p.m.	Cod, ...	2	..	2	
								Codling, ...	33	10	43	
								Haddock (1), ..	5	..	..	
								,, (2), ..	34	..	..	
								,, (3), ..	77	..	..	
								,, (4), ..	711	..	..	
									— 827	203	1,030	
								Whiting, ...	26	31	57	
								Turbot, ...	1	..	1	
								Brill, ...	10	..	10	
								Black Sole, ..	1	..	1	
								Plaice (1),.. ..	16	..	..	
								,, (2),.. ..	151	..	..	
								,, (3),.. ..	741	..	..	
									— 908	21	929	
								Com. Dab,.. ..	100	196	296	
								Witch, ...	6	..	6	
								Gurnard, ...	..	24	24	
								Thornback, ..	12	..	12	
								Angler, ...	4	6	10	
									1930	491	2421	
7. Same Locality.	Nov. 10.	..	.	..	4½ to 10	3 a.m.	7 a m.	Cod, ...	3	..	3	
								Codling, ...	32	11	43	
								Haddock (2), ..				
								,, (3), ..				
								,, (4), ..	25	..	..	
									— 25	50	75	
								Whiting, ...	..	34	34	
								Brill, ...	31	..	31	
								Turbot, ...	5	..	5	
								Plaice (1), ...	27	..	..	
								,, (2), ...	176	..	..	
								,, (3), ...	897	..	..	
									—1100	58	1158	
								Lemon Dab, ..	9	..	9	
								Com. Dab,.. ..	64	240	304	
								Gurnard, ...	..	102	102	
								Thornback Ray, ..	2	9	11	
								Angler, ...	2	2	4	
									1273	506	1779	
8. Same Locality.	,	7·8	9·8	10	5 to 10	8 a.m.	10.35 a.m.	Cod, ...	3	..	3	W.S W. strong breeze; showery.
								Codling, ...	..	7	7	
								Haddock, ...	..	25	25	
								Whiting, ...	..	11	11	
								Brill, ...	7	..	7	
								Plaice (1), ...	13	..	..	
								,, (2), ...	139	..	..	
								,, (3), ...	526	..	..	
									— 678	25	703	
								Com. Dab,.. ..	40	140	180	
								Gurnard, ...	..	186	186	
								Thornback Ray, ..	5	..	5	
								Angler, ...	..	4	4	
									733	398	1131	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
9. Dornoch Firth, off Golspie.	..	..	..	..	5 to 13	3.25 p.m.	7.30 p.m.	Codling,	11	6	17	Sea smooth.
								Haddock (1),	232	..	..	
								,, (2),	214	..	..	
								,, (3),	413	..	..	
								,, (4),	191	..	..	
									—1050	50	1100	
								Whiting,	2	2	4	
								Brill,	3	..	3	
								Plaice (1),	5	..	..	
								,, (2),	167	..	..	
								,, (3),	1092	..	..	
									—1264	902	2166	
								Lemon Dab,	6	2	8	
								Com. Dab,	4	126	130	
								Grey Skate,	1	..	1	
								Thornback,	5	15	20	
								Sandy Ray,	..	1	1	
								Angler,	..	2	2	
								Gurnard,	..	33	33	
									2346	1139	3485	
10. Same Locality.	Nov. 11	9·2	9·8	9·4	,,	5.40 a.m.	10.5 a.m.	Codling,	32	8	40	
								Haddock (1),	158	..	..	
								,, (2),	53	..	..	
								,, (3),	56	..	..	
								,, (4),	56	..	..	
									— 323	52	375	
								Whiting,	8	2	10	
								Brill,	4	..	4	
								Plaice (1),	6	..	..	
								,, (2),	103	..	..	
								,, (3),	453	..	..	
								,, (4),	416	..	..	
									— 978	259	1237	
								Com. Dab,	22	78	100	
								Thornback Ray,	1	5	6	
								Sandy Ray,	..	1	1	
								Gurnard,	..	34	34	
								Angler,	..	1	1	
									1368	440	1808	
11. Same Locality.	,,	..	..	..	,,	4.10 p.m.	8.40 p.m.	Cod,	2	..	2	Weather calm.
								Codling,	6	9	15	
								Haddock (1),	100	..	..	
								,, (2),	162	..	..	
								,, (3),	219	..	..	
								,, (4),	530	..	..	
									—1011	271	1282	
								Halibut,	1	..	1	
								Megrim,	1	..	1	
								Plaice (1),	6	..	..	
								,, (2),	87	..	..	
								,, (3),	482	..	..	
								,, (4),	356	..	..	
									— 881	114	995	
								Com. Dab,	..	144	144	
								Long Rough Dab,	..	6	6	
								Gurnard,	..	60	60	
								Thornback,	..	7	7	
								Angler,	..	1	1	
									1902	612	2514	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No thrown Overboard.	Total No.	Remarks.
12. Same Locality.	Nov. 12.	..	..	..	..	2.55 a.m.	7.55 a.m.	Cod, ...	22	..	22	
								Codling, . ..	23	3	26	
								Haddock (1), ..	97	..	..	
								,, (2). ..	78	..	..	
								,, (3), ..	..	..	..	
								,, (4), ..	107	..	..	
									—— 282	46	328	
								Brill . ..	1	..	1	
								Plaice (1), ...	2	..	..	
								,, (2), ...	137	..	..	
								,, (3), ...	319	..	..	
								,, (4), ...	214	..	..	
									—— 672	169	841	
								Lemon Dab, ..	3	1	4	
								Com. Dab, ..	12	63	75	
								Megrim, ...	1	..	1	
								Gurnard, ...	..	50	50	
								Thornback Ray. ..	..	4	4	
								Sandy Ray, ..	..	1	1	
								Angler, ...	..	2	2	
									1016	339	1355	
13. Same Locality.	,,	..	..	..	6 to 10	11.40 a.m	3.20 p.m.	Codling, ...	5	4	9	
								Haddock (1), ..	3	..	..	
								,, (2), ..	3	..	..	
									—— 6	13	19	
								Plaice (1), ...	7	..	..	
								,, (2), ...	331	..	..	
								,, (3), ...	795	..	..	
								,, (4), ...	784	..	..	
									——1917	184	2101	
								Com. Dab, ..	20	35	55	
								Gurnard, ...	..	16	16	
								Thornback, ..	2	4	6	
								Angler, ...	..	3	3	
									1950	259	2209	
14. Same Locality.	Nov. 13	..	..	..	6 to 11	5.15 a.m.	10.15 a.m.	Codling, ...	1	1	2	Wind S.; fresh breeze; squally.
								Haddock (1), ..	66	..	..	
								,, (2), ..	149	..	..	
								,, (3), ..	197	..	..	
								,, (4). ..	169	..	..	
									—— 581	53	634	
								Brill, ...	17	..	17	
								Plaice (1), ...	3	..	..	
								,, (2).	331	..	..	
								,, (3), ...	571	..	..	
								,, (4), ...	756	..	..	
									——1661	320	1981	
								Com. Dab, ..	71	300	371	
								Lemon Dab, ..	6	..	6	
								Gurnard, ...	..	20	20	
								Angler, ...	..	2	2	
									2337	696	3033	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Overboard.	Total No.	Remarks.
15. Burghead Bay.	Nov. 13.	..	..	..	5 to 10	1.25 p.m.	6.25 p.m.	Cod, ...	4	..	4	Wind S.; fresh breeze.
								Codling.	33	6	39	
								Haddock (1), ..	..	..	..	
								,, (2), ..	26	..	..	
								,, (3), ..	30	..	..	
								,, (4), ..	131	..	..	
									— 187	46	233	
								Brill, ...	36	..	36	
								Plaice (1), ...	10	..	..	
								,, (2), ...	316	..	..	
								,, (3), ...	601	..	..	
								,, (4), ...	412	..	..	
									—1339	215	1554	
								Lemon Dab, ..	3	..	3	
								Com. Dab. ..	40	156	196	
								Thornback Ray, ..	2	..	2	
								Gurnard, ...	..	150	150	
								Angler, ...	..	3	3	
									1644	576	2220	
16. Same Locality.	Nov. 13 & 14.	..	..	..	,,	7.10 p.m.	12.10 a.m.	Cod, ...	3	..	3	
								Codling, ...	24	25	49	
								Haddock (1), ..	3	50	53	
								Whiting, ...	..	7	7	
								Turbot, ...	5	..	5	
								Brill, ...	43	..	43	
								Plaice (1), ...	22	..	..	
								,, (2), ...	381	..	..	
								,, (3), ...	311	..	..	
								,, (4), ...	389	..	..	
									—1103	150	1253	
								Lemon Dab, ..	3	2	5	
								Com. Dab, ..	..	320	320	
								Gurnard, ...	..	105	105	
								Thornback Ray, ..	3	5	8	
								Angler, ...	..	7	7	
									1187	671	1858	
17. Same Locality.	Nov. 15	..	..	..	,,	7 a.m.	11 a.m.	Cod, ...	77	..	77	
								Codling, ...	30	3	33	
								Haddock, ...	..	2	2	
								Whiting, ...	..	1	1	
								Turbot, ...	2	..	2	
								Brill, ...	15	..	15	
								Plaice (1), ...	12	..	..	
								,, (2), ...	205	..	..	
								,, (3), ...	381	..	..	
								,, (4).	234	..	..	
									— 832	99	931	
								Lemon Dab, ..	..	1	1	
								Com. Dab, ..	30	124	154	
								Gurnard, ...	..	67	67	
								Thornback, ..	..	5	5	
								Angler, ...	..	1	1	
									986	303	1289	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
	1903.											
1, Aberdeen Bay, off Black Dog.	Dec. 11.	..	..	..	4½ to 10	10.15 a.m.	1.15 a.m.	Cod, ...	28	..	28	Wind S.; strong breeze; sea rough; rain.
								Codling, ...	118	..	118	
								Coal-fish, ...	..	1	1	
								Haddock (1), ..	142	..	..	
								,, (2), ..	45	..	..	
									—169	..	169	
								Whiting, ...	13	8	21	
								Brill, ...	1	..	1	
								Plaice, ...	1	..	1	
								Com. Dab, ..	4	..	4	
								Starry Ray, ..	..	1	1	
									334	10	344	
2. Same Locality.	,,	8·3	9·6	..	,,	2 p.m.	6 p.m.	Cod, ...	77	..	77	
								Codling, ...	105	..	105	
								Coal-fish, ...	..	2	2	
								Haddock (1), ..	19	..	..	
								,, (2), ..	4	..	..	
									— 23	..	23	
								Whiting, ...	1	13	14	
								Plaice (2), ...	2	..	..	
								,, (4), ...	4	..	..	
									— 6	..	6	
								Starry Ray, ..	..	16	16	
									212	31	243	
3. Same Locality.	,,	..	..	..	,,	6.30 p.m.	11.40 p.m.	Cod, ...	53	..	53	
								Codling, ...	75	..	75	
								Coal-fish, ...	..	2	2	
								Haddock (1), ..	13	..	13	
								Plaice (3), ...	7	..	..	
								,, (4), ...	5	..	..	
									— 12	..	12	
								Com. Dab, ..	3	..	3	
								Starry Ray, ..	..	33	33	
									156	35	191	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Over-board.	Total No.	Remarks.
1 Aberdeen Bay, off Stains Castle.	1903. Dec. 23.	8·7	9·6	8·9	10 to 30	3 p.m.	7.20 p.m.	Cod, ...	77	..	77	Net split.
								Codling, ...	3	..	3	
								Haddock (2), ..	5	2	7	
								Whiting, ...	..	1	1	
								Plaice (2), ...	2	..	..	
								,, (3), ...	64	..	..	
									— 66		66	
								Com. Dab, ..	1	..	1	
								Starry Ray, ..	30	..	30	
								Conger, ...	..	1	1	
								Sand-eel, ...	..	20	20	
									182	24	206	
2. Same Locality.	,,	..	..	..	,,	8 p.m.	11.30 p.m.	Cod, ...	23	..	23	Net split.
								Codling, ...	8	..	8	
								Haddock (1), ..	1	..	..	
								,, (2), ..	4	..	..	
									— 5		5	
								Whiting, ...	..	2	2	
								Plaice (2), ...	3	..	..	
								,, (3), ...	8	..	..	
								,, (4), ...	12	..	..	
									— 23		23	
								Com. Dab, ..	..	1	1	
								Starry Ray, ..	46	..	46	
									105	3	108	
3. Same Locality.	Dec. 24.	..	..	..	,,	12.40 a.m.	4 a.m.	Cod, ...	26	..	26	Net again split.
								Codling, ...	1	..	1	
								Haddock (1), ..	8	..	8	
								Plaice (2), ...	3	..	..	There were none unmarketable.
								,, (3), ...	8	..	..	
									— 11		11	
								Starry Ray, ..	24	..	24	
									60	..	60	
4. Moray Firth ; Burghead Bay.	Dec. 25.	..	..	..	8 to 11	1.15 p.m.	6.20 p.m.	Cod, ...	4	..	4	Wind S.W ; light breeze.
								Codling, ...	9	9	18	
								Haddock (1), ..	3	..	..	
								,, (3), ..	120	..	..	
									—123	604	727	
								Whiting, ...	76	120	196	
								Brill, .. .	2	.	2	
								Plaice (1), ...	2	..	..	
								,, (2), ...	73	..	..	
								,, (3), ...	64	..	..	
									—139		139	
								Com. Dab, ..	...	52	52	
								Long Rough Dab,	..	7	7	
								Gurnard, ...	..	4	4	
									353	796	1149	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in Fms.	Time Trawl Down. Shot.	Time Trawl Down. Hauled.	Fish Caught. Name.	No. taken to Market.	No. thrown Over-board.	Total No.	Remarks.
5. Moray Firth; Burghead Bay.	1903. Dec. 25.	..	..	..	..	6.45 p.m.	11.55 p.m.	Cod, ...	8	..	8	Weather foggy.
								Codling, ...	..	17	17	
								Haddock (1), ..	3	..	..	
								,, (2), ..	23	..	..	
								,, (3), ..	346	..	..	
									—372	2086	2458	
								Whiting, ...	120	108	228	
								Turbot, ...	2	..	2	
								Brill, ...	19	..	19	
								Plaice (1), ...	7	..	..	
								,, (2), ...	134	..	..	
								,, (3), ...	86	..	..	
									—227	14	241	
								Lemon Dab, ..	1	..	1	
								Com. Dab, ...	25	39	74	
								Gurnard, ...	..	7	7	
									784	2271	3055	
6. Off Tarbetness.	Dec. 26.	7·4	9	9·2	16 to 25	9.30 a.m.	11.15 a.m.	Codling, ...	13	4	17	Thick fog. Net split.
								Haddock (1), ..	129	..	..	
								,, (2), ..	36	..	..	
								,, (3), ..	150	..	..	
									—315	23	338	
								Coal-fish, ...	5	..	5	
								Whiting, ...	27	15	42	
								Brill, ...	1	..	1	
								Plaice (1), ...	9	..	..	
								,, (2), ...	23	..	..	
								,, (3), ...	10	..	..	
									— 52	18	70	
								Lemon Dab, ..	6	..	6	
								Com. Dab, ..	11	52	63	
								Witch, ...	1	..	1	
									431	112	543	
7. Dornoch Firth.	,,	..	..	..	7 to 11	4.40 p.m.	8.40 p.m.	Cod, ...	8	..	8	Thick fog.
								Codling, ...	..	4	4	
								Haddock (1), ..	160	..	..	
								,, (2), ..	498	..	..	
								,, (3), ..	112	..	..	
									—770	55	825	
								Whiting, ...	..	23	23	
								Turbot, ...	2	..	2	
								Brill, ...	4	..	4	
								Plaice (1), ...	15	..	..	
								,, (2), ...	70	..	..	
								,, (3), ...	46	..	..	
								,, (4), ...	17	..	..	
									—148		148	
								Com. Dab, ..	..	54	54	
								Long Rough Dab,	..	26	26	
								Flounder, ...	1	..	1	
									933	162	1095	
8. Off Lybster.	Dec. 27.	6·2	7·5	8·3	18 to 22	12.45 p.m.	5 p.m.	Cod, ...	2	..	2	Net badly split. No offal
								Codling, ...	2	..	2	
								Haddock (1), ..	38	..	..	
								,, (2), ..	6	..	..	
									— 44		44	
								Whiting, . ..	9	..	9	
								Plaice (1), ...	3	..	..	
								,, (2), ...	1	..	..	
									— 4		4	
								Witch, ...	1	..	1	
									62	..	62	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Overboard.	Total No.	
9. Burghead Bay.	1903. Dec. 28	..	..	..	5 to 13	2.30 p.m.	7.45 p.m.	Cod, ...	9	..	9	Weather fine; calm.
								Codling, ...	25	7	32	
								Haddock (1), ..	4	..	..	
								,, (2), ..	9	..	..	
								,, (3), ..	160	..	..	
									—173	540	713	
								Whiting, ...	..	22	22	
								Turbot, ...	3	..	3	
								Brill, ...	37	..	37	
								Plaice (1), ...	21	..	..	
								,, (2), ...	198	..	..	
								,, (3), ...	87	..	..	
									—306		306	
								Lemon Dab, ..	3	..	3	
								Com. Dab, ...	10	54	64	
								Gurnard, ...	..	8	8	
								Cat-fish, ...	1	..	1	
									567	631	1198	
10. Same Locality.	Dec. 29.	1·8	5·0	7·3	5 to 12	4.25 a.m.	9.25 a.m.	Cod, ...	7	..	7	
								Codling, ...	..	6	6	
								Haddock (1), ..	3	117	120	
								Whiting, ...	..	13	13	
								Turbot, ...	1	..	1	
								Brill, ...	9	..	9	
								Plaice (1), ...	7	..	..	
								,, (2), ...	41	..	..	
								,, (3), ...	15	..	..	
									— 63		63	
								Com. Dab, ...	27	14	41	
								Long Rough Dab,	..	2	2	
								Gurnard, ...	..	7	7	
									110	156	269	
11. Same Locality.	,,	..	..	..	4½ to 10	12 p.m.	4 p.m.	Cod, ...	2	..	2	
								Codling, ...	..	3	3	
								Haddock, ...	..	56	56	
								Whiting, ...	..	5	5	
								Brill, ...	7	..	7	
								Plaice (1), ...	3	..	..	
								,, (2), ...	84	..	..	
								,, (3), ...	12	..	..	
									— 99		99	
								Com. Dab, ...	..	11	11	
								Cat-fish, ...	1	..	1	
								Gurnard, ...	..	7	7	
								Thornback, ..	2	..	2	
									111	82	193	

TRAWLING INVESTIGATIONS—TABLE II.

Giving particulars as to Boxes of Fish brought to Market.

LARGE HADDOCKS.

No. of Fish.	Length—Cm.		Weight.				Remarks.
	Range.	Average.	In Bulk.		Separately.		
			Lbs.	Oz.	Lbs.	Oz.	
142	33·2–67·5	36·7	140	4	...		
114	33·4–67·3	41·4	...		132	14	
128	27·6–48·6	38·8	127	8	126	2	
78	36 8–57·6	45·4	143	–	139	14	From Faröe.
85	36·1–60·5	45·3	149	9	148	10	,, ,,
114	37 –54·2	...	134	4	...		
111	36·1–54·5	...	127	12	...		
110	37 –60·1	...	129	12	...		
28	50 –71·4	61·6	127	3	126	10	From Iceland.
117	36·7–59·5	...	135	–	...		
127	34·2–64·0	...	136	–	...		
87	38 –62	...	132	7	...		
94	36·5–56	...	136	–	...		
87	39·0–64	...	137	4	...		
87	38·2–58·8	...	130	–	...		
115	33 –53	...	130	13	...		
135	34 –51	40·7	137	8	134	8	
111	36 –52·3	...	127	2	...		
132	31·7–54	...	106	–	...		
148	33 –37	...	106	5	...		
130	36·2–49·5	...	112	14	...		
134	33·5–50·7	...	110	12	...		
122	33 –66·3	42·0	136	8	135	12	
120	34·2–51	42·0	134	3	133	3	
103	36·5–52·3	...	131	2	..		
95	35·5–54·3	...	127	13	...		
90	34·6–57	...	130	–	...		
96	35·5–52	...	121	8	...		
101	29·5–51·6	...	135	5	...		
102	36·9–54·5	...	140	4	...		
95	35 –54·7	...	137	3	...		
102	35 –56·7	...	144	14	...		
95	36 –59·7	...	131	14	...		
94	37·1–57·4	...	130	8	...		
95	34·8–60·5	...	127	3	...		
97	35·8–55·6	...	131	7	...		
35	50·5–70·8	59·2	122	10	..		Extra L.
35	52·7–73·5	60·3	128	3	..		,,
35	51·4–72·8	60·1	133	14	..		,,
37	51·6–68·8	58·7	132	–	...		,,
38	50·7–66·9	58·5	127	15	...		,,
35	50·3–70	59·7	122	15	...		,,
83	34·7–63·1	44·9	131	6	...		

TRAWLING INVESTIGATIONS—TABLE II.

MEDIUM HADDOCKS.

No. of Fish.	Length—Cm.		Weight.		Remarks.
	Range.	Average.	In Bulk.	Separately.	
			Lbs. Oz.	Lbs. Oz.	
186	30·3–37	33·2	124 3	...	
180	31 –38	33·8	...	118 11½	Also 1 codling 36·9.
180	28·8–41·3	34·5	121 4	119 –	
175	28·6–39·5	34·5	119 8	118 8	
209	30·9–38·1	34·1	128 8	126 10	
209	31·3–37·6	34·0	126 12	123 4	
159	31·6–40·6	...	118 4	...	
233	29·8–35·1	...	120 12	...	
221	29·6–37·1	33·1	118 8	117 13	
223	30 –38·2	34·3	124 6	122 14	Also 1 whiting 28·0 cm., 4 oz.
185	32·6–38·5	...	130 –	...	
179	30·3–40·3	...	126 8	...	
180	28·9–44·9	...	129 4	...	
169	30·1–40·	..	121 10	...	
190	26·7–40·6	..	121 –	..	
184	29·5–38·2	..	126 8	...	
176	32· –39·4	..	124 8	...	
173	29·8–39·7	...	124 5	..	
168	30·4–41·	...	120 7	..	
207	31·0–38·5	...	124 12	..	
195	28 –39·4	..	123 2	..	
158	27·8–53·2	36·4	123 12	121 9	
151	32·2–48·5	..	123 8	...	
226	27·3–40·6	32·6	128 11	...	
167	26·8–38·	...	108 4	...	
192	28·4–40·6	...	126 9	...	
230	30·2–39·6	...	139 –	..	
181	31·4–41·3	...	129 –	...	
212	29·5–37·5	...	121 12	...	
209	26·9–40·1	..	124 1	...	
222	29·6–43·9	...	126 9	...	
189	25·3–39·	...	123 6	..	
177	28·7–40·2	...	122 3	..	
182	27·6–38·9	...	125 14	..	
148	32·4–48·4	...	124 19	...	

TRAWLING INVESTIGATIONS—TABLE II.

SMALL HADDOCKS.

No. of Fish.	Length—Cm.		Weight.				Remarks.
	Range.	Average.	In Bulk.		Separately.		
			Lbs.	Oz.	Lbs.	Oz.	
287	22·4–30·2	...	103	–	...		Also 5 whitings and 6 codlings.
246	26·3–25·	30·3	110	13	105	4	
259	22·8–35·1	...	111	4	..		
264	24·6–36·7	31·0	120	–	120	2	Also 1 whiting 30·1 and 5 oz.
280	24·8–30·7	...	119	6	...		
262	27·9–33·4	...	112	15	...		
247	27·5–36·4	32·5	114	15	114	–	
240	26·6–36·6	31·5	116	6	...		
247	26·1–36·0	31·6	122	8	122	4	
255	26·8–35·6	31·9	128	12	126	12	
293	24·4–36·4	31·1	134	–	...		
268	25·6–36·2	...	121	2	...		
273	23·2–33·6	30·2	114	8	...		
269	23·1–33·5	31·1	114	8	...		
257	21·9–33·8	30·4	106	12	...		
277	24·2–34·8	30·6	117	10	...		
271	23·1–34·3	30·	103	12	...		
268	24·7–33·5	30·3	108	5	...		
287	22·8–34·3	29·9	113	13	...		
249	24·3–34·3	...	103	12	...		
247	21·6–34·7	...	101	10	...		Also 2 whitings 41·1 and 46·3 cm.
273	21·9–33·7	...	107	12	...		
278	23·1–34·7	...	110	4	109	8	
261	21·7–34·6	...	113	2	...		
258	25·0–35·6	30·2	108	8	107	12	
319	24·5–36·6	29·4	123	0	122	15	
216	27·0–34·6	...	104	12	...		
231	28·2–34·1	...	108	2	...		
203	27·8–34·8	31.5	102	15	...		
274	26·8–33·2	...	122	2	...		
270	24·3–34·8	30·7	127	4	127		
223	26·9–36·0	31·4	109	12	...		Also 1 whiting 43·5 cm.
208	27·4–37·0	32·5	115	–	113	2	
221	27·6–34·6	...	110	4	...		
211	28·1–35·3	...	102	13	...		
250	25· –35·1	...	114	2	...		
248	23·4–33·9	...	105	7	...		
241	24·8–35·5	...	106	14	...		
226	26·3–34·5	...	105	–	...		
228	26·4–34·9	...	104	10	...		
255	24·8–35·2	...	107	–	...		

TRAWLING INVESTIGATIONS—TABLE II.

CODLING.

No. of Fish.	Length—Cm. Range.	Length—Cm. Average.	Weight In Bulk. Lbs.	Weight In Bulk. Oz.	Weight Separately. Lbs.	Weight Separately. Oz.	Remarks.
39	38·2–66·8	56·6	...		114	15½	Also 1 cat-fish, 2 lbs. 5½ oz.
85	36·1–60·5	45·3	149	9	148	10	
51	30·4–73	49·6	127	6	126	9	
47	30·3–69·6	48·1	124	13	118	14	Also 1 ling, 73·6 cm., 5 lbs. 2 oz.
77	29·5–71·9	...	133	–	...		Also 1 ling, 53 cm., and 1 whiting.
30	34 –77·5	...	125	–	...		
35	41·5–74·9	...	156	4	...		
42	28 –68·8	...	125	6	...		
39	41·2–73	...	128	9	...		
36	38 –74	...	132	13	...		Also 1 ling, 58 cm.
70	28·5–66·5	...	137	5	...		
44	30·3–76	51·2	127	10	125	9	Also 1 ling, 1 lb. 12 oz.
34	36·1–75·1	...	122	12	...		
74	29 –70·4	...	131	–	...		
40	28·5–72	...	124	–	..		
47	34·9–71·8	...	131	14	...		
26	50·4–78·3	...	125	8	...		
68	28·2–78·5	...	135	3	...		
51	37·2–75·	50·4	136	12	135	8	
68	31·2–65·1	43·5	132	12	131	10	
53	34·4–71·9	50·6	139	–	138	2	
58	33·2–80·8	45·7	135	–	134	8	
35	36·5–71·1	54·0	125	4	121	1	Also 1 ling, 60·6= 2 lbs. 8 oz.
40	34·8–71·6	51·5	...		128	9	
26	42·4–70·4	59·0	...		116	–	Ungutted.
56	28·3–62·6	39·6	...		93	7	,,

TRAWLING INVESTIGATIONS—TABLE II.

WHITING.

No. of Fish.	Length—Cm.		Weight.				Remarks.
	Range.	Average.	In Bulk.		Separately.		
			Lbs.	Oz.	Lbs.	Oz.	
155	30·3–53·5	38·	...		125	2	Also 1 haddock, 1 lb. 10 oz.
180	28·1–45·5	35·9	131	3	130	11	Also 1 haddock, 34·0 =6 oz.
157	30 –52·4	...	128	12	...		
192	28·6–46·3	...	129	4	...		
216	24·2–48·1	34·3	91	5	91	5	
260	24·7–44·7	...	109	11	...		Also 1 haddock, 32·0 and 1 codling, 43·2.
218	22·2–46·7	...	94	6	...		Also 2 haddocks, 31·8, 28·8, and 1 codling, 38·3.
183	27·3–43	33·2	117	4	113	10	Line, ungutted.
123	32·2–44·2	36·6	106	–	97	12	Do. do.
183	27·9–34·7	31·0	87	7	86	5	Do. do.
138	29·2–45	34·9	103	–	101	9	Do. do.
85	31·9–46·2	37·2	90	9	86	10	Do. do.
225	27·3–40·2	32·1	118	5	116	12	Also 4 haddocks 25·5—27·2=1 lb. 4 oz.

TRAWLING INVESTIGATIONS—TABLE II.

SMALL WHITING.

No. of Fish.	Length—Cm.		Weight.				Remarks.
	Range.	Average.	In Bulk.		Separately.		
			Lbs.	Oz.	Lbs.	Oz.	
279	24·3–33·5	29·5	106	5	103	13	Round, ungutted. Also 3 haddocks =10 oz.
351	20·6–32·6	26·4	97	13	96	5	Line, gutted.
415	20·8–33·9	...	113	4	...		Also 1 haddock 21·0 cm.
274	24·7–33·7	28·5	92	–	90	2	Line, gutted.
257	23·1–36·5	27·3	91	14	89	14	Line, ungutted.

LARGE PLAICE.

No. of Fish.	Length—Cm.		Weight.				Remarks.
	Range.	Average.	In Bulk.		Separately.		
			Lbs.	Oz.	Lbs.	Oz.	
60	40 –56·8	...	136	15	...		
24	55·7–73·5	...	140	11	...		
24	51·0–69·3	...	141	2	...		
27	55·1–64·0	...	144	4	...		
26	50·8–66·0	...	150	4	...		
27	53·4–68·2	...	140	12	...		
35	47 –59·7	...	129	4	...		
24	55·3–72	...	139	8	...		
25	52·8–69·7	60·4	149	1	...		
42	33·7–67·9	...	135	9	...		
11	57·9–87·6	74·8	138	6	...		
17	52·6–80·8	64·0	132	13	...		
15	55·9–78·8	66·2	132	12	...		
21	56· –73·3	63·1	147	10	...		
23	55·1–68·3	60·4	139	14	...		
24	54·7–68·4	60·1	144	–	...		
23	55·7–68·7	60·7	135	11	...		
23	54·3–70·1	61·4	146	12	...		

TRAWLING INVESTIGATIONS—TABLE II.

MEDIUM PLAICE.

No. of Fish.	Length—Cm.		Weight.		Remarks.
	Range.	Average.	In Bulk.	Separately.	
			Lbs. Oz.	Lbs. Oz.	
144	30 -53·0	35·8	131 6½	...	
134	29·2-47·5	34·2	135 13	...	
66	30·6-50·6	41·3	129 –	128 1	
109	30·7-46·2	36·6	126 8	...	
89	30·1-55·4	38·6	131 5	..	
73	33·2-55·5	42·2	125 5	125 10	
90	33·7-54	...	133 –	...	
88	33·6-51·5	...	132 –	...	
84	33·6-64·5	39·0	137 15	137 12	
79	30·5-52	40·0	127 5	126 12	
61	32·3-57·7	43·3	...	124 13	
47	38·2-59·2	46·0	119 4	117 12	
115	30 -57	35·6	128 8	128 1	Small, medium.
60	33·4-54·5	...	148 –	...	
56	31·6-56·7	...	145 –	...	
56	32·7-54·8	...	135 –	...	
54	29·2-56·5	...	121 –	...	
59	33·3-54·5	...	147 8	...	
59	33·6-60·9	...	137 12	...	
63	29·9-53·4	...	139 12	...	
54	28·6-53·4	...	135 3	...	
58	32 -56·8	...	143 6	...	
66	32·4-51	...	137 14	...	
70	33·1-54·6	...	144 12	...	
75	35 -51	...	140 7	...	
63	32·2-51·4	...	142 2	...	
66	33·5-57·1	42·6	130 13	129 8	
74	33·1-54	44·1	128 15	128 14	
122	30·4-44·9	34·8	129 8	129 6	
96	30·5-56·8	36·8	140 3	...	
89	31·5-48·1	...	138 13	..	

TRAWLING INVESTIGATIONS—TABLE II.

SMALL PLAICE.

No. of Fish.	Length—Cm.		Weight.				Remarks.
	Range.	Average.	In Bulk.		Separately.		
			Lbs.	Oz.	Lbs.	Oz.	
205	22·3–36·2	29·4	...		126	7	
215	24·1–35	29·4	131	13½	...		
210	23·4–35·6	...	128	–	..		
217	22·8–36	...	129	8	..		
150	26·3–39·6	32·5	129	10	...		
107	31·4–40·2	...	118	10	...		
145	24·7–38·4	...	141	3	...		

TRAWLING INVESTIGATIONS—TABLE II.

LARGE WITCHES.

No. of Fish.	Length—Cm.		Weight.				Remarks.
	Range.	Average.	In Bulk.		Separately.		
			Lbs.	Oz.	Lbs.	Oz.	
133	32·7–47·8	39·7	...		125	1½	Also 3 megrims=3 lbs. 10½ oz.
143	33·6–49·7	39·4	...		121	8	Also 1 megrim=1 lb. 7 oz.
113	32·5–49·3	43·2	...		134	4	
119	32 –50	42·7	...		137	12	
129	31·8–53	39	125	4	123	7	Also 1 megrim=8 oz.
131	33·5–49·6	...	121	13	...		
115	31·0–50·3	38·3	136	13	136	4	
143	29·8–48·1	...	142	7	...		
137	30·1–48	...	132	–	...		
152	30·8–47·5	...	128	8	...		
161	33 –45·7	...	133	3	...		
156	31·3–47·5	38·7	186	10	135	12	
160	32·3–50·1	...	127	13	...		
125	32·4–49	41·6	123	8	122	15	
99	32·8–53·6	40·7	122	6	121	1	Gutted.

TRAWLING INVESTIGATIONS—TABLE II.

SMALL WITCHES.

No. of Fish.	Length—Cm.		Weight.				Remarks.
	Range.	Average.	In Bulk.		Separately.		
			Lbs.	Oz.	Lbs.	Oz.	
292	22·6–35·2	29·8	103	8	...		Also 12 megrims and 2 lemon dabs = 6 lbs. 7 oz.
323	19 –35·2	...	107	4	...		
441	19·8–34·6	...	116	10	...		
423	18·1–33·7	...	106	13	...		
315	24·0–40·6	...	130	4	...		
240	28·2–40	...	114	0	...		
298	21·6–36·9	...	106	8	...		
304	19·7–36·2	...	111	12	...		
302	24·2–37·9	...	104	6	...		
378	21·1–34·6	...	93	5	..		
407	19·1–37·3	...	122	14	...		

SMALL LEMON DABS.

No. of Fish.	Length—Cm.		Weight.				Remarks.
	Range.	Average.	In Bulk.		Separately.		
			Lbs.	Oz.	Lbs.	Oz.	
193	17·3–32·8	26·8	104	5	...		
256	20·6–34·7	...	111	8	...		

TRAWLING INVESTIGATIONS—TABLE II.

LARGE LEMON DABS.

No. of Fish.	Length—Cm.		Weight.		Remarks.
	Range.	Average.	In Bulk.	Separately.	
			Lbs. Oz.	Lbs. Oz.	
115	28·5–44·3	35·3	142 –	138 12	
99	29·9–45·7	37·6	145 4	145 8	
100	28·7–46·0	...	134 –	...	
93	29·7–46·7	38	147 15	145 3	
104	28·1–48·2	...	147 12	...	
115	28·8–47·6	35·8	151 6	150 0	
89	26·4–47·7	...	135 6	...	
91	26·9–45·2	...	134 11	...	
97	27·0–45	37·6	142 7	141 5	
88	28·1–48·1	37·5	127 15	126 11	
93	31 –44·7	...	140 1	...	
85	30·5–46·6	...	141 2	...	
88	26·4–46·3	...	140 14	...	
84	27·6–46·7	39·0	141 9	140 12	
110	29 –46·4	36·9	142 4	141 13	
83	28·8–47·4	38·2	129 6	129 0	
114	29 –46·0	36·0	149 5	146 10	
84	32·1–45·9	...	146 13	...	

COMMON DABS.

No. of Fish.	Length—Cm.		Weight.		Remarks.
	Range.	Average.	In Bulk.	Separately.	
			Lbs. Oz.	Lbs. Oz.	
115	21·9–40·6	27·7	...	59 15¾	Also 1 megrim and 4 lemon dabs= 1 lb. 6¾ oz.
109	21·7–38·6	...	...	...	

II.—CONTRIBUTIONS TO THE LIFE-HISTORIES OF THE EDIBLE CRAB (*CANCER PAGURUS*) AND OF OTHER DECAPOD CRUSTACEA:—IMPREGNATION: SPAWNING: CASTING: DISTRIBUTION: RATE OF GROWTH.

By H. Chas. Williamson, M.A., D.Sc., Marine Laboratory, Aberdeen. (Plates I.-V.)

CONTENTS.

In the Eighteenth Annual Report of the Fishery Board (1900) I published a paper dealing generally with the life-history of the crab. Since then I have, as occasion offered, continued my observations on this form, and on other Decapod Crustacea. Attention has been directed specially to the phenomena of Impregnation and Spawning. While the fact of the impregnation was well evidenced by the presence of the internal spermatheca liberally stocked with sperms, the exact mode in which the sperms were transferred to the female was not very apparent. With a view to elucidating the process a detailed examination has been made of the copulatory organs of the male, and the spermatheca of the female. While every stage in the process of impregnation has not yet been determined, still a considerable advance towards the full description of it has been attained.

In connection with the spawning of the higher Crustacea the attachment of the eggs to the endopodite branches of the pleopods has been variously described. The secret of the attachment has been ascribed to various agencies, the principal of which has been the assistance of a strong cement which glued the eggs to the hairs. This I have been able to show is not the case. The stalk of the egg is really formed by the

* "Contributions to the Life-History of the Edible Crab (*Cancer pagurus*)." *Eighteenth Annual Report of the Fishery Board*, Part III.

outer envelope of the egg. The chorion of the egg is pierced by a hair of the endopodite. The hair skewers the eggs on one after the other until it is filled.

Observations on the distribution of the edible crab, and additions to the list of the labelled crabs which have been recaptured, are also included in this paper.

Impregnation.

The act of impregnation is not very easily studied. It takes place immediately after the female crab has cast. The conjunction of the male with the female is so close, and at the same time so readily broken, that it is not possible to follow the act completely by direct observation. The study of the anatomy of the parts, however, enables one to understand the operation in a satisfactory degree. While it is probably the case that in the Brachyura impregnation takes place in a similar way in each species, still the great variety in the form of the intromittent organ,* and also of the vagina, of different species naturally infers a certain amount of dissimilarity in the details of the operation.

An attempt was made to observe the fertilisation in *Cancer pagurus*, but actual coition was not seen. The female, which had just cast, was put in beside a hard male crab. The female was so soft that it yielded to the pressure of the fingers in every part. It lay a plump, almost inert mass when it was withdrawn from the water. The male was in a box a little more than 1 ft. cube. The female was introduced at the corner farthest away from it. The female immediately made its way towards the male, and when it came within reach of its chelæ it remained perfectly still: the male then gathered the female up with its legs and tucked her underneath him. Sometimes the female was right side up, at another she was turned upside down beneath the male. In the case of *Carcinus mænas*, the male, on seizing hold of the female, immediately introduces its penes into the vulvæ. This did not happen in the case of *Cancer pagurus*. This species appeared less at home in the boxes: the quantity of light was probably too great. The male and the female were accustomed to lie perfectly still. The former does not injure the female except by accident, as for example when it is interfered with. The crab is extremely quick in noticing a shadow cast on the water, and throws its chelæ wildly about to find the foe whose presence has been thus heralded. On one occasion, when the two crabs had been separated in order to be examined, the male on being released blindly striking out seized the chela of the female and destroyed the limb. Impregnation was effected in the case of the crabs (*C. pagurus*) in the Laboratory, but probably at night, as it was not observed.

The male sexual organ consists of three parts. First, the genital papilla (fig. 47), which contains the external opening of the *vas deferens*, *v.d.*; second and third, the appendages of the first and second abdominal segments. Each of these organs is paired, so that there is a double male organ, consisting of three parts. The female genital organs are also paired.

The genital papilla (*g.p.*, figs. 39, 41, 47) is situated on the coxopodite of the fifth pereiopod.† The *vas deferens* issues through a hole (*o.*, fig. 55*a*) in the coxopodite, and is protected externally by the wide sac-like genital papilla, the wall of which is strong though soft. The papilla is capable of distension, and in the living crab is usually turgid. This condition appears to be due to the introduction of fluid into the space surrounding

* Brocchi.

† *Cf.* Grobben and Brocchi.

the *vas deferens.* The hole in the ccxopodite round which the base of the papilla is attached is situated close to the proximal edge of the bone, and when the limb is drawn forward the base of the papillla is pressed up against the edge of the sternum of the thorax (*c.p.*, figs. 39 and 41). The effect of this is to render the papilla more tense and erect. The outer skin is invaginated into the end of the *vas deferens.* Within the papilla there is on the *vas deferens* a valve (*v.*, fig. 47) surrounded by a white mass, probably muscular. The genital papilla has been termed the penis (Duvernoy*). It is not the penis in *Cancer pagurus*; it is a physical impossibility for the genital papillæ to reach the vulvæ of the female. The sperms have to be transferred from the papilla by means of the abdominal appendages. The remaining genital organs are the abdominal appendages. They are attached to the first and second segments and are very dissimilar in form. They are in fact complementary. The first appendage is of tapering shape, and is tubular. The tube is formed by the involution of its sides. The second appendage is a long rod, bent, and jointed about the middle of its length. Different authors have ascribed different functions to these appendages. Thus they have been regarded as "exciting organs," which were introduced into the vaginæ of the female, and on being withdrawn their places were taken by the genital papillæ. Duvernoy described the first abdominal appendage as a duct for transferring the sperms from the "penis" (genital papilla) to the spermatheca; the second abdominal appendage he supposed to be a sort of strut, which rested on the thorax of the female and thus formed a sort of prop between the male and female when *in coitu.* Neither of these descriptions meets the fact. The first and second abdominal appendages together form one organ, the penis. The second or rod-like appendage is during copulation inclosed within the first penis and moves up and down in it like the plunger of a pump.

It is first necessary to describe the abdominal appendages in detail. The first appendage, which will be hereafter referred as the first penis (while the second abdominal appendage will be denominated the second penis), is the more complicated.

The First Penis.

The first segment of the abdomen bears a large chevron-shaped expansion on its ventral surface (fig. 65). This chevron is really double; a small chevron (*i.ch.*), which is united with the larger (*o.ch.*, fig. 46) posteriorly, is hid beneath the latter anteriorly. The double chevron is continued backwards on either side as a broad wing-like plate, at the end of which is attached the first penis (1 *p.*). The first penis consists of two parts, a short basal joint and a long tubular distal part (fig. 37). The basal joint consists of a peculiarly shaped bone (*b.*, figs. *ib.* and 59) to which is attached some loose membranous tissue. The membranous tissue is shown in the sketches by dotted areas. The involution of the two sides of the distal portion forms a single tube opening by the separation of the two sides at the top. The opening is towards the median line. Fig. 25 shows a transverse section of the first penis near the tip, with the second penis *in situ.* The outer skin of the penis is hard bony chitin, but lining the tube the inner surface is soft flexible membrane. The latter is shown in the sketches by a thick black line. Fig. 16 shows an intermediate section, and fig. 4 exhibits a transverse section near the base. It shows the sides of the penis drawn

* Duvernoy, "Fragments sur les organes de génération de divers animaux." *Mémoires de l'Académie des Sciences de l'Institut de France,* t. xxiii., p. 105, Pl. I.-IX., Paris, 1853.

apart, throwing the second penis outside, but at the same time a longitudinal septum (*m.*, figs. 37, 59, 60) has appeared which continues the tube. It is merely a continuation of the side of the penis by a soft flexible membrane instead of by the hard chitin wall. The second penis is situated behind the first, and when it is introduced into the first penis it crosses over this membrane, which yields readily to pressure. In length the membrane is short; it is united below to the basal bone and forms the tissue binding that bone on one side to the tubular part of the first penis. In fig. 10 is shown a transverse section through the base. The basal bone (*b.*, fig. 59), has a large segment cut out of it, leaving its proximal part simply a narrow rim to which the membranous septum is attached. The membrane stops just a little beyond the point where the inturned edges of the penis meet and form the tube.

The tube of the penis opens in the base on the anterior side. The posterior side of the beginning of the tube is formed by the membrane. The genital papilla is inserted in the beginning of the tube. When the second penis is in the first, its broadened base lies on the posterior surface of the basal joint. Any pressure of the second penis due to its movement is transmitted through the membrane to the genital papilla (fig. 60). Moreover, as will be shown later, the second penis moves up and down in the first in a manner similar to that of the plunger of a pump; so that sperms or spermatophores ejected from the *vas deferens* into the penis tube will be pumped up and out of it. The groups of hairs that are found on the wing of the chevron and round the basal joint act as valves or packing round and in the beginning of the tube.

The Second Penis.

The second penis is rod-like. It consists of three main parts, first an arm from the end of which the rod rises at right angles (*ar.*, figs. 65, 61, etc.). This arm, which is fused to the ventral edge of the second joint, is formed in its lower half of chitin and in its upper part of soft membrane, in figs. 65 and 68. The arm is the immovable part of the second penis. From its posterior extremity rises the movable penis. It consists of two parts, viz., a base and the rod. The base consists of two bones, *a.* and *b.*, figs. 53, 54, and 56, loosely connected together and to the proximal end of the rod with soft membrane. The largest bone is of a tooth-shape. It consists of a rather broad tooth rising from an expanded base. The other is a narrow somewhat bow-shaped bone. The loose integument between it and the other basal bone permits of the former folding over towards the latter to a considerable degree.

The proximal end of the rod is expanded and cut obliquely off (*ib.*). Distally the rod tapers, at first rapidly then gradually, up to about two-thirds of its length, where there is a joint permitting a slight amount of movement. The loose part of the rod is curved, with the convexity forward. At the joint there is on the anterior side a little tuft of long spine-like teeth (fig. 104). Above the joint the rod tapers more, and it is curved in the opposite sense to the proximal portion. The tip bears a depressed oval cap set obliquely on the end; it is fringed with teeth (fig. 105). The top of the rod is cast slightly in towards the median line.

The Muscular System.

The Abdomen.—The posterior edge of the carapace has attached to its under surface on each side a membranous plate directed forward into which a muscle is inserted. This plate is attached by a strong membrane to the edge of the outer chevron, and the muscle is inserted into the posterior edge of the epimeron. The truncated membranous tip of the first abdominal segment is attached round its sides to the inside of the carapace. The inner chevron is attached by a long jointed rod (*r.*, figs. 52 and 65) to a delicate muscle inserted on both sides of the bottom of the thoracic cavity. A small muscle arises on the under surface of the outer chevron and joins this bony rod. The outer chevron is fastened to the posterior edge of the thoracic cavity by means of a membrane attached to its anterior edge.

The muscular system of the abdomen of the Brachyura has been briefly described by Duvernoy. Fig. 52 shows a median longitudinal section of the abdomen of the male *Cancer*. Half of the abdominal muscles only are of course shown. The muscles consist of flexors and extensors. There are two very long flexors, arising on the thorax, and being inserted one into the telson, the other into the skin covering the ventral surface of the united third, fourth, and fifth joints. The abdomen is flexed or extended as a single structure. The telson has movement independent of the remainder of the abdomen; thus it may, when the abdomen is flexed on to the thorax, be bent backwards from the thorax to permit the escape of the fæces, while the abdomen itself remains fast. Between the second and third joints and between the sixth joint and telson there are pairs of muscles (a flexor and extensor on each pair). At each of these joints there is a larger movement than at the other abdominal joints. Between 1 and 2, and between 2 and 3 the action of the joint is extension and flexion: the latter joint is freer than the former and affords more extension than any of the joints: between 5 and 6 there is flexion alone practically: and between the sixth and the telson there is flexion mainly, but also extension.

First Penis.—In the first penis there is a muscle which, arising on the surface of the basal bone (*b.*) and also from the side of the tubular part, is inserted farther up the same, *mu.*, fig. 59, and *1*, fig. 48. The muscle will have the effect of tending to cause the bending of the two parts of the penis towards one another. There are in addition two muscles, *2* and *3*, fig. 48, which arise from the outer half of the chevron and are inserted into the basal bone. The upper muscle draws the first penis forward: the lower tends to rotate the penis.

The two sides of the double chevron are connected by membrane. The chevrons, although fixed to the first abdominal segment, are not absolutely rigid. They are elastic.

Second Penis.—Just as in the first penis, there is also in the second penis a muscle connecting the terminal part with the basal joint. In this case the muscle, *mu.*, arises on the tooth-like basal bone, figs. 61 and 66, and is inserted a little way up the rod. Another muscle (*mu.'*, *ib.*) is inserted into the same basal bone: it arises from the side of the fixed arm of the second penis. A third muscle arises from the downward-bent end of the arm and is inserted into a bony button-like prominence on the ventral skin of the third joint (*m.'''*, fig. 46). A long muscle arising from the front of the chevron is inserted into the third joint (*m.'*, *ib.*); and a broad muscle, *m.''*, that rises from the base of the fixed arm is inserted on the anterior border of the inner chevron.

The Action of the Penis.

If the genital papilla of a hard male crab is pressed spermatophores may be extruded. When the abdomen of a male crab is examined the genital papilla is sometimes found inserted into the tube of the first penis, but oftener it is lying on the posterior surface of the base of that organ. But if the first penis is drawn backwards into the position it occupies when in the vagina of the female the papilla usually slips into the tube, and if the fifth pereiopod is brought forward in such a way that the genital papilla is pressed up against the edge of the sternum the introduction is aided. The coxopodite of the fifth pereiopod abuts into the narrow neck of the abdomen at the first and second segments, and the genital papilla lies just beneath the first penis.

Occasionally a male has been found in which the second penis was inside the first, but usually they are separate. When the united penes are inserted into the vaginæ, the abdomen is fixed at both ends. The telson lies on the thorax of the female, and the beginning of the abdomen is fixed at its proximal end by its connection to the thorax. The first penis is then held firmly, but is capable of retraction and re-insertion. The second penis is, however, free to work up and down in the first penis quite independently of it. See figs. 44 and 45. In fig. 44, which is intended to represent the position occupied by the abdomen of the male during coition, A and B are the fixed points, B being the thorax of the female, A the carapace of the male crab. The abdomen of the female is outside and closely applied to the abdomen of the male. The drawing shows the condition in which the second penis is completely entered into the first, and its tip appears projecting outside the tip of the first. In this position it is to be noted that joints 2 and 3 are extended, *i.e.* the joint between them is depressed. In the drawings they are shown upside down. Now by the flexing of joints 2 and 3 the second penis is withdrawn partly from the first, while the first remains stationary (fig. 45). By each movement the second penis presses on the genital papilla, and therefore probably causes the issue of spermatophores into the tube. The efficacy of the pumping arrangement was demonstrated experimentally. A small quantity of a thin carmine paste was introduced into the bottom of the tube, and by alternately pushing in and withdrawing the second penis the carmine was pumped out at the top. By the flexion and extension of the portion of the abdomen, then, the sperms (spermatophores) would be gradually transferred to the spermatheca, into which the first penis penetrates.

The Condition of the Spermatheca.

If the soft female crab after it has been impregnated is examined, it will be found that the mouth of the spermatheca and the vagina is filled up by a large plug of white material (*pl.*, fig. 49). This plug may be usually split into two halves, as was shown in a previous paper.* The spermatheca is globular in shape and is filled with an amber-coloured fluid, and a more or less extensive white patch of sperms, situated in the proximal and external part of the organ. The top of the plug which extends just within the spermatheca is soft and pulpy, being in contact with the fluid, whereas in the vagina the plug is hard and fibrous in appearance. It has been noticed that the top of the plug has been grooved or scored as if a thin body had been repeatedly impressed in it.

In a hard female crab which has been impregnated the spermatheca is of much smaller size than in the soft crab (fig. 67). It is then flattened, shrunk, disc-shaped, and contains a quantity of sperms (*sp.*) and some amber-coloured hard material (*sl.*), which is the solidified remains of the fluid which filled the spermatheca at the time of fertilisation. The inner wall of the spermatheca (*sp.w.*) and the vagina (*v.w.*) are continous, but that of the spermatheca is much the thinner (fig. 38).

In my previous paper on *Cancer pagurus* I stated that the inner lining of the spermatheca and the contents of the latter were thrown off with the cast integument during the moult, an opinion held also by Cano.

* "Contributions to the Life History of the Edible Crab (*Cancer pagurus*)." *Eighteenth Ann. Report of Fishery Board for Scotland*, Pt. III., 1900.

This I find is not the case, with adult crabs at least. Each crab which I have examined after it had cast, and before it had been in contact with the male, was found to have a spermatheca resembling in general that of a hard crab, *i.e.*, it contained a quantity of sperms and some amber-coloured solid. If a soft crab which has been with the male, and is plugged, be dissected, no amber solid will be found in the spermatheca, and there is usually a large quantity of sperms with a large quantity of amber fluid. When does the crab get rid of the old sperms and amber solid? The inner lining of the spermatheca, although it does not come away during moulting, is nevertheless very loosely attached, and I have drawn out the inner lining and the contents of the spermatheca, along with the lining of the vagina, through the vulva, in a dead hard crab. On casting only a very little of the inner lining of the spermatheca is shed; that is, the part round the mouth.

Just inside the spermatheca the lining thins out quickly. The mouth of the spermatheca is surrounded by a sphincter muscle, *mu.*, fig. 38.

The break between the lining of the vagina and that of the spermatheca takes place near the point where the thick layer of the vagina thins down to that of the spermatheca (fig. 38). In the newly cast crab, moreover, there was no fluid in the spermatheca. The spermatheca of the crab has a glandular secreting surface. It is probably the case that the secretion of the fluid causes the loosening of the inner layer, and on the introduction of the penis the amber solid and the old sperms may be expelled with the outflow of fluid. The secretion of fluid in the spermatheca is possibly stimulated by the presence of the male. The vulvæ are always tightly closed except when they are kept open by the plugs. On the introduction of the penis the fluid will flow out round it in the vagina and will prevent the entrance of sea-water into the spermatheca. *Vide* diagram, fig. 55. This fluid coagulates with sea-water, forming a whitish precipitate. The plug in the vagina is of a hard fibrous structure and of white colour. During the time the male and female are in conjunction, a period of probably several days, the piston-action of the second penis would transfer the sperms to the spermatheca. The crab, then, on casting does not get rid of the remains of the old stock of sperms until it has the opportunity of being impregnated afresh.

Some experiments were made with certain crabs which cast during 1902, August 31st to October 15th, and the results are of interest. A female, measuring $5\frac{3}{4}$ inches across, was put with the male crab as soon as it was seen to have cast, and four days later pieces of plug were seen projecting from the vulvæ. Another measuring 5 inches was separate from the male two days after, and at that time a plug projected from the vulva. A female crab, measuring $6\frac{3}{8}$ inches across, was kept for four days after casting. It was not in contact with a male crab. It was then killed: no fluid was found in the spermatheca. Six days after casting the soft crab which measured $6\frac{1}{16}$ inches across, and which had not been in contact with a male crab, was dissected. The spermatheca contained sperms and a row of hard amber-coloured solid. A small soft crab, viz. $4\frac{1}{8}$ inches across, was put with a male crab. Twenty-four hours after, no plugs were seen, but they were visible two days after the introduction of the female.

It is to be noted that while in the male crab the sperms are contained in spermatophores, in the spermatheca the sperms are loose; in very few cases was a spermatophore seen. According to Duvernoy, sea-water causes the spermatophores to burst.

The extrusion of the spermatophores from the *vas deferens* is no doubt aided or effected by the following circumstances. The *vas deferens* of the hard male crab is usually in a swollen condition, and therefore the opening of the valve in the genital papilla would immediately be followed by a free issue of spermatophores. The opening of the valve may be due to the pressure of the second penis as it moves in the first, aided possibly by the forward movement of the fifth pereiopod, which will result in increasing the turgidity of the papilla.

A portion of white plug material has been found on the penis in more than one crab. One case calls for special mention.

A large male crab, 6 inches across, hard, was examined at the beginning of June. The second penis was inside the first, the genital papilla was inserted into the beginning of the tube. Projecting from the aperture in the tip of the first penis there was a narrow rod-like white body. At the inner side of the base of the first penis there was a small white mass. On examining the rod with the microscope it was found to be a tube crammed with spermatophores; on its outer surface there were sperms and spermatophores. The tube was formed of parallel fibres. It was found in one penis only. No spermatophores were found in the lower white mass, which had the same fibrous appearance that the plug has. In no case were spermatophores found in the spermatheca packed in a tube. The tube, if it is the normal condition, may act simply as a sheath inside of which the spermatophores travel. It is formed simply by the introduction by the base of the penis of some of the fluid of the spermatheca which had flowed out from the vagina. By working the second penis in piston-fashion the tube was gradually pushed out of the first penis. It had apparently been connected to the white mass at the base.

The Impregnation of Carcinus mænas.

The structure of the intromittent organs and of the spermatheca differs considerably from those of *Cancer pagurus*. It is not, however, proposed to deal with these differences, but to describe the act of fertilisation so far as it was possible to follow it with the naked eye. It is not likely to be strictly homologous to that in *Cancer*.

Carcinus mænas is not apparently incommoded to any considerable extent by captivity, and it is possible to observe the act of impregnation. In the following case the male was put into a glass jar, and a female which had cast the previous night was then introduced beside it (September 16th). The male immediately turned the female, with the assistance of the latter, upside down. The female raised (or extended) its abdomen and brought it outside the abdomen of the male. The male then extended its abdomen, and rested its telson (bent at right angles to the abdomen) on the thorax of the female between the vulvæ, immediately thereafter inserting its penes into the two apertures. These operations took place in a few moments. The male then pushed the penes into the vaginæ and drew them out slightly, about once every two seconds, but while under observation intermittently. The male carries the female about with it, and the female is attached to the male simply by the hooked penes. The legs of neither crab are used for attachment. The penis appears to be inserted only a short distance.

On September 18th the two crabs were still *in coitu*, but on the 20th they were separate.

The female was now fairly hard. It was killed on the 20th.

There were no externally projecting plugs. The spermatheca was filled with a large irregular plug which projected a little way into the vagina. In the vagina from the end of the plug just mentioned to the vulva there was another short plug with a rounded upper extremity; along its length it showed a slight groove. Round the external end of the spermatheca and along the vagina there is a layer of gelatinous-like tissue, probably glandular. Some spermatophores were found on the plug inside the spermatheca. In the vagina of the other side the short plug was absent.

A female which cast between the 22nd and 23rd October, and which had not been in contact with a male, was dissected on the latter date. It was already fairly hard, the integument resembling in feel stiffish brown paper. The spermatheca was large, with thick walls; it had a little white mass at its mouth. There was a certain amount of fluid in both spermathecæ, but the latter were not globular.

The Spawning of Cancer pagurus.

The Mode of Attachment of the Eggs to the Swimmerets.

The external eggs of the edible crab are, like those of other decapod crustacea, carried, during incubation, on the hairs of the inner branches of the swimmerets of the female. They are arranged on the hairs from their bases to the tips as thickly as they can lie. When the hair of a berried crab is examined, a condition similar to that shown in fig. 21 is seen. The eggs are attached by independent stalks to the hair, and they are moreover so closely set together that their stalks intertwine. As, however, the egg is not always attached to one hair alone, but sometimes to two, we have the hairs grouped in bunches which correspond to their whorl arrangement on the endopodite, *e.g.*, *cf.* fig. 26. The intertwining of the stalks of eggs also tends to bind the hairs together.

How do the eggs become attached so closely and regularly and in a manner so economical of the space at their disposal?

Several agencies have been invoked to explain this. Cano* and Herrick† have each given an historical resumé of the theories held with regard to the mode in which the attachment of the eggs to the pleopods was brought about. It is not necessary to recapitulate it nor Cano's full discussion of the egg-membranes of the decapods. According to Lereboullet‡ certain zoologists had explained the attachment of the ova to an extension of the primary egg-membrane.

There has, however, been general agreement that the fixation of the egg is due to a cement with which it is coated; that the egg becomes in one way or another covered with a cement which on exposure to sea-water hardens, after having glued the egg to the hair of a pleopod. The cement was supposed to be derived from the ovary or oviduct by Milne Edwards and Rathke; from the spermatheca by Cavolini and Cano,§ and in the case of *Astacus* from the integumental glands found on the pleopods and ventrum of the abdomen by Lereboullet and Braun.

While in the case of macrurous decapods this explanation might not be dismissed on *a priori* grounds, it is impossible to accept it as applicable to the Brachyura. It matters not how the cement is produced, the question reduces itself to this position—Given an egg coated with a cement strong enough to form the stalk of the egg, which resists rupture for a period of eight or nine months, a period during which time the swimmerets are being continually agitated in order to aerate the eggs, is it at all likely that it would always attach itself to a hair, and never to another egg similarly coated? If we examine the eggs of a *Cancer*

* Cano, "Morfologia dell' apparecchio sessuale femminile, glandole del cemento, e fecondazione nei Crostacei Decapodi." *Mittheil. Zool. Stat. zu Neapel*, ix. Bd., 4 Heft., 1890.

† "The American Lobster." *Bull. U.S. Fish Commission* for 1895, p. 127.

‡ Herrick, "The American Lobster." *Bull. U.S. Fish Commission* for 1895.

§ Cano, *op. cit.*

pagurus, *Carcinus mænas*, *Portunus* sp., *Hyas* sp., etc., we will find the eggs attached by their long stalks to the hairs of the endopodites. They are closely set together, but in no case do we find two eggs stuck together. If the eggs had been coated with cement, they could not have avoided sticking together, and also to the exopodites. What special affinity can there be between the cement and the hair which does not exist between the cement of two eggs? If the cement on being acted upon by sea-water hardened, what is to prevent the two eggs from sticking together? When the eggs are extruded they lie in the incubatory chamber formed by the curved abdomen in a semi-fluid mass, and they are there retained by the overlapping exopodites. The latter prevent the eggs flowing out over the edge of the abdomen. Now if each egg were coated with a layer of cement, we should have the eggs concreted into a solid mass, and while the endopodites would be imbedded in it, the exopodites would be probably glued to the outside. The eggs never attach themselves to the exopodites with which they are in close contact.

No cement is supplied by the spermatheca. When the eggs are extruded the spermatheca is dry except for the pasty white mass of sperms; the solid remains of the spermatheca fluid are present. This solid is the consolidated residue of the fluid which was secreted by the spermatheca just after the crab cast and when it was impregnated. Cano evidently supposed that the cement was secreted by the spermatheca.

The egg does not derive a coating of cement from the ovary. The ripe eggs, if taken out of the ovary, sometimes have a slight coating of an albuminous substance; it is derived from the yolk of ruptured eggs, which is somewhat sticky, for by it an egg may become attached to the bottom of the vessel in which it is; but the union is of the slightest, and a touch from a camel-hair brush is enough to dislodge the egg. That the attachment does not result from an external coating of cement is therefore apparent.

An opportunity which I had of observing the spawning of *Cancer pagurus* has enabled me to describe the manner in which the attachment of the eggs is effected. The fact that the eggs are attached to the hairs of the endopodite, which are smooth, and not to the hairs of the exopodite, which are plumose, necessitates a condition in which an attraction or affinity exists between the egg and the endopodite hair which does not exist between it and the exopodite hair.

The conditions which are necessary to the regular attachment of the eggs to the hairs of the endopodite, and to them alone, are the following—(1) the eggs themselves must not be coated with a fluid which is of itself sufficient to cause it to adhere to anything when it is extruded, or otherwise we should have the eggs adhering to one another; (2) the hairs must not likewise be coated with an adhesive cement, or they also would be glued together; (3) after extrusion a condition must arise which will lead to the attachment of the eggs to the hairs of the pleopods, and the relation is one which acts between each egg and some particular hair.

The intimate relationship between the egg and the hair is due to the hair acting as a skewer upon which the eggs are impaled and strung.

On extrusion the ripe egg has two investing membranes, the outer or chorion and the very delicate vitelline membrane, the "dotterhaut" of Rathke. The hair perforates the chorion and enters the "perivitelline chamber," and passes out again without piercing the vitelline membrane which is so closely applied to the yolk-sphere, and is moreover so delicate that it is not readily recognised. The process is more easily followed when the structure of the abdominal appendages is examined.

The endopodite and exopodite of the pleopod are very different from one another, and their different functions are very evident from a minute examination of their forms. They will therefore be described below in detail.

In addition to the discussion of this question in the case of *Cancer pagurus*, observations on the spawning of *Carcinus mœnas*, and on the manner of egg-attachment in *Homarus*, *Nephrops*, *Munida*, and other forms, will be added.

The Swimmerets.

There are four pairs of swimmerets, attached to the second, third, fourth, and fifth abdominal joints respectively, fig. 15. Each consists of an outer, the exopodite (*ex.*), and an inner branch, the endopodite (*en.*).

The description of the swimmeret of *Carcinus mœnas* by M'Intosh* applies very well to *Cancer pagurus*:—"*First pair of Abdominal Feet.*—The internal limb [endopodite] is clothed for the most part with long, delicate, silky hairs, which are simple throughout, with the exception of some branched hairs at the base, best seen on the anterior surface of the foremost limb. The former are pale and translucent, and come off in distinct bundles all the way up from their commencement. The tufts above the middle joint arise from the upper part of each of the pseudo-joints that compose the flabellar extremity, being situated, likewise, only on the posterior surface and sides of the limb, the anterior surface being free. The hairs themselves are very beautiful, presenting externally a brownish or yellow outline, within this a pale streak, and then a more or less granular central portion . . . The external limb is covered with branched hairs from base to apex along both outer and inner edges, the hairs on the outer row being rather longer than those on the inner. A few short, smooth bristles are distributed over the general surface of the limb." "The ova, when present, are attached solely to the inner limb of each abdominal appendage."

The Endopodite.

The endopodite (*Cancer pagurus*) is long, cylindrical, tapering to a blunt point; it is bent slightly in bow-shape, the concavity being towards the anterior side. Over its whole length it bears tranverse rows of long, stiff, slender hairs. These rows are not set at right angles to the long axis of the endopodite, but run obliquely downwards from the inner (next the median line of the abdomen) to the outer edge, *en.*, fig. 20*a*. They are moreover confined to the posterior surface, their ends appearing at the edges only of the anterior surface. On the outer edge they come a little further on to the anterior surface than on the inner side, *en.*, fig. 20*b*, and fig. 63, which gives a plan of one of the rows. The tips of the two endopodites of opposite sides meet in the middle line, and the hairs on their inner surfaces are together bent forwards, fig. 13. The hairs are thus pointed in every direction. The arrangement of the hairs on the posterior surface of the tip is shown in fig. 62.

The hairs from their extreme thinness are very flexible. They are perfectly smooth, except near the tip. The latter ends in a sharp process, and close to the extremity of the hair there are a number of delicate cilia (fig. 23*a*). The tips of the hairs do not all conform to this type. Considerable diversity of structure was found in different hairs, *vid.* figs. 22, 23, 31, 33; they usually, however, end in a more or less acute point, and the cilia are generally to be made out. It is probable

* M'Intosh, "On the Hairs of *Carcinus mœnas.*" *Trans. Linn. Socy.*, vol. xxiv., p. 97.

that the variations are due to the delicate terminal spine being broken off, and the different conditions noted and drawn in the figures may be stages in the regeneration of the extremities of the hairs. This repair would appear to be continuous.

The hair is tubular, and in the central cavity or core there is a large quantity of minute oval corpuscles.

The shell of the hair consists of two main thick layers, viz., an outer, *o.l.*, and an inner, *i.l.*, figs. 30 and 32. They are laminated in structure; the outer layer shows a division into one, sometimes two, thin cuticular layers; and the inner layer usually shows a separation into one thin layer on the outer side, and sometimes also a thin layer next the core. The internal surface of the inner layer is uneven, corrugated in appearance. The inner layer varies in thickness in different parts of the hair: at the base it is especially thick, fig. 30. It is practically a replica of the outer layer. The two layers are to some extent independent, or at least separate easily from one another. This is seen when a hair is broken. It often happens that when the outer layer is snapped, the inner layer remains intact, and the two parts of the outer layer become separated by an interval, *vid.* fig. 6. It does not appear that the separation of the broken halves of the outer skin is due wholly to a sliding over the inner, but rather also to the fact that the inner layer expands on the release afforded by the rupture of the former.

The anterior surface of the endopodite has scattered over it short, stiff hairs, fig. 50.

The endopodite is jointed at about a fourth of its length from the base, and at this point there are muscles for moving the distal portion. The latter bears the greater mass of the hairs.

The Exopodite.

The exopodite resembles somewhat the endopodite in form. It is, however, more flattened in its proximal part than the latter. With the exception of the fourth, the exopodites are more or less twisted on their axes in such a way that the edges bearing the hairs are brought into an obliquely antero-posterior position, *vid.* fig. 13.

The exopodite is furnished on either side from base to tip with a very thickly set row of plumose hairs. These are of various length, *vid.* figs. 11, 12, 35, and 36. In the case of the shortest hairs, the ciliation commences close to the base, while in the others it begins further along the stem in proportion to the length. In the case of the longest hairs almost the whole of the proximal half is bare of cilia, fig. 36. Through the closely set arrangement of the hairs of different lengths, the short hairs supply the ciliation which is absent from the stems of the long hairs. In this way there results the formation of a thickly-set hedge, with no unnecessary overlapping of structures. The ciliation is at first sparse, but quickly increases in amount.

The cilia are all long, stiff, terminating in fine points; they are moreover serrated. On the shortest hairs they are long and slender, fig. 8; on the longer hairs flattened, lanceolete in shape, fig. 7. They are arranged all round the stem of the hair, recalling generally the structure of a test-tube brush. At the extremity of the hair, in consequence of the shortening of the nodes, the cilia are packed closely together round the falcate tip.

The stem of the hair is tubular. The core is narrow, the wall thick and composed of several layers, fig. 9. Fig. 17 shows an ocular section at the base of the hair. The tube of the hair is continuous with a canal in the exopodite.

The plumose hairs are not confined to the two edges of the exopodite, but are also found on the outer surface, *vid.* fig. 42. They do not, however, run round the stem in rows as do the hairs of the endopodite; they are simply scattered over the outer surface.

The inner surface of the exopodite, fig. 51, is provided with scattered short hairs, which are serrated.

The Ripe Egg.

The eggs of *Cancer pagurus* are ripe during October, November, December, and January,* and spawning may take place in each of these months. The eggs are extruded in a short space of time, probably within a period of twenty-four hours.

In my former paper, "Contributions to the Life-History of the Edible Crab (*Cancer pagurus*)," I described the ripe ovary as follows:—"The ripe ovary is of a turkey-red colour. . . . All the eggs are not of one size. The diameter of the yolk-mass may vary from ·3—·41 mm.; in some eggs the yolk-sphere is as small as ·24 mm. The diameter of the *Zona radiata* varies greatly from the fact that the egg in the ovary has a large perivitelline space. . . . The diameter of the capsule may vary from ·4—·7 mm.; the eggs attached to the swimmerets measure ·45 and ·5 mm. in diameter." I have, however, come to the conclusion that the condition just described, where the ovarian egg shows a large perivitelline space, is a pathological one. I have since then only found it in crabs that died during the spawning season; the dropsical condition of the ovary having possibly been the cause.

The ripe ovary, however, sometimes exhibits a condition which suggests the presence in it of eggs with large perivitelline space. In a crab measuring $7\frac{1}{8}$ inches across (17 November, 1903) the ovary was full and of a crimson-red colour. When its outer surface was examined with a lens, a clear area was seen surrounding the egg. This clear area is a sort of fluid space in the follicle, and is not a perivitelline space; it is outside the egg.

The ripe egg has *two* envelopes—the inner, the vitelline membrane (*v.m.*), is clearly applied to the yolk-sphere; the outer, the chorion (*chr.*), is separated from the former by a very narrow space when the egg is *in ovario*. Fig 5 shows a section of the ripe ovarian egg. It is contained in the follicle (*f.*). The yolk-sphere is composed of large corpuscles. Mayer † was of the opinion that fertilisation took place in the ovary before the egg was invested with the chorion.

Rathke ‡ described, on the egg of *Astacus*, *three* egg-membranes, viz. "die Dotterhaut" [the vitelline membrane], "die Lederhaut," and "die aussere Eihaut" [the chorion]. In the egg, previous to the commencement of the development of the embryo, there is a space between the "Dotterhaut" and the "Lederhaut," which contains a transparent fluid; the quantity of this fluid diminishes as the development proceeds. In this way the "Dotterhaut" and the "Lederhaut" come to lie closely together. The "aussere Eihaut" is that by which the egg is attached to the swimmeret. This description does not apply to *Cancer pagurus*, where there are only *two* egg-membranes.

A section of a dropsical ovarian egg is seen in fig. 34. These eggs can be made out with the naked eye scattered over the surface of a lobule of the ovary when few in number; when the majority of the eggs are

* Heath's observations lead to a similar spawning-period for *Cancer magister* on the coast of California. *American Naturalist*, 1902.

† P. Mayer, *Jena. Zeit. Naturwissen*, 11 Bd., 1877.

‡ Rathke,

thus distended the ovary is swollen and contains a considerable quantity of an amber-coloured albuminous fluid. In the dropsical ovarian egg the perivitelline space is filled with an amber-coloured fluid, which is somewhat granular in appearance. Some of the eggs had been preserved in a one per cent. solution of formaldehyde in sea-water, and the perivitelline fluid was found to have solidified into a whitish substance resembling coagulated albumen. This substance cut easily, being of a cheese-like consistency, and it formed round the yolk-sphere a thick rind which could be removed in two hollow hemispheres. The dropsical eggs when fresh are rather dull in colour, in contrast to the bright normal egg.

The ovarian eggs, and also those which are lying on the abdomen of the crab before they become attached to the swimmerets, show under the microscope no trace of cement on the outside; the chorion shows a sharp clean surface. If the ripe eggs be taken from the ovary and put into sea-water a perivitelline space of more or less extent begins soon to appear. The egg imbibes water, and the chorion or outer envelope is distended, and stands out all round clear of the inner, the vitelline membrane (*vide* fig. 95).

Certain ripe eggs were extracted from the vagina of a female that had been spawning, by means of a pipette introduced by the vulva. They were practically identical with the ovarian egg, there being practically no perivitelline space (fig. 94).

If the eggs which have been extruded, and which are found in a semi-fluid mass lying on the abdomen of the crab, be examined, some will be found to be attached to the hairs, while others are loose. The latter show large perivitelline spaces, but not so large as in the dropsical eggs. A large quantity of eggs which had been extruded a week previously, and which had not become attached, but were lying in a heap in a corner of a box in which a spawning female was confined, had very large perivitelline spaces; they were stuck together, but were easily separated.

The essential for the attachment of the egg to the hair of the endopodite is the large perivitelline space, to which the great ductility of the chorion contributes materially. In each of the eggs, from that showing practically no perivitelline space, viz. the ovarian egg, to the egg which has been a considerable time in water and in which the perivitelline space has reached enormous dimensions (fig. 96), the chorion always shows a sharp definite outline without wrinkles, *i.e.*, as long as the chorion is unpierced by the hair.

Certain experiments bearing on the formation of the perivitelline space were made on the eggs from apparently ripe ovaries during November. A portion of the ovary was teased out in sea-water. It is to be noted that the space does not begin to form in all cases—and even if it does form it may be only slight in extent—although the eggs may be indistinguishable from others which do so. Whenever the vitelline membrane is ruptured (as may often happen in teasing the ovary), the egg immediately forms a large perivitelline space, and the fluid in the latter becomes amber-coloured or pinkish, whereas in the normal egg it is colourless.

On November 17 a female measuring $7\frac{1}{8}$ inches across was dissected. The ovary was friable, and the eggs, which measured ·37 and ·4 mm. in diameter, separated out easily in water. There was no perivitelline space visible. At the end of three minutes a distinct perivitelline space had appeared.

In another crab the ovary was full and of a crimson-red colour. After being in sea-water for about an hour the eggs showed perivitelline spaces of considerable amount.

A crab measuring $7\frac{1}{2}$ inches across on November 9th had an ovary which was large and full. The eggs measured about ·4 mm. in diameter. Some were a little less; others larger and narrower. Certain of the eggs were put into fresh water: others into sea-water. They began to form spaces in a few minutes. In the fresh water the eggs which had been of a bright red colour imbibed the water so much that the inner egg (yolk-sphere) became disorganised, and the fluid in the space became red or amber-coloured. The whole egg, moreover, became whitish-pink to the naked eye—the condition seen in dead eggs. A considerable perivitelline space formed in the eggs in the sea-water in about ten minutes, and the eggs were not disorganised.

The rapidity with which the perivitelline space is formed depends on the stage of development of the egg. Minute differences occur between eggs of an apparently similar stage of ripeness.

In another case the eggs were examined twenty minutes after they were put into sea-water, and they then showed perivitelline spaces. Several days afterwards, the perivitelline spaces had increased in extent, but the eggs retained the fresh normal colour.

In none of the experiments did any of the eggs stick to the glass.

On October 30th a crab was found to have spawned, probably during the preceding twenty-four hours. A large quantity of eggs was lying in a heap on the bottom of the tank, while a large amount of eggs was contained on the abdomen. Some of the hairs of one of the endopodites were snipped off, and on examination the attached eggs showed an early condition of the process of attachment. In some the zona was not yet completely collapsed: some of the eggs were however already stalked. There was a number of dead eggs attached to the hairs. On one of the hairs the little cilia were seen to be turned back, as if they had been bent over as the hair was pushed through the egg membrane. The eggs that were lying on the bottom of the box were quite separate, and they showed under the microscope no coating of cement, as did neither of the ovarian or attached eggs.

An experiment was made with the view of testing whether or not the perivitelline fluid had adhesive properties: this fluid was found to be sticky. Some ripe eggs were put into sea-water and left there until the perivitelline spaces were well developed. Four of these were transferred to a watch-glass. The chorion of one egg was pierced by means of a needle, and the egg began immediately to show an adhesive property. Under the microscope a slightly refractive fluid was seen to have flowed out of the puncture and to have stuck to the glass. On the following day the egg was attached to the glass, while the others were freely movable. It was, however, detached by a puff of sea-water from a pipette, although it resisted gentle suction by the same instrument.

The egg then having the large perivitelline space is pierced by and skewered on to an endopodite-hair. The chorion collapses, and being extremely delicate falls round the hair clinging to it. The perivitelline fluid being somewhat sticky no doubt helps to glue the chorion to the vitelline membrane, to other parts of the chorion, and to the hair.

The eggs which escaped piercing, and which lay on the bottom of the box, showed large perivitelline spaces: they grow dull in colour and die. It is probable that the pressure set up within the chorion by the osmosis is sufficient to cause the death of the egg, unless it is relieved by the piercing of the membrane.

In certain ovaries degenerating eggs were found. They were usually of a dull pink colour, and their contents were disorganised. The ovaries were sometimes full of these eggs, *e.g.*, in some of the crabs kept in confinement—spawning having in some way been prevented.

The Attachment of the Eggs.

On being expelled from the ovary the eggs are received into the so-called "incubatory chamber" formed by the curved abdomen. The perivitelline space rapidly develops in each egg. The abdomen is withdrawn from the thorax, and the sixth abdominal joint and the telson are turned upwards, giving a quadrant shape to a longitudinal section of the abdomen, *ab.*, fig. 14. The thorax forms the anterior end, the abdomen the floor and posterior end of the chamber. The two sides are formed by the exopodites, which by means of their plumose edges overlap and prevent the eggs flowing out over the edge of the abdomen. The condition is shown semi-diagrammatically in fig. 19. The eggs are apparently extruded continuously until all are expelled. They then lie in a semi-fluid mass in the "chamber," and embedded in the mass of eggs are the endopodites with the flexible sharp-pointed hairs. The endopodites have, independently of the exopodites, two distinct movements, of small extent, one in an antero-posterior plane, viz., *a.—a.*, fig. 19, and the other in an oblique direction across the abdomen, indicated by the arrow, *p.* — *p.*, and *p.'—p.'* ; *p.—p.* referring to the endopodites of the right side, *p.'—p.'* to the endopodites of the left side. This oblique motion belongs to the distal parts of the jointed endopodites. The hairs reach every portion of the receptacle. The continued double movement of the sharp slender hairs through the mass of eggs confined in the incubatory chamber results in the eggs being impaled and thickly skewered on to the hairs. This condition is shown in fig. 1, which represents a hair taken from a crab which had extruded its eggs only a short time, probably not more than twenty-four hours, previously. In the drawing the perforations in the zona are exaggerated. The hair avoids piercing the yolk, simply passing through the zona into the perivitelline space, and then issuing at a place near the point of entrance. Some dead eggs which were being devoured by Nematodes and Acarinæ were found on the hairs. How far the death of the eggs was due to the accidental piercing of the yolk by the hair, or to the unfavourable conditions under which the crab was living at the time (viz., in confinement in a small hatching-box), is open to question. The hair on striking and entering the zona will almost of necessity force the egg to turn round in such a way as to bring the yolk-sphere off the line of impact. The yolk-sphere would naturally tend to keep at the lower pole of the egg.

In a short time the zona collapses, and it becomes glued to the hair by means of the perivitelline albuminous fluid. The stalk or pedicle is formed by the adhesion together of the parts of the zona which meet. This condition was found when the eggs were examined twelve days later. Figs. *3a*, *3b*, *3c*. An interval of that duration is, however, possibly not necessary for this change to occur. The stalks vary in breadth, and they are now more or less wrapped round the hair. All the crabs under observation threw off their eggs shortly afterwards, but in a crab which had spawned in a tank, and which was examined in January, the stalks were now found to be rope-like in many cases. The stalks of the eggs were also intertwined. The movement of the swimmerets, which is probably continuous in order to afford aeration to the eggs, will, by tending to throw the yolk-sphere as far away as possible from the point of attachment, result in the formation of the long rope-like stalk, fig. 21.

Some of the eggs are pierced by two hairs, and through this it happens that the hairs are bunched together. This takes place not only with the hairs of one row, but also with the hairs of adjacent rows. The grouping of the hairs is, however, no doubt mainly due to the interlocking of the eggs attached to different hairs.

Sometimes a hair is seen to be fixed in a position in which it is bent double.

The egg in the condition last described, firmly attached to the hair, is seen on sectioning (figs. 18*a* and 18*b*) to have three layers, which are the three layers noticed by Rathke in the egg of Astacus, but this author regarded the outer investment ("Aussere Eihaut") (the chorion) as derived from the "cement." The three layers of the egg-shell are, (1) outermost, the chorion (*chr.*); (2) next the yolk, the delicate vitelline membrane, *m.* ("Dotterhaut"); and between the two a thicker layer which appears to have been formed simply by the solidification of the perivitelline fluid, *sl.*, figs. 18*a* and 18*b* ("Lederhaut"). This results in gluing the two primary layers together, in that way forming an efficient protecting envelope to the egg.

The Sloughing of the Empty Egg-Capsules.

A point of some interest is the manner in which the crab gets rid of the empty egg-capsules after the hatching of the brood. This is effected by sloughing off the outer layer (*o.l.*, fig. 32) of the wall of the hair along with the attached capsules, fig. 43. The slough of the hair is shown of greater diameter that it ought to be in proportion to the rest of the figure.

The minute oval corpuscles found in the cavity of the hair probably function in forming a new inner layer of the hair, and in repairing injuries which the hair may receive.

The Attachment of the Eggs in other Decapod Crustacea.

A number of species have been examined with a view to determining whether or not the condition of the attached eggs was such as would lead one to infer that the mode observed in the case of *Cancer pagurus* was a general one or not.

The spawning of *Carcinus mænas* was observed, and it will be treated below. In the following species of Brachyura and Anomura the berried females were examined, viz., *Maia squinado*, *Portunus* sp., *Hyas* sp., *Stenorhynchus* sp., *Eupagurus* sp., *Lithodes maia.* In these the condition of the endopodite and the attached eggs was similar to that of *Cancer pagurus*, and the mode by which the eggs become attached is the same.

In *Maia squinado* ($4\frac{5}{8}$ inches across the greatest breadth of the carapace) the spermatheca is very large, and it differs much from that of *Cancer*. In the latter the solidified remains of the fluid secreted by the spermatheca are got rid of at the next impregnation; in the former they are retained, and as a fresh secretion of fluid takes place with each impregnation the spermatheca attains enormous dimensions.

The berried females of certain Galatheidæ and Macrura were also examined, and the details will be given below.

In the Macrura the pleopods differ much from those of the Brachyura. In some cases the exopodites afford attachment to the eggs, while also hairs on the sternum of the abdomen attach to themselves eggs. Both branches are more or less thickly furnished with densely plumose setæ which function for swimming. The egg-hairs, usually ciliated in part, are short, and so there are not many eggs on one hair. The eggs are in large measure attached to the protopodite of the pleopod. The conclusion reached with regard to these also was that the attachment of the egg was effected through the piercing of the chorion by the egg-hair.

Munida rugosa.—The eggs are much larger than those of *Cancer.*

The pleopod has no exopodite; it consists of a single-jointed protopodite and a 2-jointed endopodite. The endopodite is furnished with a great quantity of fine egg-hairs (fig. 27).

The eggs have very long stalks and are not arranged along the hairs as in *Cancer*, but the tips of one or of many hairs are inserted into the stalk of the egg; and they sometimes pass up the stalk for a considerable distance (figs. 28 and 29). In this case, then, there is never more than one egg to each hair, but very often only one egg to a group of hairs. Its position on the extremity of the hair gives occasion to much rotary movement of the egg, and through this the stalk becomes tightly twisted like a rope.

Some of the hairs of this species are setose over the whole of their length, the cilia being long: the extremity of the hair is bare for a greater or shorter distance. The short egg-hairs are setose on the middle of their length (fig. 27). The cilia are longer at the distal end and become less as they are more proximal. This probably prevents the hair entering the egg very far on its piercing the chorion.

Galathea dispersa.—In this form there does not appear to be more than one egg to each hair; and a group of hairs sometimes enters one-egg stalk. A cluster of eggs is sometimes found on one fascicle of hairs.

A condition similar to *Galathea dispersa* is apparently present in *Calocaris macandreæ.*

Homarus vulgaris.—The pleopod is short and paddle-like. The endopodite is 2-jointed. The two branches are provided with the usual setose hairs round their margins, and on the posterior or concave surface of the endopodite there are arranged round the margin the egg-hairs. They are not nearly so numerous as the plumose setæ. On the exopodite at its basal outer corner there is a fascicle of egg-hairs. There are several fascicles of the same on the protopodite and also on the sternum of the abdominal segment.

The egg-hairs are extremely delicate. The tips only are ciliated, and the cilia are directed forward along the extremity of the hair (fig. 58).

The eggs are not attached to the distal parts of the endopodite and exopodite. In this form they are attached in two ways—(1) by the usual stalk attachment to the hair, a condition brought about in a way similar to that of *Cancer*; (2) eggs are attached to one another by stalks and without the intermediary of an egg-hair, *vide* figs. 56 and 57. The stalks which these eggs show, and which may be two or three in number, exactly resemble the stalks of the eggs attached to hairs; they are without doubt formed by the chorion. In no case were two eggs found to be sticking together in the way in which the demersal eggs of a fish, *e.g. Cyclopterus lumpus*, stick together. In the latter case the two eggs form at the point where they are glued together a flat common wall. In the lobster, on the other hand, the eggs are all stalked, and the fact that each egg usually has more than one stalk gives some apparent ground for the theory of the cement-covering of the egg.

Scott* has recently described the spawning of the lobster. The female lay on its back, and the eggs flowed down into the incubatory chamber formed by the flexed abdomen. When the eggs, just after they emerged from the genital openings, were placed in a glass of sea-water and collected into a heap they all became attached one to the other, "and also to the glass. Moreover, the adhesive material only remains soft for a short time, as when the individual eggs were isolated and prevented from adhering to the glass it was found that at the end of half-an-hour

* Scott, "On the Spawning of the Lobster." *Report of the Lancashire Sea-Fisheries Laboratory for* 1902. No. xi. Liverpool, 1903, pp. 20 *et seq.*

the adhesive property had completely disappeared." The stickiness is not a true cement, it is merely an albuminous substance, not a fluid 'chitin" capable of forming an outer envelope.

While it is not easy to say exactly how the stalked attachment between the eggs is produced, it is still possible to describe a process by which the same might be arrived at.

I have not seen the newly-extruded egg, but assume that on passing out of the oviduct it will show little if any perivitelline space. The egg in gaining contact with sea-water would immediately begin to develop a perivitelline space. The extruded eggs lying on the abdomen would, by the mutual pressure due to their weight, tend to cause the expulsion of some of the perivitelline fluid by the micropyle (which, although it has not yet been described, very probably exists). Through this the now flaccid chorion might be glued to an egg, which in a similar way might attach itself to a third or to the first egg. Again, these eggs may have been pierced by the hairs without actually becoming attached to them. The eggs that are attached to one another are close to the base of the pleopod, where they are not subjected to any very violent movement. They are often found on the outside of the eggs which are attached to a fascicle of hairs.

The weight of the egg tends to stretch out the ductile chorion into long thin stalks. Two attachments may sometimes be seen to one broad stalk.

Nephrops norvegicus.—The pleopod is short and paddle-like; the endopodite is 2-jointed. Both branches are fringed with densely plumose setæ. The egg-hairs (fig. 64) have sharp points, and are ciliated near their extremities; the cilia are small, soft, and blunt. Sometimes the fourth of the length of the hair is ciliated. The egg-hairs are arranged round the periphery of the hind surface of the endopodite; they are also found on the protopodite. At the joint on the endopodite the projecting corner of the proximal segment bears a fascicle of egg-hairs. The egg-hairs do not carry nearly so many eggs as they do in the Brachyura.

Crangon vulgaris.—The egg-hairs are short, but more than one egg is strung on one hair. The eggs are attached to the protopodite, not to the endopodite or exopodite.

Pandalus Montagui.—In this form also the eggs are attached to the inner surface of the protopodite, and not to either the endopodite or exopodite. The egg-hairs are short.

The eggs are also attached to one another as in the lobster.

The duty of bearing the eggs is not allowed to interfere with the swimming function of the pleopod. In *Crangon* and *Pandalus*, where the pleopods are important swimming organs, the eggs are attached to the protopodite.

In *Homarus*, where the swimming function of the pleopod is practically in abeyance, the eggs are attached to the endopodite and exopodite, but not to their distal parts.

In the Brachyura, in place of a pleopod which performs both functions, viz. of swimming and of carrying the eggs, we have an organ which is suited solely for bearing and protecting the eggs. The endopodite is provided with special hairs to which the eggs become attached, while the exopodites function in protecting the attached eggs during the period of incubation.

Carcinus mænas.

The writer had the opportunity of observing part of the spawning process in *Carcinus*. Four females extruded their eggs at the Laboratory.

† P. Mayer

The ovaries of these and of a number of other crabs were examined. So far as could be made out, little difference exists between the process of spawning in this form and in *Cancer*.

The Formation of the Perivitelline Space in the Egg.

Ovarian Eggs.—A number of non-berried impregnated female crabs (*C. mænas*) were examined in October, at a time when other individuals of this species were spawning. They measured in greatest breadth $1\frac{7}{16}$ in. and upwards. Of these, some had orange ovaries containing eggs which were practically ripe: others had pale, white, immature ovaries. The two classes differed in external appearance. The shells of the crabs which had orange ovaries were darker coloured than in the others. In the former the thorax and third maxillipedes especially showed some brown colour. In the crabs having immature ovaries the legs and thorax were of a light green colour, which indicated that they had cast more recently than the former (probably during the summer just past).

The ripe egg, on being extruded, soon shows a perivitelline space. In several instances when ovarian eggs, which were apparently ripe, were put into sea-water a small separation of the chorion from the vitelline membrane began to show itself, but although the eggs were kept in the water till next day no large or, in many cases, even distinct perivitelline spaces developed, except in those eggs in which the inner (vitelline) envelope had been ruptured, when large perivitelline spaces were rapidly (in half-an-hour) formed.

The formation of the perivitelline space would then appear to be due to the osmosis set up through the chorion by the presence between the chorion and the vitelline membrane of a fluid derived from the yolk. The non-formation of the perivitelline space in the above-mentioned eggs was possibly due to the fact that the complete ripening of the egg, viz. with the occurrence of this fluid between the two envelopes, had not yet succeeded.

A few ripe eggs were found in the spent ovaries of certain berried crabs. The spent ovary is a colourless empty sac, and shows here and there usually one or two ripe orange-coloured eggs which have not been extruded. In two cases examined none of the ovarian eggs showed a perivitelline space, but on being transferred to sea-water the spaces began to develop, and in a short time were large. In some cases the space was distinctly reddish-coloured. It would therefore appear that a change which makes the egg more favourable for osmosis takes place in the ripening, probably just before extrusion.

Spawned Eggs.—Some eggs which were taken by means of a brush off the thorax of a spawning female were found to have a very slight perivitelline space, but after they had been left in sea-water for a little they showed large spaces.

One female which was found spawning, or which had just finished that process, had surrounding it a thick layer of eggs on the bottom of the box. A small quantity of eggs only was attached to the endopodites. The crab was transferred to a glass vessel, and in the course of that operation a considerable quantity of eggs rolled off the abdomen. These eggs showed large perivitelline spaces, and most had a peak-like eminence on the exterior of the chorion.

The eggs lying free on the bottom of the box round the crab also showed large perivitelline spaces, but the little prominences were not seen on the chorion.

As was concluded in the case of *Cancer*, the perivitelline fluid is of a sticky nature.

Eggs picked off the bottom alongside the spawning female had large perivitelline spaces, with perfectly smooth chorion; there was no trace of any sticky fluid outside the egg.

The eggs which were displaced from the abdomen in transferring the spawning female to a glass jar from the box in which it had previously been kept lay on the bottom of the dish, and were with few exceptions emptied out of the dish by gentle rinsing. The few which remained attached to the glass were dislodged by the touch of a brush or with a pipette.

When the pipette was crowded with eggs, and in one case where the eggs were allowed to accumulate in a compact mass, on forcing them out some remained sticking to the glass. These were the eggs which showed the little prominences on the chorion mentioned above. On examining the end of the pipette with the microscope, at nearly every egg a little refractive globule was seen attached to the exterior of the chorion. This is without doubt the perivitelline fluid which has been squeezed out and which served to glue the egg to the glass in this case.

In another case the eggs which lay on the bottom of the box were found the next day to be stuck together in masses, which, however, readily broke. The attachment of the eggs to one another was probably due to the perivitelline fluid which the mutual pressure of the eggs would no doubt tend to press out. A similar condition was observed in the case of the unattached eggs of *Cancer pagurus*. After several days the eggs which lay on the bottom of the box had become attached together in masses.

The Spawning of C. mœnas.

A crab which had just extruded its eggs on September 28th was surrounded by a quantity of eggs which looked like red dust on the sand. It was removed to a glass vessel and examined in water. It was then seen that the abdomen of the crab was being held away from the thorax and that it formed a kind of basin. The points of the endopodites lay on the openings of the vulvæ. A small quantity of eggs were attached to each endopodite, and eggs were noticed in the openings of each vagina. The endopodites were moved forwards, backwards, and outwards, widely separated laterally, inwards, and forwards. The independent movement of the distal part of the endopodite was seen. The exopodites move a little in unison with the endopodites in certain of the movements.

The crab gradually threw off the eggs that were attached to the endopodites.

On the endopodites a similar condition to that seen in *Cancer pagurus* was found. The chorion of the egg had been pierced by the hair and it was in a collapsed condition.

On October 16th a crab was examined which had spawned since the previous day. The eggs on the endopodite showed their outer envelopes (chorion) all wrinkled, but the yolk-sphere was not pushed to the pole away from the hair: it lay simply in the middle of the irregularly crinkled envelope. The stalk was not yet formed.

A considerable number of dead eggs was found attached to the endopodites of a berried Carcinus (October 14th) which had just spawned in the Laboratory. The inner or vitelline membrane had been ruptured and the yolk-sphere was broken up. It is possible that the yolk-sphere may have been pierced by the endopodite hair, though other agencies may have been the cause of their destruction.

Spawning seems to be completed within 24 hours.

Notes on Casting, Distribution, etc., of Cancer pagurus.

The Periodicity of Spawning and Casting.—Certain berried crabs were obtained during the summer of 1902. Their eggs hatched during August, September, and October. None of these crabs spawned again until the end of October 1903, when two did so. None of the crabs cast during the period.

In February 1904 two of the crabs were berried, and two were found dead. In the two latter the ovary was spent in one, and in the other was ripe but dropsical.

The Colour of the Soft Crab.—When a crab has just cast it is a plump inert mass, which yields in all its parts to the slightest pressure of the fingers. It is of a dark purple colour all over the dorsum and dorsal surfaces of the pereiopods : the ventral surface is yellowish white. As the shell hardens the dorsum gradually becomes of a lighter hue, turning into a brick-red colour. Meantime the third or white layer of the shell is thickening.

In the paragraph dealing with the migration of crabs the question of the abstention from casting is discussed in connection with one of the labelled crabs.

Casting.—During the autumn of 1902, 31st August to 15th October, a number of female crabs cast in the tanks at the Bay of Nigg. With the exception of the first, all the females recorded in the following Table cast at this time. The size of the crab before and immediately after casting is shown in parallel columns opposite the date when the cast took place.

[Table.

TABLE I.

CRABS THAT CAST IN THE MARINE LABORATORY, BAY OF NIGG.

Date.	Hard Crab —Inches.	Soft Crab —Inches.	Increase— Inch.	Ratio of Increase.
August 16, ...	$1\frac{3}{8}$ ♀	$1\frac{5}{8}$	$\frac{1}{4}$	1/5·5
,, ,, ...	$1\frac{7}{16}$ ♂	$1\frac{3}{4}$	$\frac{5}{16}$	1/4·6
,, ,, ...	$2\frac{5}{8}$ ♂	$3\frac{3}{8}$	$\frac{3}{4}$	1/3·5
,, 31, . . .	$4\frac{7}{8}$ ♀			
September 1, . .	$4\frac{1}{2}$ ♀			
,, 6, . .	$4\frac{1}{8}$ ♀	5 *	$\frac{7}{8}$	1/4·7
,, 8, . .	$4\frac{7}{8}$ ♀	$5\frac{3}{4}$	$\frac{7}{8}$	1/5·5
,, 9, . .	$5\frac{1}{2}$ ♀	$6\frac{3}{8}$	$\frac{7}{8}$	1/6·2
,, 10, . .	$5\frac{1}{8}$ ♀	$6\frac{1}{16}$	$\frac{15}{16}$	1/5·4
,, ,, . .	$4\frac{7}{8}$ ♀	$5\frac{1}{2}$	$\frac{5}{8}$	1/7·8
,, 11, . .	$3\frac{5}{8}$ ♀	$4\frac{3}{8}$*	$\frac{3}{4}$	1/4·8
,, 16, . .	$1\frac{3}{8}$	$1\frac{5}{8}$	$\frac{1}{4}$	1/5·5
,, ,, . .	$3\frac{1}{4}$ ♀	$3\frac{7}{8}$	$\frac{5}{8}$	$\frac{1}{5}$
October 5, . . .	1 ♂	$1\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
,, 8, . . .	$1\frac{11}{16}$ ♂	$2\frac{1}{8}$	$\frac{7}{16}$	1/3·8
,, 9, . . .	$3\frac{7}{8}$ ♀			
,, 13, . . .	$2\frac{13}{16}$ ♀			
,, ,, . . .	$4\frac{5}{8}$ ♀			
,, 16, . . .	$4\frac{7}{8}$ ♀	$5\frac{1}{2}$*	$\frac{5}{8}$	1/7·8

* Measured several days after casting.

As was previously* shown, the ratio of increase at each cast varies greatly. In the Table then given the ratio varied from $\frac{1}{3}$ to $\frac{1}{9}$. In the present case, in only one instance was the ratio greater than $\frac{1}{4}$, and it was as small as $\frac{1}{8}$.

The histological changes that accompany the ecdysis of the crab have been dealt with by Witten.

At the time when the crab casts, the shell of the three proximal joints of the chela becomes absorbed along certain lines, thereby allowing of the expansion of these joints to permit the withdrawal of the large claw. In fig. 100, Plate IV., is shown the cast chela. The absorption-lines are on the coxopodite, basi-ischiopodite, and meropodite, viz., *abs*. The part of the shell lying between the lines is movable. Similar absorption areas appear in the lobster (Herrick).

Distribution.—In discussing the question of the distribution of the crab, I was of the opinion that a group of crabs measuring from $2\frac{1}{2}$ to 4 inches would be found to inhabit the shore waters just outside low-water mark. This group was distinct from the beach group, which is considerably smaller, viz. from $\frac{7}{8}$ to $2\frac{1}{2}$ inches, and is itself smaller than the adult group, which measures from about 4 inches upward; it is required to fill up the very considerable gap which separates these two groups. (*Vide Pl. III.*)*

* "Contributions to the Life History of *Cancer pagurus*."

TABLE II.—CRABS CAUGHT IN CREELS SHOT CLOSE TO THE SHORE. BAY OF NIGG.

No.		Inches.	1⅜	½	⅝	¾	⅞	2	⅛	¼	⅜	½	⅝	¾	⅞	3	⅛	¼	⅜	½	⅝	¾	⅞
		Cm.	3·5	3·8	4·1	4·4	4·8	5·1	5·4	5·7	6	6·3	6·7	7	7·3	7·6	7·9	8·2	8·6	8·9	9·2	9·5	9·8
1	March 1901—17 Crabs,	♂	-	-	-	-	-	3	-	1	1	1	-	1	-	-	-	-	-	-	-	-	-
		♀	1	-	-	-	1	1	-	-	-	1	-	-	-	-	1	-	-	-	1	1	-
2	April 1901—19 Crabs,	♂	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	1	2	-	-
		♀	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	1	-	1	1	1	-
3	May 1901—197 Crabs,	♂	-	-	1	-	2	-	1	1	4	2	4	4	2	2	5	1	1	1	1	4	1
		♀	-	-	1	1	-	1	3	-	3	4	2	7	6	3	3	3	6	11	2	7	3
4	June 1901—235 Crabs,	♂	-	-	-	-	-	2	-	-	-	-	-	1	-	1	-	2	-	3	2	3	4
		♀	-	-	-	-	-	-	1	1	1	-	2	-	1	1	1	2	1	5*	2	2	1
5	June 1900—243 Crabs,	♂	-	-	-	-	-	-	-	-	-	2	3	3	4	4	2	6	6	2	7	5	4
		♀	-	-	-	-	-	1	-	1	3	7	5	3	5	5	6	14	11	5	7	9	3
6	July 1900—449 Crabs,	♂	-	-	-	-	-	-	2	2	2	2	3	9	3	5	3	9	6	3	8	6	5
		♀	-	-	1	-	-	1	-	-	-	4	7	7	7	4	5	8	3	7	8	10	8
7	July 1901—110 Crabs,	♂	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	4	2
		♀	-	-	-	-	-	-	1	-	-	-	-	1	-	-	1	1	-	-	-	2	1
8	August 1900—246 Crabs,	♂	-	-	-	1	-	1	2	1	1	-	4	-	-	3	10	4	2	3	3	10	2
		♀	-	1	-	-	1	-	2	2	2	-	3	-	5	3	3	3	7	3	3	4	4
	Total,		1	1	3	2	5	11	12	9	17	23	33	36	34	33	42	55	44	46	47	68	38

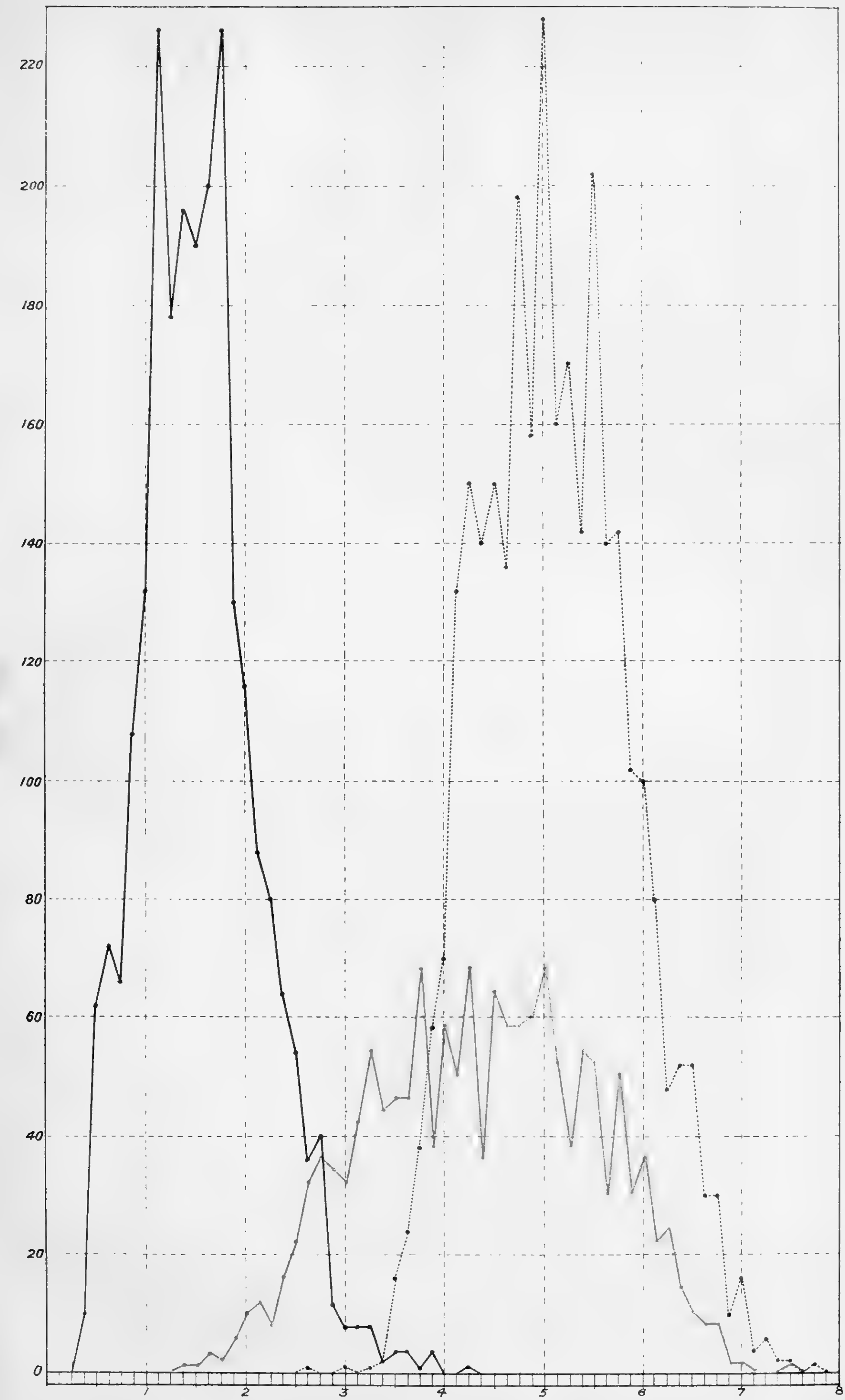
* Sex not noted.

TABLE II.—CRABS CAUGHT IN CREELS SHOT CLOSE TO THE SHORE. BAY OF NIGG—*continued.*

No.	4	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	5	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	6	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	7	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$
	10·2	10·5	10·8	11·1	11·4	11·7	12·1	12·3	12·7	13	13·3	13·6	14	14·3	14·6	14·9	15·2	15·5	15·9	16·2	16·5	16·8	17·1	17·5	17·8	18·1	18·4	18·7	19
1	·	·	·	·	·	·	·	·	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	1	·	·	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
2	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	·	·	·	1	2	2	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
3		1	3	3	8	5	5	2	4	4	1	3	3	2	2	1	·	·	·	·	·	1	·	·	·	·	·	·	·
		3	8	2	5	6	5	2	2	1	·	·	1	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·
4	12	8	8	5	9	7	12	10	19	7	3	12	8	5	5	9	8	5	5	2	2	1	·	1	·	·	·	·	·
	5	2	4	3	5	1	2	2*	1*	1	2	1	·	·	1	·	·	·	·	·	·	·	1	·	·	·	·	·	·
5	7	3	5	2	5	3	6	5	6	7	2	4	7	1	7	1	5	2	·	·	·	·	1	·	·	·	·	·	·
		4	6	3	3	3	3	1	1	1	·	1	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
6	10	15	16	10	15	18	11	18	21	16	17	13	14	12	17	11	5	5	2	7	2	1	1	·	1	·	·	·	·
	1	4	7	2	3	2	1	3	·	2	·	3	4	1	3	2	3	1	1	·	·	·	·	·	·	·	·	·	·
7	2	3	1	2	2	2	2	6	7	5	6	3	2	4	8	3	4	5	5	4	1	1	·	·	·	·	·	·	1
	·	2	2	·	1	1*	1	1	·	1	·	1	1*	·	·	·	·	·	·	1	·	·	1	·	·	·	·	·	·
8	4	3	5	1	6	6	9	8	7	7	4	14	11	5	6	1	10	5	12	1	4	3	4	·	·	·	·	·	·
	1	2	3	2	7*	1	1	1	·	·	2*	·	·	·	1	·	1	·	·	·	1	1	·	·	·	·	·	·	·
T'l.	59	50	69	36	65	58	58	60	69	52	39	55	53	30	50	29	36	23	25	15	10	8	8	1	1	·	·	·	1

* Sex not noted.

Total—1523 Crabs.



———— 2336 BEACH CRABS (♂+♀) II. .... 3029 CREEL CRABS (♂+♀) Ordinary Crab-Fishing, IV.
———— 1523 CREEL CRABS (♂+♀) Creels shot close to the Beach _ Group III.

With a view to testing the theory respecting this group (III.) a number of creels were shot during March to August in 1900 and 1901. They were set just outside low-water mark and were occasionally left dry by the ebb. Some of the creels were at times shot in 2 or 3 fathoms. One or two of the creels were covered with small-meshed netting. The number and sizes of the crabs got in each month are set out in Table II.

In March and April very few crabs were got. This was in part due to the fact that at that period of the year it often happens that bad weather prevents fishing for a considerable time, but this does not account for the small catches. Because even when the creels were fishing, it very often happened that no crab was caught. Their absence from the creels does not necessarily mean their absence from the region. They may not then feed eagerly. Crabs that are kept in the Laboratory during winter became very inactive. The cold has a much more paralysing effect on the edible crab than it has on *Carcinus mœnas*, so that it is possible that the inshore crabs may not move about much before the month of May. In this month (May) a considerable number of crabs were got in the creels shot in the same place as in the preceding months. (*Vide* Table II.)

An examination of the catch of crabs shows that it consists of a large number of crabs which fall into the gap between the Beach and the Adult groups, but it also contains a large proportion of adult crabs. The adult crabs appeared in the catches all through the summer.

The curve formed by the measurements of these crabs has been introduced into a chart along with the curves of the Beach and Adult crabs. The latter are taken from my previous paper (*Tables VIIIA and IX.*)

A reference to the chart shows that the new group (red curve) tends to fill up the gap between the two former groups. The curve overlaps both groups. It measures from about 2 inches to over 7 inches. The examination of the shore waters was not carried on during the whole of the year, and the inshore migration of the adult crabs introduces larger crabs than actually belong to the group under consideration.

We then have in the summer in the shallow inshore water a double group, consisting of the III. and IV. groups. In the autumn and winter, investigation will very probably show that the adult group will be entirely, or almost entirely, absent, and in these seasons, therefore, a better defined Group III. should be found.

Rate of Growth.—As material for the study of the rate of growth of the crab, I have introduced here the measurements of the monthly collections made on the beach at Dunbar (Table III.), and also the details of the individual catches which were measured (Table V.). The totals were given in my former paper, and the regions where the catches were made are in certain instances given in *Table V.* I have also introduced three additional collections made on the beach, Dunbar, in 1899 and 1900 (Table IV.).

Mr H. T. Waddington, Bournemouth, has kindly furnished me with particulars of two series of casts of this form. The various ecdyses which the two specimens underwent have been carefully recorded by him, and he has permitted me to publish them here (Table VI.). The measurements of the successive casts of a third crab, which were presented by Mr. Waddington to Professor Howes, were kindly supplied to me by Mr. William Wallace, B.Sc., Lowestoft.

Specimen A. when captured, viz., in August, measured 3·25 mm.; it had probably been in the megalops stage not more than a month previously. When one year old it measured 30·75 mm., *i.e.*, $1\frac{1}{4}$ inches; when two years old it measured nearly 46 mm., *i.e.*, a little less than 2 inches across. Assuming that the rate of growth in nature approximated to the data here given, we should conclude that the beach group consisted of crabs in their second year, and that a crab of $4\frac{1}{4}$ inches across would be not less than three years, nor probably more than four years old.

TABLE III.—CRABS COLLECTED TWICE MONTHLY BETWEEN TIDE-MARKS ON THE BEACH AT DUNBAR.

The Numbers indicate Hard + Soft Crabs. The Numbers within brackets indicate Soft Crabs alone.

	Inches.			½			⅝			¾			⅞			1			⅛				¼		
	Cm.	1·1	·2	·3	·4	·5	·6	·7	·8	·9	2	·1	·2	·3	·4	·5	·6	·7	·8	·9	3	·1	·2	·3	·4
October 1897—215 Crabs,*	♂	-	-	-	6	3	1	-	1	-	-	2	2	1	3	2	5	1	2	4	2	3	4	1	2
	♀	-	2	-	1	1	1	2	1	1	-	1	2	4	2	2	2	-	1	2	5	2	6	2	1
ovember 1897—241 Crabs,	♂	-	-	-	-	(1)	-	-	(1)	-	(1)	-	-	3 (1)	4 (3)	2 (1)	(3)	(3)	(1)	4 (1)	7 (6)	2 (1)	1	6 (4)	1
	♀	-	-	-	(1)	(2)	(2)	-	-	(1)	1	2 (1)	-	5 (4)	(1)	(4)	(1)	2 (1)	2 (1)	-	8 (6)	5 (2)	2 (1)	4 (3)	6 (2)
December 1897—140 Crabs,	♂	-	-	(1)	-	-	-	-	1	1	1	1	-	2	2	1	3 (2)	2	1	-	1	2 (1)	(3)	4 (2)	(1)
	♀	-	-	-	-	-	(1)	-	2 (1)	-	2	2 (1)	1	2	2	2	-	1	(1)	2	-	7	2	4	2
January 1898—132 Crabs,	♂	-	-	-	1	-	1	-	-	-	-	-	-	(1)	-	2 (1)	1	1	1	-	2	2	1	-	-
	♀	-	-	-	-	1	-	-	-	-	-	-	-	-	3 (1)	-	-	2	2	4	3	2	3 (1)	1	3 (1)
February 1898—163 Crabs,	♂	-	-	-	1	1	-	1	-	-	2	2	-	4	2	3	1	2	2	1	1	4	2	2	2
	♀	-	1	-	2	1	2	2	1	-	3 (1)	2	1	2	1	-	3	1	-	2	1	6	2	1	4
March 1898—132 Crabs,	♂	-	1	-	1	1	2	1	-	-	-	-	1	1	1	1	2	1	1	1	3	1	-	5	-
	♀	-	-	-	2	1	-	-	-	-	(1)	-	-	3	-	-	3	1	-	1	5	-	-	4	2
April 1898—154 Crabs,	♂	-	-	2	-	-	-	2	-	-	-	1	-	-	1	3	1	1	2	3	1	1	-	-	1
	♀	-	1	-	1	1	1	1	-	1	1	-	-	-	1	-	1	1	-	3	3	1	4	-	3
May 1898—193 Crabs,	♂	-	-	-	1	3	3	2	1	-	-	2	-	2	1	-	5	2	1	1	2	-	2	6	1
	♀	-	-	-	-	-	1	2	-	1	4	1	-	2	-	2	3	1	4	2	1	2	-	3	2
June 1898—152 Crabs,	♂	-	-	-	2	-	-	(4)	(1)	(1)	-	(1)	-	2 (1)	-	(1)	2	1	1	3	3	2	1	2	1
	♀	-	-	-	(1)	-	-	-	-	2 (1)	(1)	-	2 (1)	-	-	-	1	-	1	-	2	-	2 (1)	2	3
July 1898—184 Crabs,	♂	-	-	1	-	-	-	1	5 (1)	-	3 (1)	-	2	1	-	2	-	2	4 (1)	2 (1)	-	(2)	-	1	4 (1)
	♀	-	-	-	-	-	-	1	2	-	1	1	-	-	(1)	4	-	1	3 (1)	-	2	2	2	2 (1)	1
August 1898—138 Crabs,	♂	1	-	-	-	-	(1)	-	2 (1)	-	2	1	-	4 (3)	3	-	4 (1)	1	5 (3)	(1)	(1)	5 (1)	-	(1)	-
	♀	1	-	-	-	(1)	-	-	1	-	-	-	-	1	6 (4)	4 (1)	-	2 (1)	2 (1)	3 (2)	-	-	2 (1)	2 (1)	1
September 1898—229 Crabs,	♂	-	-	-	-	(4)	(2)	2 (1)	-	(1)	-	(1)	5 (1)	1	3 (2)	2 (1)	-	(5)	2 (1)	(1)	5 (3)	3 (2)	4 (2)	4 (2)	(3)
	♀	-	-	-	(1)	-	(2)	(2)	-	1	-	(1)	3 (1)	(1)	(1)	3 (1)	(1)	4 (3)	5 (3)	4 (3)	5 (3)	3	6 (5)	(1)	(1)

* In 5 of these, viz., ·9, 1·3, 1·5, 2·6, 3·9 cm. respectively, the sex was not noted.

TABLE III.—*continued.*

	Inches.	1 3/8			1/2			5/8			3/4				7/8			2			1/8		
	Cm.	3·5	·6	·7	·8	·9	4	·1	·2	·3	·4	·5	·6	·7	·8	·9	5	·1	·2	·3	·4	·5	·6
October 1897—*continued*,	♂	2	2	4	7	4	3	4	4	6	4	3	1	2	2	2	-	2	-	3	1	1	2
	♀	5	4	1	4	-	4	1	2	1	3	2	2	4	5	4	1	3	1	5	1	1	-
November 1897—*continued*,	♂	(2)	4 (2)	5 (2)	(2)	3 (2)	7 (3)	6 (4)	6 (3)	3 (1)	5 (4)	4 (2)	1	1	3 (2)	(3)	-	-	2	(1)	1	(2)	(1)
	♀	(3)	(3)	6 (4)	7 (5)	3 (2)	5 (3)	5 (2)	-	4 (3)	2 (1)	5 (3)	3 (1)	4 (2)	(2)	(2)	5 (4)	3 (2)	4 (3)	(2)	-	(2)	(1)
December 1897—*continued*,	♂	5	4	3 (1)	2	(2)	3 (2)	3	4 (1)	-	3 (2)	-	-	1	4 (1)	1	1	1	-	1	1	-	-
	♀	3 (1)	3	4	-	2	2	-	1	3 (1)	4 (2)	(1)	1	2	1	(1)	2 (1)	(1)	-	1	-	-	1
January 1898—*continued*,	♂	1	-	3	3	4	1	3	-	3	1	2	4	2	1	1	1	2	-	1	1	(1)	2
	♀	5	1	3	-	1	6	4	7	2	1	4	1	-	2	2	1	1	1	1	1	-	-
February 1898—*continued*,	♂	5	-	7	5	3	3	-	3	-	2	-	2	2	1	-	-	-	-	1	-	-	-
	♀	4	4	2	4	-	5	4	3	3	1	4	4	3	1	-	1	2	3	1	-	1	1
March 1898—*continued*,	♂	-	2	2	3	3	1	3	5	3	3	3	2	2	1	1	1	-	-	1	-	-	-
	♀	3	3	1	5		2	1	2	2	2	2	1	5	1	1	1	1	1	-	1	-	2
April 1898—*continued*,	♂	1	1	2	2	2	4	1	-	2	-	5	1	3	2	1	5	3	1	-	2	-	-
	♀	3	2	3	2	2	-	1	1	2	3	4	5	2	1	4	2	8	3	1	1	1	1
May 1898—*continued*,	♂	1	3	1	-	4	2	2	1	1	1	1	2	1	-	1	3	2	2	2	3	1	5
	♀	2	1	3	1	-	2	-	1	4	1	1	1	5	2	1	2	4	-	1	-	3	-
June 1898—*continued*,	♂	3	1	2	3	1	2	6	3	4	1	2	4	2	1	1	2	1	1	3	-	1	-
	♀	-	-	2	-	-	2	2	4	1	-	1	1	3	2	2	2	1	1	-	2	4	3
July 1898—*continued*,	♂	1	(2)	3	2 (1)	2 (1)	1	5 (2)	1	-	5 (3)	4	2	1	4 (1)	1	2 (1)	(1)	4 (2)	-	2 (1)	2 (1)	-
	♀	1	3	2 (1)	-	4 (1)	4 (1)	3 (1)	3 (2)	(1)	1	3 (1)	5 (1)	2	-	2 (1)	5	3 (1)	3 (2)	-	2	2 (1)	1
August 1898—*continued*,	♂	1	-	-	-	-	2	3 (1)	2	(1)	1	3	1	(1)	(2)	-	(1)	(1)	-	-	(1)	-	(1)
	♀	1	1	-	1	(1)	-	2	4 (2)	3 (2)	4 (1)	(1)	(1)	-	-	-	(1)	(1)	1	-	2 (1)	-	(1)
September 1898—*continued*,	♂	(3)	(3)	6 (3)	5 (4)	3 (1)	(2)	3 (2)	3 (2)	2 (1)	2	(2)	1	2 (1)	(4)	(2)	2 (1)	(2)	(1)	1	-	3 (2)	5 (3)
	♀	(1)	3 (1)	(3)	2	(4)	(1)	1	7 (3)	(2)	2	1	3 (1)	5 (3)	1	1	1	(1)	1	3 (2)	-	(1)	(2)

TABLE III.—*continued.*

	Inches.	2¼			⅜			½				⅝			¾			⅞			3		
	Cm.	5·7	·8	·9	6	·1	·2	·3	·4	·5	·6	·7	·8	·9	7	·1	·2	·3	·4	·5	·6	·7	·8
October 1897—*continued*,	♂	2	·	·	1	·	·	·	·	·	·	1	2	·	·	·	·	1	·	·	·	·	·
	♀	·	·	1	·	1	·	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·
November 1897—*continued*,	♂	(3)	·	·	(2)	(1)	·	·	1	·	·	·	(1)	·	·	(1)	·	·	·	·	·	·	·
	♀	(2)	(1)	·	(1)	(1)	·	·	·	·	·	·	·	1	·	(1)	·	·	(1)	·	·	·	1
December 1897—*continued*,	♂	·	(1)	·	·	·	·	·	·	·	·	·	(1)	·	·	·	1	·	·	·	·	·	·
	♀	·	1	·	·	·	·	·	·	1	·	·	·	·	(1)	·	·	·	·	·	·	·	·
January 1898—*continued*,	♂	1	·	(1)	·	1	·	1	·	·	1	·	1	·	·	·	1	·	·	·	·	·	·
	♀	·	·	1	·	1	1	·	1	·	·	·	·	·	1	·	2	·	·	·	·	·	·
February 1898—*continued*,	♂	1	·	·	·	·	·	1	·	·	·	·	·	·	·	·	1	·	·	·	·	·	·
	♀	·	·	·	·	·	·	·	·	·	1	·	1	·	·	·	·	·	·	·	·	·	·
March 1898—*continued*,	♂	3	1	1	·	1	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	♀	1	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
April 1898—*continued*,	♂	·	·	2	1	·	·	·	·	1	·	·	·	·	·	·	·	·	·	1	1	·	·
	♀	1	·	1	1	1	·	1	·	2	·	1	1	·	1	·	1	·	·	·	·	·	·
May 1898—*continued*,	♂	1	2	3	1	1	2	1	3	2	·	·	1	·	1	·	1	·	·	·	·	·	·
	♀	3	2	2	1	2	1	2	1	1	1	1	·	·	1	·	2	·	·	·	·	·	·
June 1898—*continued*,	♂	·	1	·	2	1	2	·	·	·	·	1	1	2	·	2	1	·	·	·	·	·	·
	♀	1	1	·	·	2	·	·	2	3	·	1	1	·	·	·	1	·	·	1	·	·	1
July 1898—*continued*,	♂	3	1	1	·	2	3	1	·	2	·	·	·	1	·	2	·	·	·	·	·	·	1
	♀	2	(2)	·	1	2 (1)	(1)	1	·	·	1	·	·	·	1	2 (1)	·	1	·	·	1	·	·
August 1898—*continued*,	♂	·	3 (1)	1	·	(3)	·	(1)	·	·	·	(2)	(1)	·	·	2 (1)	·	·	·	·	·	·	·
	♀	·	·	2 (1)	4 (2)	(2)	(1)	·	·	(2)	·	(1)	·	(2)	(2)	(1)	·	·	·	·	·	·	·
September 1898—*continued*,	♂	(2)	(1)	(3)	·	(1)	(1)	·	·	·	·	·	(1)	·	·	·	·	(1)	(2)	·	·	·	·
	♀	·	(3)	(1)	(1)	·	·	2 (1)	(1)	·	·	(1)	(1)	1	·	2 (1)	·	·	·	(1)	·	·	(1)

TABLE III.—*continued.*

	Inches.	3⅛			¼				⅜			½			⅝			¾			⅞			Total.
	Cm.	7·9	8	·1	·2	·3	·4	·5	·6	·7	·8	·9	9	·1	·2	·3	·4	·5	·6	·7	·8	·9	10	
October 1897—*continued*,	♂	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	111
	♀	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	99
November 1897—*continued*,	♂	·	·	·	·	·	·	·	·	·	·	·	·	·	·	(1)	·	·	·	·	·	·	·	112
	♀	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	129
December 1897—*continued*,	♂	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	70
	♀	·	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	70
January 1898—*continued*,	♂	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	56
	♀	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	76
February 1898—*continued*,	♂	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	70
	♀	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	1	·	·	·	·	·	·	93
March 1898—*continued*,	♂	·	1	·	·	·	·	·	·	·	·	·	·	·	·	1	·	·	·	·	·		·	69
	♀	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	62
April 1898—*continued*,	♂	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	63
	♀	·	·	·	·	·	1	·	·	1	·	1	·	1	·	·	·	·	·	·	·	·	·	91
May 1898—*continued*,	♂	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	89
	♀	·	·	·	·	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	104
June 1898—*continued*,	♂	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	85
	♀	·	·	2	·	·	·	·	·	·	·	·	1	1	·	·	·	·	·	·	·	·	·	67
July 1898—*continued*,	♂	·	·	·	·	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	95
	♀	·	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	1	·	1	·	·	89
August 1898—*continued*,	♂	·	·	·	·	·	·	(1)	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	67
	♀	·	·	(1)	(1)	·	·	·	·	·	·	·	(1)	·	·	·	·	·	·	·	·	·	·	71
September 1898—*continued*,	♂	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	1	(1)	119
	♀	·	·	·	·	(1)	·	·	·	·	(1)	·	·	·	·	1	(1)	·	·	·	·	·	·	110

TABLE IV.—CRABS CAPTURED ON BEACH AT DUNBAR.

SIZE.		May 1899.		June 1900.		August 1899.		SIZE.		May 1899.		June 1900.		August 1899.		SIZE.		May 1899.		June 1900.		August 1899.	
Cm.	Inches.	♂	♀	♂	♀	♂	♀	*Cm.*	Inches.	♂	♀	♂	♀	♂	♀	*Cm.*	Inches.	♂	♀	♂	♀	♂	♀
1·1		-	-	-	-	-	-	**2·5**	**1**	-	-	3	3	3	4	**3·9**		3	3	-	-	-	-
·2		-	1	-	-	-	-	·6		-	2	-	-	-	-	**4**		1	2	-	-	-	-
·3	½	1	-	1	-	-	-	·7		3	1	-	-	-	-	·1	1⅝	3	3	4	3	4	2
·4		3	2	-	-	-	-	·8	⅛	3	3	6	2	1	-	·2		-	1	-	-	-	-
·5		7	3	-	-	-	-	·9		2	-	-	-	-	-	·3		1	3	-	-	-	-
·6	⅝	2	2	-	1	2	-	**3**		3	3	-	-	-	-	·4	¾	-	1	3	6	1	4
·7		1	1	-	-	-	-	·1		2	2	-	-	-	-	·5		1	1	-	-	-	-
·8		2	-	-	-	-	-	·2	¼	3	3	5	6	-	2	·6		-	1	-	-	-	-
·9	¾	2	1	-	1	1	2	·3		8	5	-	-	-	-	·7		2	1	-	-	-	-
2		-	4	-	-	-	-	·4		5	-	-	-	-	-	·8	⅞	-	2	-	1	2	1
·1		2	-	-	-	-	-	·5	⅜	2	-	4	5	-	3	·9		2	2	-	-	-	-
·2	⅞	2	1	1	-	-	2	·6		5	5	-	-	-	-	**5**		3	-	-	-	-	-
·3		2	1	-	-	-	-	·7		4	3	-	-	-	-	·1	**2**	1	2	4	4	-	2
·4		1	1	-	-	-	-	·8	½	3	1	3	1	3	3	·2		1	1	-	-	-	-

TABLE IV.—CRABS CAPTURED ON BEACH AT DUNBAR.—*continued.*

SIZE.		May 1899.		June 1900.		August 1899.		SIZE.		May 1899.		June 1900.		August 1899.		SIZE.		May 1899.		June 1900.		August 1899.	
Cm.	Inches.	♂	♀	♂	♀	♂	♀	*Cm.*	Inches.	♂	♀	♂	♀	♂	♀	*Cm.*	Inches.	♂	♀	♂	♀	♂	♀
5·3		4	2	-	-	-	-	6·6		-	3	-	-	-	-	7·9	$3\frac{1}{8}$	-	2	-	1	-	-
·4	$2\frac{1}{8}$	1	-	1	6	-	1	·7	$2\frac{5}{8}$	-	1	2	2	1	1	8		-	-	-	-	-	-
·5		2	2	-	-	-	-	·8		1	2	-	-	-	-	·1		-	-	-	-	-	-
·6		2	4	-	-	-	-	·9		1	-	-	-	-	-	·2	$\frac{1}{4}$	-	-	1	-	-	-
·7	$\frac{1}{4}$	3	3	2	4	1	1	7	$\frac{3}{4}$	1	1	1	4	1	3	·3		-	-	-	-	-	-
·8		2	-	-	-	-	-	·1		-	1	-	-	-	-	·4		-	-	-	-	-	-
·9		2	1	-	-	-	-	·2		1	-	-	-	-	-	·5		-	1	-	-	-	-
6	$\frac{3}{8}$	3	-	3	3	-	1	·3	$\frac{7}{8}$	-	-	1	1	-	-	·6	$\frac{3}{8}$	-	-	-	1	-	-
·1		2	5	-	-	-	-	·4		1	1	-	-	-	-	·7		-	-	-	-	-	-
·2		1	-	-	-	-	-	·5		1	-	-	-	-	-	·8		-	-	-	-	-	-
·3	$\frac{1}{2}$	2	1	3	3	1	1	·6	3	1	-	3	3	-	-	·9	$\frac{1}{2}$	-	-	1	-	-	-
·4		1	-	-	-	-	-	·7		-	-	-	-	-	-	9·8	$\frac{7}{8}$	-	-	-	-	-	1
·5		2	3	-	-	-	-	·8		1	-	-	-	-	-	10·8	$4\frac{1}{4}$	1	-	-	-	-	-

TOTAL, May—♂, 122 : ♀, 101; June—♂, 52 : ♀, 61; August—♂, 21 : ♀, 33 — 390 Crabs.

TABLE V.—CREEL CRABS, DUNBAR. *December* 1897 *to August* 1899.

TOTALS at each Size. The number of SOFT Crabs is shown within brackets alongside the Total (HARD and SOFT).

SIZE.		Dec. 20, 1897.		Jan. 28, 1898.		Feb. 25, 1898.		Mar. 31, 1898.		May 3, 1898.		May 27, 1898.		June 3, 1899.		July 12, 1899.		Aug. 4, 1899.		Nov. 5, 1898.	
Inches.	*Cm.*	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
2⅝	6·7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
¾	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
⅞	7·3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	7·6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
⅛	7·9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
¼	8·2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
⅜	8·6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	(1)
½	8·9	-	1	-	-	-	-	-	-	3	-	1	2	-	-	-	1	-	1	(4)	(3)
⅝	9·2	(1)	2 (1)	2	1	-	-	1	-	3	4	1	2	-	-	1	-	-	(1)	(2)	(3)
¾	9·5	2 (1)	(1)	2	1	-	-	-	2	2	2	5	2	-	-	(1)	-	5	-	(7)	(7)
⅞	9·8	2 (1)	6 (3)	3	2	-	-	3	-	3	4		7	1	-	1	-	4 (1)	-	(8)	(10)
4	10·2	6 (2)	5 (3)	5	3	-	-	2	2	5	1	1	5	2	1	3	7 (2)	3 (1)	(1)	(9)	(10)
⅛	10·5	5 (3)	6 (2)	7	7	-	-	3	7	17	8	4	4	4	5	5 (1)	7 (4)	6	(2)	19(16)	16(15)
¼	10·8	12 (3)	14 (1)	6	8	8	4	7	6	14	10	3	7	4	8	6 (1)	3 (1)	2	(2)	17(15)	10 (8)
⅜	11·1	(1)	2 (1)	9	13	17	3	12	11	12	11	4	7	2	5	3 (1)	6	3	2 (1)	13 (2)	4 (2)

TABLE V.—CREEL CRABS, DUNBAR.—*continued.*

Size.		Dec. 20, 1897.		Jan. 28, 1898.		Feb. 25, 1898.		Mar. 31, 1898.		May 3, 1898.		May 27, 1898.		June 3, 1899.		July 12, 1899.		Aug. 4, 1899.		Nov. 5, 1898.	
Inches.	Cm.	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
4½	11·4	6	10	8	5	6	8	13	12	21	9	2	8	9	11	5	1	3	2	18 (5)	12 (4)
⅝	11·7	1 (1)	9	3	6	6	5	10	12	11	3	4	3	10	3	2	4 (1)	2 (1)	1	17 (4)	15 (3)
¾	12·1	6 (2)	8	7	7	12	14	18	11	16	19	7	6	9	4	1	1	1	4 (1)	26 (4)	21 (5)
⅞	12·3	-	2	11	5	6	18	14	14	12	12	2	9	5	2	3	2	1	1	27 (5)	12
5	12·7	7	14	10	6	16	20	26	25	12	13 (1)	3	5	13	3	5	3	1	5 (2)	27 (2)	15 (1)
⅛	13	3	6	3	9	7	11	18	17	12	8	6	9	3	4	2	5	1	1	20 (4)	16 (3)
¼	13·3	4 (1)	7	7	4	9	14	15 (1)	20	10	9	3 (1)	4 (1)	2	7	4	-	-	4 (1)	30 (1)	18 (2)
⅜	13·6	1	2	5	4	14	9	19	10	9	9	2	7	4	3	3	1	5	6	21 (1)	9
½	14	5 (1)	11	4	17	6	17	21	21	4	10	8	7	11	7	5	-	-	5 (1)	26 (2)	17 (1)
⅝	14·3	6 (4)	5	1	8	6	12	15	14	4	9	6	3	4	8	3	1	2	4	17	13 (1)
¾	14·6	3 (1)	4	6	8	7	14	6	12	8	8	4	3	9	4	3	3	1	7	18 (5)	14
⅞	14·9	(3)	3	5	11	3	9	5	5	6	4	2	4	5	1	5	1	1	9	8 (4)	13
6	15·2	3 (1)	8	1	5	5	12	13	7	6	-	2	4	2	-	4	5	-	6	10 (4)	7 (1)
⅛	15·5	3	1	-	4	4	8	9	3	1	3	3	1	5	2	2	6	-	5	15	6
¼	15·9	2	3	1	7	2	-	2	2	1	1	-	1	1	2	3 (1)	2	1	4	4	9
3	16·2	(2)		-	6	2	5	2	4	-	4	1	1	3	2	3	2	-	5	4 (1)	6 (1)

TABLE V.—CREEL CRABS, DUNBAR.—*continued.*

Size.		Dec. 20, 1897.		Jan. 28, 1898.		Feb. 25, 1898.		Mar. 31, 1898.		May 3, 1898.		May 27, 1898.		June 3, 1899.		July 12, 1899.		Aug. 4, 1899.		Nov. 5, 1898.	
Inches.	Cm.	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
6½	16·5	(1)	3 (2)	-	4	1	3	4	1	2	1	1	1	8	-	2	-	1	3	9 (3)	8
⅝	16·8	-	-	1	2	3 (1)	2	1	-	3	1	-	-	4	-	-	1	-	3	5 (2)	4
¾	17·1	1	1	-	5	1	1	-	2	-	1	-	-	5	2	2	-	2	4	-	4
⅞	17·5	-	1	-	2	(1)	1	1	-	-	-	-	-	2	-	-	1	1	-	1	-
7	17·8	(1)	1	-	-	-	-	-	1	-	2	-	1	3	-	-	1	-	3	-	3
⅛	18·1	1	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	1
¼	18·4	-	-	-	-	-	2	-	-	1	-	-	1	1	-	-	-	-	1	-	-
⅜	18·7	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
½	19	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	1	-	-
⅝	19·4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
¾	19·7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
		98	136	108	160	143	192	240	221	199	166	79	114	131	85	78	66	48	94	383	288

Total,

	Hard.	Soft.	Hard and Soft.
Males.	1355	152	1507
Females.	1405	117	1522

3029 Crabs.

TABLE VI.

WADDINGTON'S SERIES OF *Cancer pagurus*.

No.	Date.	Size—Mm.	Rate of Increase.	Interval—Days.	No.	Date.	Size—Mm.	Rate of Increase.	Interval—Days.
	A	♀				B			
1	4 Aug., 1899,-	3·25					9·25		
2	15 ,, ,, -	4·75	1/2		1	30 April, 1900,-	13	1/3·4	
3	7 Sept., ,, -	5·75	1/4·7	23	2	25 Aug., ,, -	15·5	1/5·2	117
4	6 Oct., ,, -	8·5	1/2	29	3	30 Oct., ,, -	18·75	1/4·7	66
5	3 Nov., ,, -	10·75	1/3·7	28	4	9 Feb., 1901, -	20·75	1/6·5	102
6	12 Dec., ,, -	14·5	1/2·8	39					
7	27 Jan., 1900, -	19·5	1/2·9	46		C	♀		
8	3 April, ,, -	24·5	1/3·9	66	1	7 Sept., 1896,-	12		
9	4 June, ,, -	30·75	1/3·9	63	2	25 Nov., ,, -	16	1/3	
10	30 Sept., ,, -	36·5	1/5	118	3	20 Mar., 1897,-	19	1/5·3	115
11	19 Mar., 1901,-	45·75	1/3·9	170	4	26 May, ,, -	24	1/3·8	67
12	5 Nov., ,, -	56·5	1/6	231	5	21 Aug., ,, -	30	1/4	87
					6	4 Nov., ,, -	37	1/4·2	75
					7	31 Dec., ,, -	46	1/4·1	57

The Migrations of Crabs.

TABLE VII.—ADDITIONS TO THE LISTS OF LABELLED CRABS RECAPTURED.

Set Free.				Recaptured.								
Label Number.	Date.	Place (A). Distance and Bearing from Dunbar.	Place (A). Depth. Fms.	Date.	Place (B). Distance and Bearing from Dunbar.	Place (B). Depth. Fms.	Condition when set Free.	Interval of Freedom. Days	Condition when Recaptured.	Distance and Bearing of Place (B) from Place (A).	Size in Inches.	Sex.
1072	Oct. 24, 1899.	Mouth of Harbour.		May 12, 1900.	$3\frac{1}{2}$m. N.W.	8	S.	200	H.	$3\frac{1}{2}$m. N.W.	$4\frac{7}{8}$	♀
1062	,, ,,	,, ,,		,, 14, ,,	$1\frac{1}{2}$m. N.W.	8	S.	202	H.	$1\frac{1}{2}$m. N.W.	$5\frac{1}{2}$	♂
894	Sep. 23, ,,	,, ,,		,, 14, ,,	7m. S.S.E.	8	S.	233	H.	7m. S.S.E.	$4\frac{7}{8}$	♂
943	,, ,,	,, ,,		,, 15, ,,	$3\frac{1}{2}$m. N.N.W.	8	S.	234	H.	$3\frac{1}{2}$m.N.N.W.	$5\frac{1}{8}$	♂
915	,, ,,	,, ,,		,, 21, ,,	4m.N.W. by N.	10	S.	240	H.	4m.N.W. by N.	$5\frac{1}{4}$	♀
1121	Oct. 26, ,,	$1\frac{1}{2}$m. E. by N.	17	,, 31, ,,	$\frac{1}{2}$m. E.	7	S.	217	H.	1m. S.W.		
1159	Nov. 4, ,,	Mouth of Harbour.		,, 31, ,,	,, ,,	7	S.	208	H.	$\frac{1}{2}$m. E.		
999	Sept. 25, ,,	$2\frac{1}{2}$m. E. by N.	25	June 4, ,,	Near Cove, 7m. from Dunbar.	11	S.	252	H.	7m. S.S.E.		
963	,, ,,	,, ,,	25	July 12, ,,	$1\frac{1}{4}$m. N.W.	5	S.	290	H.	3m. W.	$4\frac{3}{4}$	♂
1100	Oct. 26, ,,	$1\frac{1}{2}$m. E. by N.	17	,, 21, ,,	1m. N.W.	7	S.	268	H.	2m. W.		
1147	Nov. 4, ,,	Mouth of Harbour.		,, 21, ,,	,, ,,	7	S.	259	H.	1m. N.W.		
1119	Oct. 26, ,,	$1\frac{1}{2}$m. E. by N.	17	Oct. 20, 1902.	$1\frac{1}{2}$m. off D'nb'r	15	S.	3 yrs.	H.		$6\frac{1}{8}$	♂

N.B.—The following contractions are used in the above Table, viz. :—" m," mile ; " yrs. " years ; " S.,' Soft ; " H.,' Hard.

A number of labelled crabs which were received after the publication of the previous paper are recorded in Table VII. One of these crabs (the last in the Table), which is a male measuring $6\frac{1}{8}$ inches across, is especially interesting. It was recaptured after an interval of three years very near the place where it was set free. When liberated it was a soft crab, and it had not cast its shell during its period of freedom. The abstention of the large crabs from casting has been exemplified by a number of instances, but the time of abstention has only been determined by secondary proofs. For example, a crab is captured with an oyster attached to its back. Since the age of the oyster may be more or less accurately judged from its size, a part of the period that has elapsed since the ecdysis has been determined. Thus Buckland recorded two crabs which had on their backs three-year-old oysters: they could not have cast for three years. Another, now in the Ipswich Museum, is said to have a four-year-old oyster on its back.

The present case gives a definite abstention for three years at the time of capture. At the beginning of 1903 it had not cast, and would not probably cast then till the summer. This would make the abstention from casting four years. There, of course, comes a stage when the crab ceases altogether from casting.

Meek gives* a list of the labelled crabs set free on the coast of Northumberland and which have been recaptured at various times during 1902 and 1903. One of these is of special interest. Set free in October it was captured in the following July at Portlethen (near Aberdeen), a point about 80 miles to the north of the place of liberation.

The Changes in the Carapace of Cancer pagurus.

Cunningham in his paper on the early post-larval stages of this Crustacean drew attention to the great difference between the early and the adult form of the carapace. In the adult the carapace is broadly oval in shape, and is crenate at the edge. In the very young crab the edge is toothed. In his opinion the general resemblance of the carapace, in this stage, to that of *Atelecyclus heterodon*, along with certain other points of similarity, indicated a closer affinity between the two species than had previously been recognised.

I have had the opportunity of examining one of the series of casts belonging to Mr. Waddington (A, Table VI.). They are, with the exception of the first, shown in natural size in figs. 71–81. The changes which take place in the shell are well seen. In fig. 103 an enlarged drawing of the second of the series is shown; it measures 4·75 mm. across the broadest part of the back. The carapace has five main lateral teeth, of which the first forms the hind edge of the orbit, while the fourth projects laterally farther than the others. The main teeth are all serrated; between each two a secondary tooth is found. The rostrum consists of three dentate lobes. The edge of the orbit is serrated; and on the surface of the carapace and on the limbs there are numerous small teeth.

In the next stage (fig. 102)—5·75 mm. in greatest breadth—a very considerable advance on the preceding is noticed. The secondary teeth have increased in proportional size, and with the main teeth are now more lobate or rounded. All of the lateral edge and the margin of the orbit is minutely dentate. On the rostrum the three lobes show merely a minutely notched anterior edge—the serrations being rounded, not tooth-like. The chela is furnished with tooth-like tubercles.

* Meek, "The Migrations of Crabs."—*Northumberland Sea-Fisheries Committee. Report on the Scientific Investigations* for the year 1903. Newcastle-on-Tyne, 1904.

Fig. 101 shows the stage immediately following, viz., 8·5 mm. The lateral teeth of the carapace are now lobes having minutely notched edges; the secondary lobes are almost as large as the primary. The margin of the orbit and rostrum is minutely notched. The tubercles on the chela are rounded.

In the succeeding stage, 10·75 mm. (fig. 98), a condition closely approaching the adult is to be noted. The notched edge of the lateral lobes of the orbit and rostrum is still more prominent than in the adult. The tuberculated chela is very noticeable. A distinction in size between the primary and secondary lobes is still to be seen. The edge of the carapace shows a triple row of tubercles. The dorsum also is tuberculated.

The sixth cast, 14·5 mm. (fig. 76), is represented in figs. 99 and 97, the former showing the frontal region. The lobes of the edge of the carapace are on the whole very similar to the adult condition. The chela is still tuberculated, and the triple row of tubercles which has succeeded the notches is very prominent.

In the cast shell shown in fig. 77 (19·5 mm. across) the tubercles are prominent but smaller.

They are further reduced in the next stage, viz., 24·5 mm. (fig. 78), and in that immediately following, viz., 30 mm. (fig. 79), the tubercles are practically reduced to the condition in the adult.

Fig. 81, the last of the series, was not made from the actual specimen, but is a drawing of a crab of the same size.

LITERATURE.

Braun.—"Zur Kenntniss des Vorkommens der Speichel— u. Kittdrüsen bei den Decapoden." *Arbeit a. d. Zool. Instit. in Würzburg*, iii. Bd., pp. 121-166, Taf. viii.-ix., 1875.

Brocchi.—"Recherches sur les organes génitaux males des Crustacés décapodes." *Annales des Sciences naturelles, Zoologie et Paléontologie*, t. ii., 1875.

Cano.—"Morfologia dell' apparecchio sessuale femminile, glandole del cemento e fecondazione nei Crostacei Decapodi." *Mittheil. a. d. Zool. Stat. z. Neapel*, ix Bd., 4 Hft., 1890, pp. 503-532, 1 tav.

Cuenot.—"Études physiologiques sur les Crustacés décapodes." *Archives de Biologie*, t. xiii., 1895.

Cunningham.—"On the Early Post larval Stages of the Common Crab (*Cancer pagurus*), and on the Affinity of that Species with *Atelecyclus heterodon*." *Proceedings of the Zoological Society of London*, March 15, 1898.

Duvernoy.—"Fragments sur les organes de génération de divers animaux." *Mémoires de l'Académie des Sciences de l'Institut de France*, t. xxiii., Paris, 1853, p. 105, pl. i.-ix.

Grobben.—"Beiträge zur Kenntniss der männlichen Geschlechts-organe der Dekapoden." *Arbeit a. d. Zool. Instit. d. Universität, Wien*, 1 Bd., pp. 1-94, Taf. i.-vi., 1878.

Heath.—"The Breeding Habits of *Cancer magister*." *American Naturalist*, xxxvi., pp. 501, 502. 1902.

Herrick.—"The American Lobster: A Study of its Habits and Development." *Bulletin, U.S. Fish Commission*, for 1895.

Lereboullet.—"Recherches sur le mode de fixation des œufs aux fausses pattes abdominales dans les écrevisses." *Annales des Sciences naturelles*, sér. 4e (Zoologie), t. xiv., 1860, p. 359.

——— "De la manière dont les Œufs des Écrevisses s'attachent aux fausses pattes abdominales."—*L'Institut*, t. xxi., No. 998, p. 64. 1853.

M'Intosh.—"On the Hairs of *Carcinus mœnas*." *Trans. Linnean Society*, vol. xxiv.

Mayer, P.—"Sur Entwicklungsgeschichte der Dekapoden." — *Jeoa. Zeit Naturw.*, 11 Bd., 1877.

MEEK.—Various Papers on the Crab in the Reports of the *Northumberland Sea-Fisheries Committee*—1898–1903.

RATHKE.—"Untersuchungen ueber die Bildung u. Entwickelung der Flusskrebses," folio, Leipzig, 1829.

SABATIER.—"De la Spermatogenèse chez les Crustacés décapodes." *Travaux de l'Institut de Zoologie de Montpellier et de la Station maritime de Cette (Sabatier et Rouzaud)*, nouvelle série, mémoire No. 3, Montpellier, 1893.

SCOTT.—"On the Spawning of the Common Lobster." *Report of the Lancashire Sea-Fisheries Laboratory* for 1902, No. xi., Liverpool, 1903, p. 20.

TULLBERG.—"Studien über den Bau u. das Wachsthum des Hummerspanzers u. des Molluskenschalen," 12 taf. *Kgl. Vetensk. Akad. Handl.*, 19 Bd. Stockholm, 1882.

VITZOU.—"Recherches sur la Structure et la Formation des Teguments chez les Crustacés décapodes." *Archives de Zoologie Expérimentale et Générale*, t. x., Paris, 1882.

WILLIAMSON.—"Contributions to the Life-History of the Edible Crab (*Cancer pagurus*)." *Eighteenth Annual Report of the Fishery Board for Scotland*, Pt. III., 1900.

——— "On the Larval and Early Young Stages, and Rate of Growth, of *Carcinus mœnas*." *Twenty-first Annual Report of the Fishery Board for Scotland*, Pt. III., 1903.

WILSON.—*Northumberland Sea-Fisheries Committee.* Reports on the Crab Fishery, 1893 and 1895. Newcastle-on-Tyne.

WITTEN.—"On the Structural Changes accompanying the Ecdysis of the Crab." *Northumberland Sea Fisheries Committee. Report on the Scientific Investigations* for the year 1902, Newcastle-on-Tyne, 1903, p. 53.

——— "On the Structural Changes accompanying the Ecdysis of the Crab' *Cancer pagurus*." *Northumberland Sea-Fisheries Committee. Report on the Scientific Investigations* for the year 1903. Newcastle-on-Tyne, 1904, p. 42.

LETTERS USED.

A.—antenna.
a.—basal bone.
ab.—abdomen.
an.—anus.
ant.—antennule.
ar.—arm of second penis.
b.—basal bone.
c.—core. —cæcum, fig. 38.
car.—carapace.
chr.—chorion.
dis.—egg with distended chorion.
e.—eye.
en.—endopodite.
ex.—exopodite.
f.—follicle.
g.p.—genital papilla.
i.ch.—inner chevron (1st abdom. seg.).
i.l.—inner layer.
j.—joint.
m.—membrane.
mu.—muscle.
o.ch.—outer chevron (1st abdom. seg.).
o.l.—outer layer.
1*p.*-2*p.*—first and second penes.
p.—p.—plane of movement of distal parts of endopodite of right side.
p′.—p′.—plane of movement of distal parts of endopodite of left side.
p.f.—perivitelline fluid.
r.—rod.
sl.—solid in spermatheca.
s.e.—secondary envelope.
sp.—sperms.
sp.w.—wall of spermatheca.
th.—thorax.
v.—valve, vulva.
v.d.—*vas deferens.*
v.m.—vitelline membrane.
v.w.—wall of vagina.
yk.—yolk.

EXPLANATION OF PLATES.

PLATE II.

All the drawings are of *Cancer pagurus*, with the exception of Figs. 27, 28, and 29, which are of *Munida rugosa*.

Figures 1, 3, 5, 11, 12, 18, 21, 23*b*, 24, 34, 35, and 36 were outlined by aid of the *camera lucida*.

Fig. 1. Eggs impaled by hair of endopodite. November 30, 1900, . × 57
Fig. 2. Lobule of ovary, showing a few distended eggs, *dis.* magnified, × 57
Fig. 3. Eggs in later stage of attachment than Fig. 1.
Fig. 4. Transverse section of first penis near base, magnified.

Fig. 5. Section of a ripe egg (in ovary).
Fig. 5*a*. Envelopes of egg, ... × 57
Fig. 6. Hair of endopodite, magnified.
Fig. 7. Part of long hair of exopodite, magnified.
Fig. 8. Part of short hair of exopodite, magnified.
Fig. 9. Ocular section of hair of exopodite, magnified.
Fig. 10. Transverse section of first penis at the base, magnified.
Fig. 11. Hair of exopodite, ... × 19
Fig. 12. Hair of exopodite, ... × 19
Fig. 13. Abdomen, showing relation of the swimmerets.
Fig. 14. Side view of the abdomen, showing the overlapping of the exopodites.
Fig. 15. Abdomen.
Fig. 16. Transverse section of median part of first penis, magnified.
Fig. 17. Ocular section of hair of exopodite, near its base.
Fig. 18*a*. Longitudinal section of an egg which had been attached to a hair of the endopodite. January 11, 1901, . . . × 57
Fig. 18*b*. Section of envelopes of 18*a*.
Fig. 19. Shows the eggs retained in the "incubatory chamber," formed by the abdomen.
Fig. 20*a*. Third swimmeret, left side, posterior surface.
Fig. 20*b*. Third swimmeret, left side, anterior surface.
Fig. 21. Group of eggs attached to a hair. January 11, 1901, . . × 5
Fig. 22. Tip of hair of endopodite, magnified.
Fig. 23*a* & *b*. Tip of hair of endopodite, magnified.
Fig. 24. Tip of hair of endopodite, oc. 2, obj. 2 mm. O.I.
Fig. 25. Transverse section of the first penis, close to tip, magnified.
Fig. 26. Group of hairs of endopodite bearing eggs, magnified.
Fig. 27. Tip of hair of endopodite of *Munida rugosa*, magnified.
Fig. 28. Egg of *Munida rugosa*, attached to hairs of endopodite, . × 19
Fig. 29. Attachment of egg-stalk to hairs of endopodite (*Munida rugosa*), magnified.
Fig. 30. Ocular section of the base of hair of endopodite, magnified.
Fig. 31. Tip of hair of endopodite, magnified.
Fig. 32. Ocular section of hair of endopodite, magnified.
Fig. 33. Tip of hair of endopodite, magnified.
Fig. 34. Section of dropsical ovarian egg with large perivitelline space.
Fig. 35. Hair of exopodite, ... × 19
Fig. 36. Hair of exopodite, ... × 19

Plate III.

The drawings, except where otherwise stated, belong to *Cancer pagurus*. Figures 56, 57, 58, and 64 were outlined by means of the *camera lucida*.

Fig. 37. First penis, posterior view.
Fig. 38. Longitudinal section of mouth of the spermatheca of a hard crab, $6\frac{13}{16}$ inches, showing three-layered wall of vagina and spermatheca.
Fig. 39. Fourth and fifth pereiopods, with genital papilla on coxopodite of the latter : fifth pereiopod posterior in position.
Fig. 41. Fourth and fifth pereiopods, with genital papilla: fifth pereiopod anterior in position.
Fig. 42. Outer surface of tip of exopodite of third swimmeret, left side, magnified.
Fig. 43. Sloughed-off outer skin of hair, with empty egg-capsules attached, magnified.
Fig. 44. Abdomen, with first and second penes in one position.
Fig. 45. Abdomen, with first and second penes in second position.
Fig. 46. Muscles of second penis, magnified.
Fig. 47. Genital papilla, magnified.
Fig. 48. Muscles of first penis, magnified.
Fig. 49. Spermatheca of soft crab, $6\frac{5}{8}$ inches across. December 1st, 1899. *pl.* Plug.
Fig. 50. Tip of endopodite, inner surface, magnified.
Fig. 51. Tip of exopodite, inner surface, magnified.
Fig. 52. Muscles of abdomen, view from median line.
Fig. 53. Second penis, anterior view.
Fig. 54. Second penis, posterior view.
Fig. 55. Diagram of relation of penis to the spermatheca and the plug. *fl.* Fluid.
Fig. 55*a*. Coxopodite of fifth pereiopod, showing the perforation for the issue of the *vas deferens*.

Fig. 56. Egg of *Homarus vulgaris*, showing three attachments, . . × 10
Fig. 57. Egg of *Homarus vulgaris*, showing three attachments.
Fig. 58. Tip of hair of endopodite of *Homarus vulgaris.*
Fig. 59. Dissection of first penis, magnified.
Fig. 60. Longitudinal section of first penis, semi-diagrammatic, to show the relationship of first and second penes and the genital papilla, magnified.
Fig. 61. Longitudinal section of second penis, to show muscles seen from median line.
Fig. 62. Tip of endopodite, posterior surface, magnified. The hairs ought in proportion to be larger (viz., about one-third longer) than they are here represented.
Fig. 63. Plan of a row of hairs of endopodite, magnified.
Fig. 64. Hair of endopodite of *Nephrops norvegicus*, . . . × 48
Fig. 65. First and second penes, lateral (external) view.
Fig. 66. Muscles of second penis.
Fig. 67. Spermatheca of hard crab, $6\frac{5}{8}$ inches. December 1st, 1899.
Fig. 68. Second penis, lateral (external) view.
Fig. 69. First penis, lateral (external) view, shows relationship of genital papilla.
Fig. 70. External (attached) egg of *Carcinus mænas*. December 21st, 1897.

Plate IV.

Figs. 94, 95, and 96 were outlined by means of the *camera lucida*.

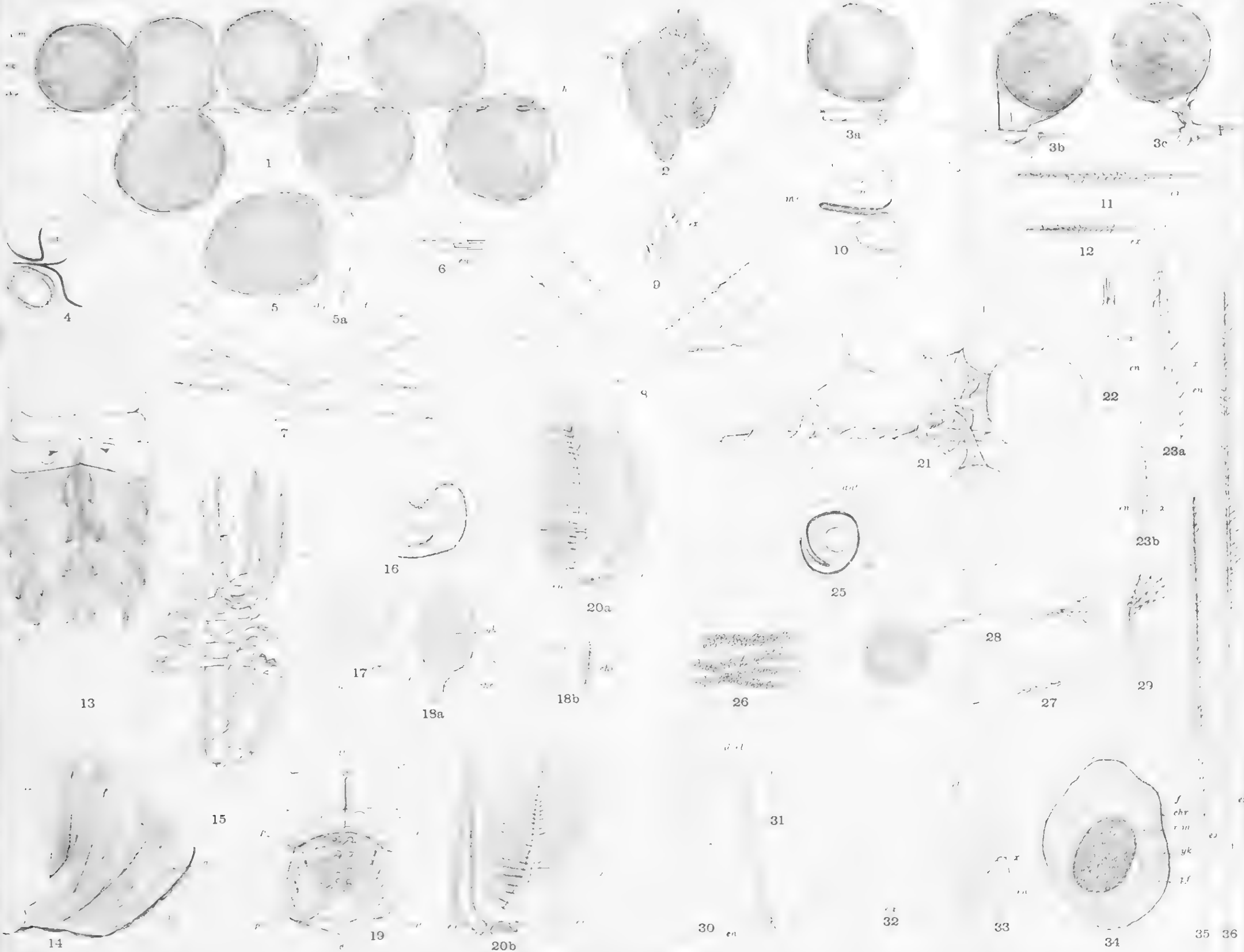
Figs. 71–81. Successive casts of a *Cancer pagurus*, Nos. 2–12 inclusive, viz., A, Table VI. Natural size.
Figs. 82–93. Successive casts of a *Carcinus mænas*, viz., No. 1 in Table I. in "On the Larval and Early Young Stages, and Rate of Growth, of *Carcinus mænas*." *Twenty-first Annual Report of the Fishery Board for Scotland*, Pt. III., p. 166.
Fig. 94. Egg of *Cancer pagurus* taken from the vagina of a spawning female by means of a pipette, 30/11/00, . . . × 57
Fig. 95. Egg just extruded, ... × 57
Fig. 96. Egg found on bottom of tank beside a spawning *Cancer pagurus*, × 57

Plate V.

The figures in this plate, with the exception of Fig. 100, were outlined by means of the *camera lucida*.

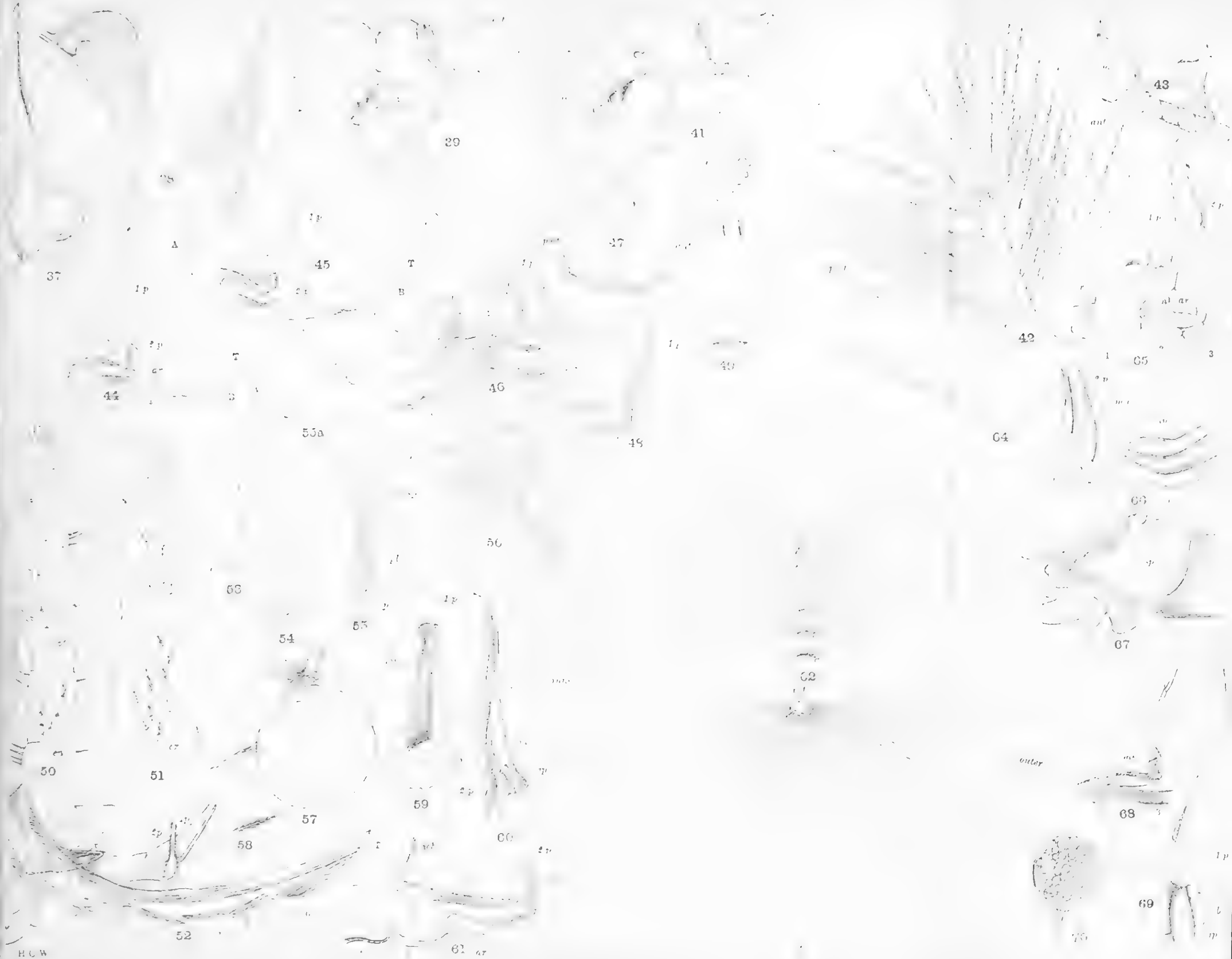
Fig. 97. Edge of carapace of the cast represented in Fig. 75, . . × 19
Fig. 98. Half of carapace do. do. 74, . . × 19
Fig. 99. Frontal region do. do. 75, . . × 19
Fig. 100. Cast chela of a *Cancer pagurus* to show the absorption lines (*abs.*) on the coxopodite, basi-ischiopodite, and meropodite joints. Natural size.
Fig. 101. Half of carapace of the cast represented in Fig. 72, . . × 19
Fig. 102. Do. do. do. 73, . . × 19
Fig. 103. Enlarged drawing of cast shell represented in Fig. 71, carapace, × 19
Fig. 104. Joint on second penis, *Cancer pagurus.*
Fig. 105. Tip of second penis, do.

N.B.—The "arrows" which accompany certain of the figures serve to indicate the antero-posterior median line; the point of the arrow is directed anteriorly.



Cancer pagurus—SPAWNING, &c.

PLATE III.



—Casting, Impregnation.

H.C.W.
Fig 100 A. H. Walker.

Cancer pagurus—Casting, Etc.

III.—THE RATE OF GROWTH OF FISHES. By Dr. T. Wemyss Fulton, F.R.S.E., Superintendent of Scientific Investigations. (Plates VI.-XII.)

Contents.

1. Introduction.

The present paper contains the results of further observations I have made on the rate of growth of fishes, and is a continuation of the investigation on this subject as dealt with in some of the preceding Reports of the Fishery Board. In that for 1901 I described fully the methods adopted,* the collections being obtained by the use of a fine-meshed net around the cod-end of the otter trawl, on the occasions when steam-trawlers were employed in the trawling investigations in the Moray Firth and Aberdeen Bay. It need only be mentioned here that the fishes are measured in millimetres, the measurements tabulated, and curves formed on the measurements as grouped into 1cm. or ·5cm. groups. It may be stated that the method of collection with a small-meshed net in the way described has now been adopted in some other countries as well as on the "Goldseeker," the vessel employed in the Scottish part of the international investigations of the North Sea.

In addition to the measurements of numerous fishes, only part of which are worked up in this paper, viz. those dealing with the sprat, the witch, the Norway pout, and the sharp-tailed *Lumpenus*, observations were also made on a large scale with the view of determining the relation between the weight and the length of a considerable number of species, and these are detailed below. I have found that the law which governs the relation between the weight and dimensions of similarly-shaped bodies does not apply with precision to fishes. They increase in weight more than the increase in length would, according to the law, imply, and since the number of fishes in which the relation between the length and weight has been determined was large, viz. 5675, belonging to nineteen species, and in no case has the law been found to apply exactly, it appears to be well-established that on the assumption that the specific gravity of the fishes does not change during growth they must increase in some other of their dimensions, whether breadth or thickness, in greater proportion than they increase in length.

* *Twentieth Ann. Rep.*, Pt. III., p. 326.

I have likewise carried on a number of experiments in order to ascertain the relation which exists between the growth of fishes and the temperature of the water in which they live. It is well known from previous observations that in the winter season the growth of fishes, at least in the inshore waters, is slower than it is in summer; in the case of those living in shallow water, subjected to the changes in the temperature of the air, and where the extremes of heat and cold are at their maximum, growth may be entirely arrested in winter. In the Annual Report of the Board above referred to I gave particulars on this point with regard to the young plaice living on the beaches, and exhibited a curve in which the relation between the temperature of the water and the degree of growth of the plaice was established.

The experiments, which are described in detail below, consisted in keeping fishes of various species in tanks in which the water was artificially heated, and the result on the growth of the fish was very marked, those in the water of a high temperature growing much faster than those in the water at lower temperature. It was, moreover, shown, as might have been anticipated, that the fishes in the warmer water ate much more food than those in the colder water, the digestive ferments being more active at the higher temperatures, and the fish being thus able to digest a larger quantity of food in a given time. It was found that the appetite of the fishes was in relation to the power of digestion, that is to the temperature of the water, those in very cold water scarcely eating at all, although abundantly supplied with food. In the same way, the metabolism in the tissues was more rapid, and nutrition and growth much accelerated.

Certain differences were found to exist in different species, which are referred to below.

2. The Relation of Length to Weight.

In dealing with the rate of growth of fishes it is customary to take one of the dimensions of the fish and compare the variations of this dimension at different periods or in different collections. In some cases, as with the rays, it is more convenient to take the breadth across the pectorals than the length. The selection of one dimension for comparative measurement is very convenient, and it is accurate on the assumption that the fish grows equally in all directions, increasing in breadth and thickness in the same ratio as it does in length. It is obvious, however, that the true criterion of growth is the increase in the mass of the fish, and this can be determined either by the variation in the volume or in the weight.

The determination of the variation in volume is a somewhat slow process, and the methods are subject to difficulties in practice. With small fishes a burette may be used with accurate results; with those of large size the quantity of water displaced by the fish was measured separately in a burette, the fish itself being placed in a convenient vessel. In the case of fishes of moderate dimensions the method used was to place them in a vessel provided with a syphon to draw off the amount of water displaced, which was then measured in a burette; the bore of the syphon being so adapted as to always remain full of fluid. As a rule this mode of determining the increase in bulk was found to be less satisfactory than the method of weighing the fish, and this was the method chiefly employed.

According to the well-known law, that the volume of similarly-shaped bodies of the same specific gravity vary directly as the cube of corresponding dimensions—a law which was brought prominently forward by Herbert Spencer in his "Principles of Biology"—a fish which has doubled its length should have increased its weight eight times. This law is a very convenient one in considering the rate of growth of fishes, all that is required, if the law holds true throughout, being to determine the relation between the weight and one of the dimensions at a particular size and then calculate the ratio between that dimension and the weight at different sizes. The truth of the law has not, however, been proved experimentally in the case of fishes, as far as I am aware, and it was decided to actually measure and weigh a large number of fishes of different sizes, and to construct curves in order to bring out the relation between the length and the weight at different sizes. In the Twentieth Annual Report of the Fishery Board* I described the method of presentation I had adopted, the abscissæ in the diagrams representing length and the ordinates weight; and I pointed out that the curves varied for different species, and that they did not everywhere agree with the rule as to similarly-shaped bodies above referred to.

Since then many more fishes and observations have been added to my lists, and I propose to discuss some of the results now.

In all cases, unless where otherwise stated, the observations have been made at different times of the year, and on fish from different localities. This method will give a better result as to the relations between length for the species generally, although it is probable that the ratio varies somewhat at different places and at certain times of the year—at all events in fish which have reached adult size. This is referred to at greater length below.

In the observations made on this subject each fish was individually measured in millimetres and then weighed in grammes, and the method adopted in presenting the results was to collect the records of weight to the nearest ·5 centimetre, and take the mean of the lot. Thus the number of observations under each ·5cm. are often unequal in amount; but it was found, on testing the method, that this system gave practically the same result as when the calculations were made for the observations under each millimetre measurement—a very laborious process.

The mean weight under a given ·5cm. was then tabulated, as well as the number of fishes at that size and the greatest and lowest weight among them, and this information for the various fishes dealt with is given in a series of tables appended (p. 205), while the average weight is represented in the series of diagrams (Pls. VI, VII). In constructing these curves the average weight of the fishes at a particular length was not itself taken, the series of averages being arithmetically smoothed, by taking the mean of the averages immediately before and after; as a rule only the one preceding and the one following was combined with the average being smoothed, but in some cases where the number of observations was small a number of the preceding and succeeding averages were combined also and the mean taken.

The fishes in which the relation between the length and weight at different sizes were determined were the following:—Plaice, common dab, lemon dab, long rough dab, witch, brill, cod, haddock, whiting, herring, sprat, Norway pout, and partly also the turbot, little sole, gurnard, halibut, flounder, armed bullhead, and *Lumpenus*.

It will be seen from the tables and the curves of these fishes how very greatly the weight for a given length differs in different species, and thus how very different is the increment of growth for a given increase in the length. Among the food-fishes examined by far the heaviest in proportion

* Page 334, 1902.

to its length is the turbot, and after it comes the brill; at the opposite extreme is the witch, which is the lightest of all:—

Cm.	Turbot.	Brill.	Lemon Dab.	Plaice.	Common Dab.	Flounder.	Witch.	Long Rough Dab.	Little Sole.	Cod.	Haddock.	Whiting.	Herring.	Sprat.
5	.	.	.	1·17	·97	.	·45	.	.	1·04	.	.	.	·67
10	.	.	.	9·6	8·7	.	.	5·7	10·8	7·93	7·8	7·1	5·9	6·7
15	.	.	32·3	34	28·1	31·3	14·1	21·6	.	30·7	28·3	23·8	23·4	.
20	.	.	89 3	77·1	74·7	78	35·4	58·5	.	71·1	65·7	54·2	55·1	.
30	.	.	.	299·1	296·4	279	170·4	.	.	271·8	243·3	213·6	219·5	.
35	922	622	561	484·6	470	440	283·5	.	.	420	381	322	.	.
40	.	978	788	708	.	683	458	.	.	614	592	513	.	.
45	2,000	1,373	1,076	1,026	.	.	677	.	.	907	828	.	.	.
50	2,706	2,145	.	1,429	.	.	.	.	.	1,139	.	.	.	.
60	5,000	.	.	2,468	.	.	.	.	.	2,057	.	.	.	.
70	8,569	.	.	3,908	.	.	.	.	.	3,380	.	.	.	.
80	.	.	.	.	.	.	.	.	.	5,000	.	.	.	.
100	.	.	.	.	.	.	.	.	.	10,194	.	.	.	.

Among the other flat-fishes the lemon sole comes after the brill, then the plaice, common dab, flounder, and long rough dab, but several of them are very close together. Among the round-fishes the cod is the heaviest in proportion to its length, with the haddock next, and then the whiting. The sprat is, in proportion to its length, heavier than the herring, which shows much the same ratio as the long rough dab. It is noteworthy that the extremes in regard to the length-weight ratio should be exhibited among the flat-fishes.

It will also be noticed that the variation in weight at a given size in the same species increases very much as the fish grows in length, so that at the larger sizes, of the cod or turbot for example, the variation in this respect is most pronounced. For this reason the terminal parts of the curves are less satisfactory than the lower parts, as may be seen in the diagrams, and it would probably require a very extensive series of observations on these larger forms to give the relation between the length and the weight with high precision. Nevertheless, I think the curves given will be found useful in dealing with many questions connected with the fisheries.

The number of the various species which have been measured and weighed for the purpose of this research are as follows:—

Cod, - - -	471	Little sole, - -	54
Haddock, - -	844	Turbot, - - -	29
Whiting, - -	507	Brill, - - -	100
Norway pout, - -	218	Flounder, - - -	48
Plaice, - - -	913	Halibut, - - -	38
Lemon dab, - -	165	Herring, - - -	482
Common dab, - -	541	Sprat, - - -	339
Long rough dab, -	335	Gurnard, - - -	63
Witch, - - -	426	Armed bullhead, -	59
		Lumpenus, - -	43

—the total being 5675 fishes.

An examination of the tables and curves shows that the law in regard to the increase in weight according to the cube of the length, although broadly true, does not accurately apply in the case of the fishes examined. With scarcely an exception, the weight at a given length is greater than the weight calculated from the law, so that if the specific gravity of the fishes remains constant they must increase somewhat more in other dimensions than in length.

In the case of the haddock, the plaice, and the sprat, I have calculated out the weights at the various sizes on the assumption that the law referred to held true during the growth of the fish, and these are given in the Table on pages 240, 241. It will be seen, by comparing them with the weights actually observed, that the latter exceed the former in all cases as stated. The datum for the calculation in each instance was the smoothed average for the smallest sizes of which the relative numbers were large. The salient features in this comparison may be given here as follows, the weights being in grammes :—

Cm.	Plaice.		Haddock.	
	Observed Weight.	Calculated Weight.	Observed Weight.	Calculated Weight.
1	—	·009	—	·008
3	—	·252	—	·213
5	1·17	1·167	—	·984
8	4·78	4·78	—	4·03
10	9·62	9·34	7·8	7·87
15	34	31·51	28·3	26·56
20	77·10	74·70	65·7	62·97
25	161	145·90	140·2	122·97
30	299·10	252·10	243·3	212·50
35	484·6	406·45	381	337·44
40	707·9	597·50	591·6	503·73
45	1,026	850·84	828·2	717·19
50	1,429	1,167·20	1,117	983·80
55	1,820	1,553·44	[1,440]	1,309·47
60	2,371	2,016·79	[1,915]	1,700
65	[3,331]	2,564·17	[3,214]	2,162·14
70	[3,908]	3,251·59	—	2,699·52

The figures in brackets represent individual fishes at or very near the dimension stated.

The comparison in the case of the sprat was as follows :—

Centimetres.	Observed Weight.	Calculated Weight.
1	—	·005
2	—	·043
3	—	·149
4	—	·343
5	·67	·670
6	1·17	1·190
7	2·02	1·838
8	3·05	2·744
9	4·63	4·015
10	6·71	5·36
11	9·48	7·13
12	12·46	9·52
12 5	14·34	—
13	[16·4]	11·78
14	—	14·71

A simple method of determining the relationship, without calculating out the ratio at all lengths, is to compare the weights at twice the size; according to the law the weight should be eight times greater. This has been done in all the possible cases throughout the tables, and, with a few exceptions in individual instances where the numbers were usually small, it has been found that the weight at twice the size is greater, and sometimes very considerably greater, than the law implies.

Thus, among plaice of which a large number were weighed (913) there is no exception to the statement made, from 4·5cm. on to 35–70cm. In all cases the weight calculated in this manner is less than the weight actually observed, and the excess over what is required by the law is in some cases considerable. The following examples may be given:—

Cm.	Observed Weight (Smoothed). Grammes.	Cm.	Weight in Grammes.		Excess.
			Calculated.	Observed.	
5	1·17	10	9·36	9·62	·26
8	4·78	16	38·24	41	2·78
10	9·62	20	76·96	77·10	·14
12	17·35	24	138·8	140·6	1·8
15	34	30	272	299·1	27·1
18	57·79	36	462·2	527	64·8
20	77·1	40	616·8	707·9	91·1
22	112·8	44	902·4	954	51·6
25	161	50	1,288	1,404	116
27	207	54	1,656	1,802	146
30	299·1	60	2,392·8	2,468	75·2

Throughout the tables of measurements for haddocks also the weight thus calculated is always under the weight observed, except in a few cases among the largest fishes. Whether this is due to the fact that the number of the fishes at the larger sizes is too small to show the true relation, or the difference is a real difference with age, cannot at present be decided. I give the selected examples for haddocks in the accompanying Table, with all the cases where the calculated weight is greater than the observed weight:—

Cm.	Observed Weight (Smoothed). Grammes.	Cm.	Weight in Grammes.		Difference.
			Calculated.	Observed.	
10	7·93	20	60·4	65·7	+5·3
12	13·6	24	108·8	118·3	+9·5
15	28·3	30	226·4	243·3	+16·9
18	48·3	36	386·4	425·2	+38·8
20	65·7	40	535·6	591·6	+56·0
22	91·4	44	731·6	777·6	+46
25	140·2	50	1,121·6	1,171	+49·4
26·5	165·6	53	1,324·8	1,379	+54·4
28·5	205·5	57	1,645·0	1,635	−10
31	271·7	62	2,173·6	2,110	−63·6
37	465·9	74	3,727	3,691	−36

Among common dabs the observed weights are always in excess also, with one exception, where the calculated weight for a fish of 12cm. is 14·80 and the weight observed was 14·7 grammes. The difference in the smaller forms here is not so great as in those of moderate size. At 6cm. the calculated weight was 1·36 grammes and the observed weight 1·85; at 10cm. the calculated weight was 7·76 and the actual weight 12·31; at 8cm. the calculated weight was 32·96 and the weight observed 34·3 grammes; at 20cm. the calculated weight was 69·76 and the actual weight 74·7; at 24cm. the calculated weight was 117·6 and the weight observed 142·3; at 30cm. the calculated weight was 224·8 and the actual weight 296·4; at 36cm. the calculated weight was 403·2 and the weight observed 487 grammes.

It was the same with the lemon dab, no exception being found. The calculated weight at 15cm. was 26·8 and the real weight 32·3; at 31cm. the former was 288·8 and the observed weight was 354 grammes; at 36cm. the respective weights were 436·8 and 595 grammes, and at 40cm. they were respectively 714·4 and 788 grammes. With the Norway pout, the herring, the sprat, the long rough dab, the cod, the witch, and the whiting the same method shows the same general result, an excess of weight over that to be deduced from the law. I append here some of the figures where this appears:—

TABLE.

Cm.	Cod.		Whiting.		Witch.		Long Rough Dab.		Herring.		Sprat.	
	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.	I.	II.
8	—	—	—	—	1·52	1·46	2·64	2·68	—	—	—	—
9	—	—	—	—	—	—	4·0	3·9	—	—	4·0	4·6
10	—	—	—	—	—	—	—	—	—	—	5·36	6·71
11	—	—	—	—	—	—	7·76	7·85	—	—	7·04	9·48
12	—	—	12	12·4	—	—	10·4	10·5	—	—	9·36	12·46
13	—	—	—	—	7·6	9·9	12·2	13·3	—	—	—	—
14	—	—	—	—	9·1	11·7	15·4	16·5	—	—	—	—
15	—	—	27·2	23·8	10·5	14	18·5	21·6	—	—	—	—
16	—	—	—	—	11·7	16·9	21·4	27·2	23·8	29·1	—	—
17	40	45·4	34·4	35·2	12·8	20	28·4	32·4	29	34·1	—	—
18	46·2	54	40·8	41·3	—	—	31·2	40·4	34·2	40·3	—	—
20	63·4	71·1	56·8	54·2	—	—	45·6	58·5	47·2	55·1	—	—
24	120	123·1	99·2	102·4	—	—	84	122	84·8	106·1	—	—
25	138·4	146·5	112·8	118	67·2	86·1	—	—	96·8	119·8	—	—
28	196·8	210·7	154·4	178·1	—	—	—	—	141·6	174	—	—
30	245·6	271·8	190·4	210·6	112·6	170·4	—	—	187·2	219·5	—	—
35	394·4	420	305·6	332	—	—	—	—	—	—	—	—
40	568·8	614·3	433·6	513	283	458	—	—	—	—	—	—
45	828	907	—	—	—	—	—	—	—	—	—	—
48	985	1,013	819	984	589	791	—	—	—	—	—	—
50	1,172	1,139	—	—	—	—	—	—	—	—	—	—
55	1,588	1,608	—	—	—	—	—	—	—	—	—	—
60	2,174	2,057	—	—	—	—	—	—	—	—	—	—
70	3,360	3,380	—	—	—	—	—	—	—	—	—	—
75	3,948	4,000	—	—	—	—	—	—	—	—	—	—
94	7,888	9,144	—	—	—	—	—	—	—	—	—	—
100	9,112	10,194	—	—	—	—	—	—	—	—	—	—
108	11,728	12,239	—	—	—	—	—	—	—	—	—	—

Among the exceptions to the statement that the rule does not apply the most common are to be found among the small and young forms and in the whiting. In many cases the weight of the smallest individuals whose weight may be calculated by the method described is under the ratio prescribed by the law, or in conformity with it, and thus differs from what obtains among the larger individuals. It seems not improbable that the explanation of this circumstance is that, in their early stages, the fishes grow in length in a greater ratio than they grow in other dimensions. This is specially observable among the whitings, witches, and long rough dabs, although in the case of the two latter, at all events, the tendency is markedly in the opposite direction later on. In many cases in the very largest fishes a few exceptions also occur, and this may be due to defective nutrition with age, or to the fact that the number of the fishes of large size examined was much less and not sufficient to bring out the true relationship. It is to be observed that the statement that the law does not accurately apply is supported by that part of the tables and curves where the observations are most numerous, and which, as a rule, includes those fishes which are in adolescence.

Among cod the greatest number of exceptions were found to occur. The observed weight continued to be greater than that required by the law from 17cm. to 48cm., and then from that point to 69cm., with one or two exceptions, it was less. The number of specimens of the larger sizes was, however, comparatively small, and in the case of the cod many of these large specimens were weighed in May, after they had spawned. In most of the other cases it may be said, although spawning and spent fish are included, the number of these is small; and the sudden loss of weight immediately after spawning is marked, although it appears to be rapidly regained.

I am not at present able to offer any satisfactory explanation of the departure from the law of growth generally accepted in the case of fishes; and perhaps it may be said that the application of this law in biology has not yet been experimentally tested on a sufficient scale among many species of animals. In the growth of some animals there is no doubt that the ratio between the dimensions does not continue constant, and that consequently alteration of shape occurs in the course of growth. In the case of fishes the relation between the length and the weight is in many, and probably most, instances modified in connection with reproduction to a considerable extent, and it may also be altered by the changes which take place in certain of the viscera, as, for example, in the liver, and by the general conditions of nutrition due to season and other circumstances. For obvious reasons, variations in the quantity of food which may be in the stomach or intestine may be neglected. It has to be noted, however, as already stated, that the fishes at periods before reproductive disturbances begin show a marked departure from the law, and that changes arising from difference of season affect fishes at different sizes.

These tables and curves will also be of value in determining the average weight of specimens of different species belonging to different series or generations, and thus showing the increase of mass from one generation to another as well as the mean weight when the reproductive period is reached and the range of variation. An example may be here given from the plaice to show the amount of growth which may take place from one generation to another, and in the following Table I give the particulars as based on the measurements of over 1800 specimens in a haul in Aberdeen Bay in November:—

Series.	Length (Mm.).		Weight (Grammes).		Mean Increase.
	Range.	Average.	Range of Mean.	Average.	
I.	[35—85	65]		2·5	
II.	91—162	118·1	6·9—42	17	14·5
III.	164—260	216·5	44—181	106	89
IV.	261—369	315	183—676	343	237
V.	363—442	400	620—970	708	365
VI.	444—479	460	990—1,280	1,092	384

From this it will be seen how very greatly the weight and therefore the amount of growth in different members of the same series may vary. The "range of the mean," moreover, refers to the average weight for the longest and shortest fish in a series; the actual or possible variation in weight is much greater, as may be seen from the Tables for the plaice on p. 205.

3. The Average Size at Maturity.

With regard to the size and age at which the males and females of the various species of food-fishes first attain maturity, a great deal of information is still required. Isolated observations have been made in a considerable number of instances on several species, sufficient to give an approximate idea of the limit between the mature and the immature, but, as a rule, they are not of such a kind as to enable the average-size as well as the extremes to be determined, and on the hypothesis that reproduction takes place at a certain age this average-size should correspond to the average for one or other of the yearly groups.

In one or two cases I have made a number of observations on the subject, particularly with regard to the plaice, the haddock, and the whiting, a number of these fishes being examined at the spawning time, the sexes determined, the condition of the reproductive organs noted, and the size of the fish measured.

A number were also examined at periods anterior to the spawning time and the progress of the development of the eggs observed.

Thus, among twenty-four whitings caught in the Moray Firth on the 14th November, comprising sixteen females and eight males, it was found that the former ranged in size from 242 to 418mm., and in weight from 108 to 517 grammes; the weight of the ovary varying from 0·2 to 38 grammes, and the diameter of the eggs from ·189 to ·294mm. The following are selected examples:—

Length.	Weight.	Weight of Ovaries.	Diameter of Largest Eggs.
Mm.	Gr.	Gr.	Mm.
242	108	0·4	·189
248	110	1·0	·231
293	196	1·7	·294
298	198	1·5	·252
304	223	2·1	·231
313	240	1·8	·189
351	354	2·8	·273
418	517	38·0	·273

The particulars in these examples show that the whitings, and probably even the smallest, would spawn at the next spawning season; and it will be observed that the size of the eggs in some of the smaller specimens is as large as in those of considerably greater size. In the males the weight of the testes was also determined, and their weight did not always correspond with the weight of the fish, as the following examples indicate:—

Length.	Weight.	Weight of Testes.
Mm.	Gr.	Gr.
293	205	0·8
322	281	1·1
335	277	0·9
323	331	2·0
339	330	3·5
364	382	0·8

All these males would also in all probability spawn at the next season.

On the 27th December some others, also taken in the Moray Firth, were examined, and the following shows the particulars in regard to some of the females:—

Length.	Weight.	Weight of Ovaries.	Diameter of Eggs.
Mm.	Gr.	Gr.	Mm.
175	40	·11	·063
227	81	0·7	·231
254	107·5	1·1	·189
260	113	3·5	·462
231	85	0·8	·210

In the males the testes were as small relatively as in those examined in November. Several other whitings of smaller size were examined, from 159 to 178mm., and in all cases the ovaries and testes were extremely small, and the eggs minute, the largest being about ·06mm.

On 23rd January another lot were examined, and it was found that both the weight of the ovary and the diameter of the largest egg had considerably increased, as shown by the following particulars of some of the females:—

Length.	Weight.	Weight of Ovaries.	Diameter of Eggs.
Mm.	Gr.	Gr.	Mm.
266	136	4·1	·609
269	160	1·8	·357
297	209	5·8	·609
302	224	3·9	·441
339	306	7·9	·462
341	335	11·7	·63

All these females would obviously spawn in the ensuing season; and it is noteworthy that some of the smaller fishes had the larger eggs. The weight of the testes in the male had also increased; in specimens from 227–232mm. they weighed 0·7–0·9 grammes, and in some from 253–267mm. they weighed from 1·2 to 3·8 grammes. From these indications probably all would spawn in the course of the next season.

On the 1st April, that is after the spawning season had begun, some others were examined. Females of 182 and 198mm. had small ovaries and unyolked eggs which measured from 0·6 to 0·8mm. Others at 225 and 227mm. ($8\frac{7}{8}$ inches) had eggs measuring up to ·672, and at 232 and 237mm. the ovaries contained ripe eggs. From the same collections 803 whitings were assorted into males and females, the condition of the reproductive organs being determined; the particulars are contained in the following Table:—

	Female.			Male.		
Cm.	Ripe.	Spent.	Immature.	Ripe.	Spent.	Immature.
13	..	..	1	..	..	..
14	..	..	3	..	..	1
15	..	..	..	..	..	..
16	..	..	4	..	..	6
17	..	..	4	..	..	4
18	..	..	1	1	..	3
19	..	..	1	2	..	1
20	1	..	1	16	..	2
21	6 4	..	4	33	..	4
22	18	..	..	58	..	2
23	33	..	3	77	..	1
24	40	..	3	70	..	..
25	44	..	3	65	..	..
26	40	..	1	56	..	..
27	38	1	..	28	..	..
28	27	..	..	21	..	..
29	13	..	..	9	..	..
30	13	..	..	8	..	..
31	10	..	..	3	..	..
32	7	..	..	1	..	..
33	4	..	..	1	..	..
34	1	..	..	..	..	..
35	3	..	..	..	..	..
36	..	..	..	..	..	..
37	3	..	..	..	..	..
38	..	..	..	..	..	..
39	1	..	..	..	..	..
40	..	..	..	..	..	..
	300	1	29	449	+	24

In addition to these observations made on board the trawlers employed in the Moray Firth, in which the collections included many whitings too small to be marketable, the opportunity was taken to examine the sexual condition of a number of whitings as brought to market. These do not include the very smallest which may be mature, but they serve for comparison, and they show, moreover, the very small proportion of this fish which is brought to market in the immature condition.

	Females.			Males.		
Cm.	Ripe.	Spent.	Immature.	Ripe.	Spent.	Immature.
23	. .	. .	. .	. .	. .	. .
24	1	. .	1	1	. .	. .
25	1	. .	1	6	. .	. .
26	3	. .	1	3	. .	. .
27	28	. .	. .	14	. .	. .
28	45	. .	. .	16	. .	. .
29	43	. .	. .	19	.	. .
30	50	. .	. .	16	. .	. .
31	29	. .	. .	16	1	. .
32	23	. .	. .	18	. .	. .
33	29	. .	. .	9	1	. .
34	33	. .	. .	20	. .	. .
35	38	. .	. .	11	. .	. .
36	24	. .	. .	7	. .	. .
37	22	. .	. .	7	. .	. .
38	29	. .	. .	1	. .	. .
39	16	1	. .	1	. .	. .
40	14	. .	. .	. .	. .	. .
41	12	. .	. .	1	. .	. .
42	3	. .	. .	. .	. .	. .
43	8	. .	. .	. .	. .	. .
44	4	. .	. .	. .	. .	. .
45	1	. .	. .	. .	. .	. .
46	2	. .	. .	. .	. .	. .

From these observations it appears that the female whiting may attain maturity when it is 20cm., or about 8 inches, in length, but that the average size when reproduction first begins is approximately 25cm., or about 10 inches.

This conclusion agrees with the previous observations made by me on the rate of growth of the whiting and the size and age at which maturity is reached. I stated in the Twentieth Annual Report* that the whiting when two years old had an average size of about $9\frac{7}{8}$ inches, the range being from about $7\frac{3}{4}$ inches to 12 inches, and that this was the generation which commenced to spawn. The tables given above show that some of the males may begin to spawn at a size less than that at which the females spawn, but the difference is not very great, and I am disposed to consider that the males also do not attain maturity till they are two years of age.

A series of corresponding observations were made in regard to the haddock, which serve to throw light on the size and age when maturity is first reached. On the 31st October a number were taken in Aberdeen Bay, the sexes determined, and the condition of the reproductive organs ascertained. The following shows the main features among the females —

* Part III., page 400.

Length.	Weight.	Weight of Ovaries.	Size of Eggs.
Mm.	Gr.	Gr.	Mm.
245	116·5	·3	·08
246	134	·5	·08–·1
253	141	·2	·08
276	182	·7	·2
341	412	2·5	·315
356	496	3·1	·315
387	616	2·7	·294
428	814	10·1	·37–·39
525	1,600	14·0	·36

On 12th November another series of observations were made on haddocks taken in the Moray Firth, and similar observations on collections obtained in Aberdeen Bay on 24th December and 14th January, and in the Moray Firth on 21st January. The particulars in some of the cases are appended:—

	Length.	Weight.	Weight of Ovaries.	Diameter of Eggs.
	Mm.	Gr.	Gr.	Mm.
November 12	338	392	3·5	·42
	333	311	5·75	·357
	315	312	2·9	·399
	317	347	3·9	·378
	355	490	3·0	·315
	415	782	7·8	·378
	528	1,345	13·5	·378
December 24	307	265	4·2	·48
	329	366	6·1	·42
	341	365	5·3	·48
	390	637	43·8	·63
	416	737	14·7	·46
	518	1,387	30·3	·52
January 14	272	178	0·4	·12
	301	224	·26	·14
	313	254	1·2	·16
	325	318	1·4	·34
	326	340	6·5	·57
	348	367	7·0	·44
	381	467	2·2	·14
	383	583	21·5	·59
	432	738	17·6	·48
January 23	169	38	..	·04
	231	96·5	0·5	·273
	257	131·5	0·7	·12
	271	158	0·6	·31
	235	99·5	0·9	·36
	223	90·5	0·3	·18
	287	182	1·0	·315

Among those taken on 23rd January in the Moray Firth several at from 146 to 170mm. which were examined had the ovaries quite small and immature; some of those of 257mm. and thereabout had only clear unyolked eggs measuring up to ·1mm., while others of the same size, or even smaller, had eggs considerably larger, yolked, and would, no doubt, spawn before the close of the spawning season. This difference is, I think, to be explained by difference in age, the less matured individuals, although larger, being younger and belonging to a later generation.

On the 1st April, among a number taken in the Moray Firth, quite ripe females were got measuring 254mm. (10 inches) and 258mm. and weighing 134 and 141 grammes, or about 4¾ ounces; others almost mature measured 256 and 258mm., while some quite immature were found measuring 283mm., or more than 11 inches. On the 23rd April a few females of 263mm. were ripe, and males of 255mm. and upwards and females of 258, 273, 296mm. and upwards were spent.

In the collection procured on 1st April a number of the ovaries were examined, with the following results:—

Cm.	Spawning or nearly Ripe.	Spent.	Immature.
16	..	..	1
17	..	..	4
18	..	..	..
19	..	..	1
20	..	..	3
21	..	..	10
22	..	..	24
23	..	..	30
24	8	..	27
25	15	..	14
26	11	..	4
27	5	..	2
28	5	1	1
29	2	..	3
30	6	2	..
31	4	..	..
32	8	1	..
33	7	1	..
34	12	..	..
35	6	..	..
36	3	..	..
37	1	..	..
38	5	..	..
39	2	..	..
40	1	..	..
41	..	..	..

The collection was a small one, and the larger fishes were for the most part absent. It shows, however, that females as small as 24cm. may be ripe and some as large as 29cm. immature, the average size at first maturity in this case being approximately 30cm., or about 12 inches, which is rather under the size brought out by some other observations. Out of a large number examined on a former occasion the smallest of the females obtained was 12 inches, and the smallest nearly mature 10 inches; and Holt from his observations at Grimsby placed the average limit between the mature and immature at 13 inches.

Some observations were also made with regard to the size at which maturity is reached in the plaice by the examination of the fish as landed and also on board as brought to deck. In the latter case the examination was only towards the close of the spawning season, when most of the fishes were spent, and the information obtained in this way is therefore of more limited scope.

On the 11th and 16th February 259 were examined, of which 134 were females and 125 males. Among the former 50 were spawning, or had the ovaries so far developed that spawning could be said to be imminent. The largest immature female measured 440mm., the next largest being 436mm. The smallest female found to be actually spawning was 373mm., or about $14\frac{3}{4}$ inches, the next smallest being 382mm; the smallest nearly ripe measured 360, 360, 368, and 378mm. The difference, therefore, between the largest immature and the smallest nearly mature was 80mm., or $3\frac{1}{8}$ inches. The numbers are not very large, but so far as they go they show that the average size when maturity is first attained is about 43 or 44cm., that is, approximately, 17 inches, the limit also found by Holt to apply to the plaice from the northerly part of the North Sea, and confirmed by Kyle.*

With the males the largest immature specimens measured 370, 367, and 366mm., and the smallest spawning males measured 306, 318, and 330mm.; the smallest nearly ripe was 317mm. and the next 322mm. The difference in this case between the smallest mature and the largest immature amounts to 64mm., or $2\frac{1}{2}$ inches. Probably the examination of a larger number of specimens would enlarge the difference both for the males and females, but as they stand they agree very well with the overlapping in length of the respective series or generations.

* *Eighteenth Annual Report Fishery Board for Scotland*, Part III., p. 190.

[TABLE

Cm.	Females. Spawning.	Females. Nearly Ripe.	Females. Spent.	Females. Total.	Females. Immature.	Males. Spawning.	Males. Nearly Ripe.	Males. Spent.	Males. Total.	Males. Immature.
27	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	3	1	-	-	1	1
31	-	-	-	-	2	1	1	-	2	3
32	-	-	-	-	4	-	1	-	1	2
33	-	-	-	-	10	4	3	-	7	7
34	-	-	-	-	14	6	6	-	12	8
35	-	-	-	-	15	5	5	-	10	
36	-	3	-	3	7	7	2	-	9	4
37	1	1	-	2	4	9	2	-	11	
38	2	-	-	2	10	9	2	-	11	-
39	-	-	-	-	1	8	2	-	10	-
40	-	2	-	2	3	3	1	-	4	
41	-	2	-	2	5	4	-	-	4	
42	2	3	-	5	2	3	-	-	3	
43	3	2	-	5	1	1	-	-	1	
44	2	2	–	4	1	1	-	-	1	
45	4	3	2	9	-	4	-	-	4	
46	1	2	2	5	-	-	-	-	-	
47	1	1	-	2	-	1	-	-	1	-
48	1	2	-	3	-	-	-	-	-	
49	-	2	-	2	-	2	-	-	2	-
50	-	2	-	2	-	2	-	-	2	
51	1	1	-	2	-	-	-	-	-	
52	1	-	-	1	-	2	-	-	2	
53	-	-	-	-	-	-	-	-	-	
54	-	-	-	-	-	-	-	-	-	
55	-	1	-	1	-	-	-	-	-	
56	-	-	-	-	-	-	-	-	-	
57	-	-	-	-	-	-	-	-	-	
58	-	-	-	-	-	-	-	-	-	-

Of those examined on the 30th of March towards the end of the spawning time, two females were still spawning, their sizes being 43 and 53cm.; the number spent was 36, the smallest that was certainly determined to have spawned being 45cm. The number immature was 51, the largest being 46·5cm., but it is possible it had spawned early in the season. Among the males, of which 65 were examined, 11 were still spawning, the smallest measuring 38cm., or nearly 15 inches. Six were taken to be spent, the smallest being 37cm. and the largest of those immature was 38cm. Among the spent females it was, as a rule, easy to determine their condition from the fact that a small quantity of ripe eggs was still contained within the ovaries, sometimes amounting to a few teaspoonfuls.

Cod

Some observations were also made upon the cod, and although they were not very extensive, so little has been exactly determined for this fish that they may be given here. At the end of March, when I was on board a trawler, we hit upon a shoal of spawning cod in the Moray Firth, some hundreds being caught in each haul of the net, and very few other round fish were taken at the same time. They were actively engaged in spawning, the ripe eggs and the spermatic fluid flowing from them, and some were spent. I was struck by the fact that among these fish there were none of a small size, and the great majority were cod of the largest dimensions usually landed, Among the smallest measured were the following:—Females 33, 35, and $35\frac{1}{2}$ inches; males $29\frac{1}{4}$ (quite ripe), $33\frac{1}{2}$, 30, $34\frac{3}{4}$, 35 inches. Among the few codlings taken I found one of 70·5cm. ($27\frac{1}{2}$ inches) quite immature; one at 56·7cm. ($22\frac{1}{4}$ inches) had an extremely small ovary. At Aberdeen on 18th April I found one measuring 72·6mm. ($28\frac{1}{2}$ inches) immature, and on the 11th February of a number of large codling examined after they had been landed I found males measuring 595mm. and 640mm. quite immature; in the latter the testes weighed only 5·3 grammes. The largest female was 60·7cm., or about 24 inches, and it was immature, the largest eggs in the ovary measuring ·18mm in diameter, and showing faint deposition of yolk at the periphery.

From these facts I concluded that the size of the cod when maturity is first attained was probably considerably higher than is generally supposed, but in the Moray Firth on the very next day, viz. 1st April, a cod was taken in 32 fathoms off Burghead with large and perfectly mature ovaries. It was 65cm. ($25\frac{3}{8}$ inches) in length and weighed 7lbs. $2\frac{1}{2}$oz., the roe weighing 432 grammes ($15\frac{1}{2}$oz.). This fish had just begun to spawn, and it was clearly of quite a different class from the great spawning shoal above alluded to, in which the smallest spawning female measured 84·0cm.

It may be added that on the 12th November codling taken in the Moray Firth, and measuring from 535 to 610mm., had small ovaries, weighing from 3·1 to 6·83 grammes, the diameter of the largest eggs being ·147 and ·2mm; while cod of 92·7 and 102·9cm. had the ovaries weighing 111·5 and 161.3 grammes respectively, the diameter of the largest eggs being ·22mm. On the other hand, a cod of 74·7cm., taken in Aberdeen Bay on 31st October, with ovaries weighing 56·5 grammes, had eggs up to ·50mm.

The average size fixed by Holt for the cod on first attaining maturity, viz. 25 inches, would therefore appear to be by no means too high; many cod, as he points out, undoubtedly reach a considerably larger size before spawning. The smallest ripe female obtained by him measured $26\frac{1}{2}$ inches; it was thus somewhat larger than the small one above recorded from the Moray Firth. He, however, obtained one which was three parts ripe and measured 22½ inches. On the other hand, among those examined during the spawning season he found females immature as large as 36 inches.*

IV.—The Influence of Temperature on the Growth of Fishes.

In one of my previous papers dealing with the growth of fishes I referred to the important influence which the temperature of the water exercises over the rate of growth, and gave examples from the observations made on certain species, and particularly the plaice in its younger stages when inhabiting the sandy beaches.† It was shown also that the haddock and whiting and other forms increase in length much more rapidly in summer than they do in winter, but from the want of a series of periodic observations on the temperature of the deeper offshore water in the various months throughout the year, it is not yet possible to bring the observations on growth into exact relation with the temperature variations in the water.

It appeared to me that some results of interest might be obtained directly by keeping fishes in the winter in water which was artificially heated, and comparing their growth with other fishes kept under similar conditions but in water at the ordinary temperatures. This has been done for over five months with the results described below.

Four different lots of fish were kept in separate and similar tanks, which may be distinguished as No. 1, No. 2, No. 3, No. 4. Each of the tanks is of concrete with the front and back of plate glass, and the light from windows in the tank-house passes through them, but not very strongly. The tanks are of uniform dimensions, measuring 5½ feet in length by 4 feet 4 inches from back to front, and the depth of water during the experiments in Nos. 2, 3, and 4 was 25½ inches; the volume of water in each of these tanks was therefore about 315·5 gallons, or 1433 litres. The other tank, No. 1, owing to a defect could not be filled so full, and in it the depth of water was 15 inches, the volume being thus about 185·5 gallons, or 842·5 litres. Tanks Nos. 1 and 2 were supplied from the ordinary supply pipe to the tank-house, the water thus having approximately the same temperature as the sea water on the beach. Tanks Nos. 3 and 4 were supplied with sea water from the same pipe, but it was first passed through a heating arrangement by which its temperature was raised. Considerable difficulty was at first experienced in raising the temperature of the water in these tanks sufficiently high. It was soon discovered that the use of oil heaters was insufficient, and the method adopted was to utilise an ordinary slow-combustion stove for heating the apartment, upon the top of which was placed a common galvanised iron hot-water tank, such as are used for supplying hot water, of forty gallons capacity, and around it was placed an iron jacket with a space between in which was enclosed the smoke pipe from the stove. This arrangement has answered very well and with comparatively little attention or extra cost.

No arrangement was employed for the mechanical regulation of the temperature, which varied considerably from time to time, as shown in the tables, falling generally during the night; but a little experience in firing enabled the variation to be to some extent controlled. The temperature was taken every few hours daily, and the supply of hot or cold water regulated accordingly, and maximum and minimum thermometers were also used in order to ascertain the extreme nightly range.

**Journ. Mar. Biol. Assoc.* III., Special Number p. 377, 380, *Ibid.* III., No. 1, 79.
†*Twentieth Ann. Rep.*, Pt. III., pp. 335, 342.

Inflow.			Tank No. I.			Tank No. II.		
Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.
5·5	4·2	5·0	—	—	—	5·4	4·6	5·2
6·0	4·0	5·3	6·3	4·8	5·6	6·4	3·8	5·0
6·0	3·8	5·1	6·2	3·8	5·1	6·4	4·6	5·5
5·2	4·4	4·8	5·4	4·0	4·4	5·6	4·6	5·0
6·1	3·0	5·0	5·4	2·8	4·1	5·2	4·2	4·4
5·2	4·2	4·7	4·3	3·6	3·9	4·6	3·8	4·3
6·8	3·8	5·1	4·8	3·4	4·2	5·2	3·6	4·4
7·4	5·4	6·5	5·8	4·5	5·3	6·8	5·0	5·8
8·4	5·2	6·3	6·2	5·0	5·5	5·8	5·2	5·6
10·8	5·8	7·9	7·8	6·3	6·6	8·8	5·4	6·4
10·6	7·5	8·3	9·4	6·4	8·3	10·4	7·0	8·4
10·8	7·6	9·0	10·2	8·0	8·8	10·0	7·8	8·7
9·2	8·2	8·9	9·4	8·0	8·9	9·2	8·0	8·6
10·6	9·8	10·2	10·4	9·8	10·1	10·2	9·4	9·7
10·4	9·9	10·2	10·6	9·9	10·3	10·4	9·8	10·8

Tank No. III.					Tank No. IV.				
Max.	Min.	Average of			Max.	Min.	Average of		
		Max.	Min.	Mean.			Max.	Min.	Mean.
—	—	—	—	—	16·4	7·2	12·6	9·4	10·8
10·6	7·4	9·3	8·3	9·0	14·2	7·4	12·7	8·0	10·9
11·4	6·3	9·3	7·8	9·1	16·4	7·8	14·4	9·7	12·1
11·4	7·2	9·6	7·9	8·9	17·2	10·0	15·4	11·5	13·5
10·1	5·0	8·0	6·8	7·6	21·0	9·6	17·2	11·2	13·2
9·0	4·4	8·5	5·7	7·0	19·6	7·6	15·3	9·3	12·4
10·2	3·9	7·5	4·8	6·0	18·3	7·8	15·6	8·9	12·0
8·9	4·4	8·0	6·1	7·1	18·9	7·4	14·5	9·9	12·3
9·5	4·4	7·7	5·3	6·4	20·0	6·8	14·9	10·3	12·9
14·0	5·0	10·8	7·0	7·8	22·8	9·2	15·0	10·7	13·2
15·0	6·7	11·6	8·2	10·0	17·8	10·0	15·9	11·8	13·6
12·8	7·0	11·0	8·5	9·7	16·1	8·3	15·0	10·6	12·8
13·9	7·0	11·4	8·1	9·5	18·3	7·8	15·2	9·9	12·6
12·8	8·3	11·8	9·5	10·6	16·1	9·4	15·2	10·5	12·5
15·6	10·0	13·3	10·8	11·9	16·1	10·6	14·9	11·7	13·1

I have tabulated the temperature observations in the accompanying tables for each of the tanks, and for the supply as it came to the apartment. Tanks Nos. 1 and 2 were not supplied with hot water; Tank No. 3 got a partial supply, and Tank No. 4 the largest supply, and it is this tank which was looked to to give the best results.

The temperature observations are tabulated in ten-day periods for the 155 days over which the experiment extended, each showing the maximum and minimum temperature recorded, the mean for the ten days; and for Tanks 3 and 4 the mean of the maxima and minima have also been calculated.

It will be seen from the tables that the mean temperature in No. 1 varied from 3·9 C. to 10·3 C. during the 155 days, the mean for the whole period being 6·5 C. (43·7 F.); the extremes of temperature observed at any time were 2·8 and 10·6. The mean temperature of No. 2 varied from 4·3 C. to 10·8 C., the mean for the period being 7·0 C. (44·6 F.); the slightly higher temperature was owing to this tank being nearer the stove that No. 1. In No. 3 it was desired to maintain a temperature intermediate between that of No. 4 and the other tanks, but greater difficulty was found in this case in adjusting the supplies of hot and cold water. The ten-day means ranged from 6 C. to 11·9 C., the mean for the period being 8·6 C. (47·5 F.). The extreme individual temperatures were 3·9 and 15·6, a difference of 11·7 C., but these variations were of short duration. In No. 4 the range of the ten-day means was 10·8 to 13·6 C., the range of the mean maxima was from 17·2 to 12·6, and of the minima from 8·0 to 11·8; the extreme temperatures recorded were 6·8 C. (44·2 F.) and 22·8 C. (73·0 F.), a difference of 16 C. or 28·8 F. The low temperature as a rule occurred when the stove or some part of the apparatus required to be overhauled, and the high ones for a short period, when the fire had been too strong; they sometimes occurred during the night. The mean temperature for this tank for the whole period was 12·5 C. (54·5 F.), which approximates to the mean bottom temperature in the sea off the East Coast in July, August, and September; in depths of from ten to fifteen fathoms the mean temperature for these months is about 52·9, and a little further out, in thirty fathoms, it is 50·7 F.

The fishes used in the experiments were young whitings, codlings, and haddocks, a few dabs, a plaice, a small starry ray, and an armed bull-head. They were procured in the small-meshed net used around the otter-trawl in the investigations made on board trawlers, and were first kept for a few weeks after being brought to the laboratory before they were placed in the experimental tanks. Each fish was measured, but not weighed, nor was its volume determined; trial showed that the risks might be too great.

With regard to the general conditions and behaviour of the fishes a little may be said. They were fed daily, or several times a day, and in all cases they got as much food as they were willing or able to take, but they were not fed during the night. Their food consisted almost entirely of the ordinary edible mussel, chopped up, varied occasionally with a few limpets, and still more rarely with live shrimps; on one or two occasions they got fragments of herrings or parts of the roe or milt, and sometimes the mussels were not removed from their shells, but were broken up and crushed. An attempt was at first made to weigh the quantity of food given to them daily, but the conditions of the experiment showed that this might be misleading and it was discontinued.

All the fishes did not by any means thrive to a like extent. The haddocks, in particular, proved to be exceptionally delicate as compared with the codlings and whitings, and most of them died at one time or other during the course of the experiments. They did not appear to make themselves at home, so to speak, as the codlings and the whitings did, and they were obviously, under the conditions of the experiment, more stupid fish. When the fish were fed the chopped mussels were dropped gradually into the water, and the moment the fragments began to sink the whitings and codlings rushed at them and, even when replete of a previous meal, took them into their mouths and put them out again, or smelt them; their movements were thoroughly purposive in relation to the food. The haddocks, on the other hand, excited by the commotion, or it may be by the odour of the mussels also, rushed aimlessly about at such times, snapping at the other fishes and missing the fragments although often quite near them and themselves quite hungry. The haddocks, it was also noticed, kept closer to the bottom, and looked for their food there rather than in the course of descent through the water.*

The fact has to be taken into account, because, although food was supplied abundantly, it is pretty certain that the haddocks, as a rule, got only what the others left.

It is probable also that the haddocks suffered more than the other fishes from not getting a more natural food. With reference to temperature they were also more sensitive than the others. When the water got comparatively warm, say about 60° F., the haddocks first showed signs of distress and went round the tank near the top gasping or tried to jump out, and I attribute the deaths of most of the haddocks to this cause. On one occasion I transferred a haddock of 19·9cm. from water of a temperature of 7·4 C. (45·3 F.) to water of 15 C. (59 F.) and it was killed in about two minutes, as if it had been poisoned; it rapidly became paralysed, swayed about a few moments and then sank with its mouth open. A small whiting (15·0cm.) transferred at the same time appeared to be doing well, but was found dead the next morning. The haddocks, moreover, were observed to seek the coolest parts of the hot-water tank, while, unless when the temperature was very high, the whitings and codlings in that tank seemed to enjoy themselves and were active and alert. It may be said that at first the hot water was run in on the top, but it was found that there was a difference of two or three degrees under these circumstances between the surface and bottom water; thereafter it was carried towards the bottom by a pipe, arrangements being made for air passing in with the water at the same time and thus the temperature was nearly equalised.

During the cold weather in winter a great contrast was shown between the fishes in the warm tanks and those in the tanks where the temperature was low, the difference in temperature being about 9 C. In the former they moved about actively and were keen and alert and, if the expression may be used, were happy; in the cold water tanks the fish, on the other hand, were sluggish, remaining a long time at one spot, and gently swaying their fins: the movement and activity in the one tank offered a marked contrast to the comparative lifelessness in the adjoining tank. It has already been said that the fishes in the warm water had a far better appetite than those in the cold water and ate much more; it was, moreover, observed that at times when the temperature was low, down to about 3·8 C., or a little above the freezing point of fresh water, the fishes in these tanks gave up feeding altogether, while in the adjoining heated tanks the fish were fighting eagerly for the food. In the former at such times the mussels would be left untouched at the bottom of the tank. This confirms

* It may be here stated that the haddocks, as a rule, swam nearer the bottom than the codlings or the whitings, and this was especially noticeable at first when the fishes were introduced into the tanks. While the haddocks grovelled about the bottom, the whitings were dispersed upwards to near the top of the tank. The observation as to the difference in habit may have reference to the fact that whitings and codlings are caught in far greater proportions than haddocks by the otter-trawl compared with the beam-trawl

my experience at Dunbar in former years, when it was found that plaice and dabs kept in small tanks lost weight in winter and gave up feeding.*

In tank No. 1, which contained as we have seen about 185·5 gallons (842·5 litres), seven whitings, five codlings, one haddock, one common dab, and one sand-eel were placed; the latter soon disappeared, and was probably eaten. The fish were measured on two occasions, (1) at an interval of 100 days, and (2) after 155 days. It would, as it turned out, have been better to have measured them more frequently, since, with the exception of the sand-eel, all the fishes survived in this tank; but from the mortality in the other tanks it was deemed advisable to disturb them as little as possible. In measuring them, they were first transferred to convenient dishes, seized cautiously with a loose cloth, and when laid on the measuring board care was taken to free the under surface of the fish from the cloth. A little practice made the process easy, the only forms requiring extra care and promptness being the haddocks. In the accompanying Table I give the particulars regarding these fourteen fishes which were kept in water at the ordinary temperatures.

TANK I.

Fish.	Length.	Mean Temperature 4·5° C. (40·1° F.). 100 Days Later. Length.	Increase. Total.	Increase. Mean per 10 Days.	Mean Temperature 9·3° C. (48·7° F.). 55 Days Later. Length.	Increase. Total.	Increase. Mean per 10 Days.	Mean Temp. 6·5° C. (43·7° F.). Increase in the 155 Days. Total.	Mean per 10 Days.
	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.
Whiting. 1	209	226	17	1·7	244	18	3·27	35	2·26
2	170	191	21	2·1	210	19	3·45	40	2·58
3	160	173	13	1·3	187	14	2·18	27	1·74
4	157	172	15	1·5	181	9	1·64	24	1·55
5	152	169	17	1·7	178	9	1·64	26	1·68
6	152	164	12	1·2	177	13	2·36	25	1·61
7	142	159	17	1·7	174	15	2·73	32	2·06
Average,	163·14	179·14	16	1·6	193·0	13·86	2·52	29·86	1·93
Codling. 1	147	185	38	3·8	226	41	7·45	79	5·1
2	143	184	41	4·1	200	16	2·9	57	3·7
3	132	169	37	3·7	208	39	7·09	79	4·9
4	129	163	34	3·4	200	37	6·73	71	4·58
5	123	160	37	3·7	194	34	6·18	71	4·58
Average, {	134·8	172·2	37·4	3·74	...	...	...	...	...
	132·7	169·2	36·5	3·65	207	37·8	6·87	75·7	4·88
Haddock.	183	210	27	2·7	238	28	5·1	55·0	3·55
Common Dab.	237	243	6	0·6	243	0·0	...	6	0·04

* *Eleventh Annual Report Fishery Board for Scotland*, Part III., p. 193.

Among the seven whitings the growth in the first hundred days when the mean temperature was 4·5 C. (40·1 F.) was not great, the increase in different fishes, as will be seen from the Table, varying from 12 to 21mm., the mean increase being 16mm., and the mean for each ten days on the average being 1·6 mm. The fishes were of different sizes as shown, and the increase per ten-day period varied from 1·2 to 2·1 mm. In the succeeding 55 days when the mean temperature of the water was 9·3 C. (48·7 F.) the actual increment of length in different fishes ranged from 9mm. to 19mm., the mean per ten days ranging from 1·64 to 3·45mm. The average increment was 13·86mm. and the mean for the lot per ten-day period was 2·52mm. Over the whole period of 155 days, the mean temperature being 6·5 C. (43·7 F.), the actual increments varied from 24mm. to 40mm. (from about one inch to an inch and nine sixteenths) the mean increase was 29·86mm., or about $1\frac{3}{16}$ inches, and for the ten-day period the mean increase was 1·93mm. There is no doubt that the greatest amount of growth was in the latter part of the second period, when the temperature was highest; at this time it was a common remark how fast the fish were growing, but for the reason above stated they were not more frequently measured. The whitings, it may be said, appeared to be in good condition and health.

The codlings grew more rapidly than the whitings. One of them (No. 2) which grew fastest during the first period developed a diseased growth or tumour in the second period when its rate of increase was therefore very slow. It has been accordingly left out of the calculations of the means in the second period, and the other four fishes have been also dealt with separately throughout. In the first hundred days the increments varied from 34 to 41mm. ($1\frac{3}{8}$ to $1\frac{5}{8}$ inches), the means for the ten days being from 3·4 to 4·1mm.; the mean increase was 37·4mm., and the ten days' mean 3·74mm. In the second period of fifty-five days the actual amount of growth was a little greater, so that under the difference of temperature indicated the codlings grew about twice more rapidly. Omitting the diseased fish the increments varied from 34 to 41mm.—precisely the same as in the first period—the average was 37·8mm. and the mean for 10 days 6·87mm. Over the whole time of 155 days the amount of growth in the four healthy fishes was respectively 79, 79, 71, 71mm., the average being 75·7mm., or about $3\frac{1}{16}$ inches—a very considerable rate considering the temperature of the water. On the other hand the fishes were supplied with abundance of food, and the codlings were the greediest of them all, and no doubt got more food in a given time than they would under natural conditions in the sea. With the exception of the one referred to they all remained healthy throughout the experiment.

The growth of the single haddock was also fairly rapid for the temperature. In the first hundred days its increase amounted to 27mm., or a little over an inch, the mean for ten days being 2·7. In the second period, like the codlings, the actual growth was about the same, although the time was only about half; it amounted to 28mm. ($1\frac{1}{8}$ inch), the ten-day mean being 5·1mm. Over the whole period the actual increase in length was 55mm. ($2\frac{3}{16}$ inches), the average for the ten-day period being 3·55mm.

The growth of the single common dab in this tank was slow and presented a contrast to the round fishes; it was an adult female. The increase in the first period was only 6mm. ($\frac{7}{8}$ inch), the mean for ten days being 0·6mm. In the second period it did not increase at all. Two circumstances may have affected this, the first that four spawning flounders were put into this tank early in the second period, and it is possible that the greater competition for food prevented the dab getting a full share; the second that it was a female of adult size and may have spawned. It was unfortunately omitted to provide apparatus in the overflow from the tank to obtain evidence as to this.

The observations in Tank No. 1 refer to growth under the ordinary temperature of the season.

TANK II.

Fish.	Length.	Mean Temperature 5·2° C. (41·4° F.).			Mean Temperature, 9·2° C. (48·6° F.).			Mean Temp., 7° C. (44·6° F.).	
		100 Days Later.			55 Days Later.			Increase in the 155 Days.	
		Length.	Increase.		Length.	Increase.		Total.	Mean per 10 Days.
			Total.	Mean per 10 Days.		Total.	Mean per 10 Days.		
	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.
Whitings. 1	179	193	14	1·4	207	14	2·54	28	1·81
2	178	192	14	1·4	202	10	1·82	24	1·55
3	170	185	15	1·5	196	11	2·0	26	1·68
4	160	179	19	1·9	192	13	2·36	32	2·06
5	151	173	22	2·2	187	14	2·54	36	2·32
6	151	171	20	2·0	184	13	2·36	33	2·13
7	148	164	16	1·6	181	17	3·09	33	2·13
8	145	160	15	1·5	177	17	3·09	32	2·06
9	140	159	19	1·9	176	17	3·09	36	2·32
10	138	158	20	2·0	171	13	2·36	33	2·13
11	134	154	20	2·0	170	16	2·91	36	2·32
12	134	152	18	1·8	164	12	2·18	30	1·93
13	[131	151	20	2·0	154	3	·5	23	–]
14	[130	150	20	2·0]	–	–	–	–	–
15	[109	128	19	1·9]	–	–	–	–	–
Average -	152·3	170·0	17·7	1·77	184·0	14·0	2·55	31·7	2·04
Haddock. 1	193	211	18	1·8	–	–	–	–	–
2	180	199	19	1·9	-	–	–	–	–
3	178	197	19	1·9	–	-	–	–	–
Average, -	183·7	202·3	18·6	1·86	–	–	–	–	–
Com. Dab. 1	241	248	7	0·7	251	3	·55	10	·07
2	146	168	22	2·2	190	22	4·0	44	2·84
Average, -	193·5	208	14·5	1·45	220·5	12·5	2·27	26	1·68
Starry Ray.	198	198	0·0	–	195	–3	–	–3	–

The same is true of Tank No. 2, except, as formerly explained, the temperature here was generally slightly higher owing to its being nearer the stove. Into this tank were placed fiteen whitings, three haddocks, two common dabs, and a starry ray; a sand-eel was also present at first, but, as in the other tank, it soon disappeared. The particulars of these fishes are given in the accompanying Table. Three of the whitings are not included in the final column and averages; No. 13 was found in the second period to have the tail and one of the eyes diseased, and its growth had been thus interferred with, No. 14 was transferred to the warm tank as already described, and No. 15 was found dead when thirty-five days of the second period had elapsed, and it then measured 134mm. In the first hundred days, with a mean temperature of 5·2 C., the increments varied from 14 to 22mm., the mean being 17·7mm., or 1·7mm. above that for Tank No. 1, a difference probably related to the somewhat higher mean temperature (·7 C.). As a rule the greatest increase was among the smaller fishes. In the second period of 55 days, with a mean temperature of 9·2 C. (48·6 F.), the increments ranged in different cases from 10 to 17mm., and the mean was 14mm., as compared with 13·86 in Tank No. 1, the mean for ten days being 2·55, as compared with 2·52—almost precisely the same. It will be seen from the tables that the mean temperature of the two tanks in the second period were also practically identical, differing by only ·1 C., but the difference was in favour of Tank No. 1, into which the sunshine entered more freely.

The haddocks did not thrive so well compared with the one in Tank No. 1, and they all died early in the second period. The mean increment in the hundred days was 18·6mm., as compared with 27mm. in Tank No. 1, the mean for the ten days being 1·86mm. against 2·7mm. One of these haddocks, 199mm. long, perished by being placed in warmer water as previously described; it was well nourished, its weight being 67·5 grammes, while the mean weight of haddocks of the same size is 65·7 grammes (see Table, p. 226). One of the others died 18 days after the measurement recorded, and it was then 216mm. long, an increase of 5m.

Of the two common dabs, the smaller grew quickly and the larger slowly. In the first period the former increased by 22m. and the latter by only 7mm.; in the second period the smaller increased by 22m. again, and the larger by only 3mm., the growth as with the round fishes being about twice quicker in the higher temperature of the second period. The small one increased in the hundred days by 44mm., or $1\frac{3}{4}$ inches, the mean rate being 2·84mm. per ten days, while the increase of the larger one amounted in the 155 days to only 10mm., or $\frac{3}{8}$ of an inch, the mean for ten days being only 0·07mm. They were both females.

The starry ray did not grow at all; during the first period it just maintained its breadth, and in the second it lost about 3mm. in the same dimension. Its loss of weight must have been relatively greater because it became very attenuated, and it was no doubt owing to lack of proper food.

In Tank No. 3 an endeavour was made to maintain a temperature intermediate between that of Tanks Nos. 1 and 2 and Tank No. 4, but as previously mentioned the variations were considerable, and the results in this tank were not so satisfactory. It appears moreover probable that in the endeavours to adjust the supply of hot and cold water the circulation was diminished. For some reason or another four of the whitings and five of the codlings put in died a short time after the experiment was begun, and these are not included in the accompanying Table, which gives the particulars regarding the rest of the fish. Two haddocks which were placed in the tank also died; the autopsy revealed no apparent cause of death, which was possibly due to the variations in the temperature of the water, but one of them, 202mm. in length, which should have weighed about 67 grammes, weighed only 63·8 grammes.

TANK III.

Fish.	Length.	Mean Temperature, 7·7° C. (45·9° F.).			Mean Temperature. 10·3° C. (50·5° F.).			Mean Temp., 8·6° C. (47·5° F.).	
		100 Days Later.			55 Days Later.			Increase in the 155 Days.	
		Length.	Increase.		Length.	Increase.		Total.	Mean per 10 Days.
			Total.	Mean per 10 Days.		Total.	Mean per 10 Days.		
	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.
Whiting. 1	162	186	24	2·4	204	18	3·27	42	2·71
2	160	180	20	2·0	190	10	1·82	30	1·93
3	153	176	23	2·3	188	12	2·18	35	2·26
4	152	170	18	1·8	185	15	2·73	33	2·13
5	[147	158	11]	...	...	...	...	...	...
6	[146	155	9]	...	...	...	...	...	...
Average,	156·7	178	21·3	2·13	191·7	13·7	2·49	35	2·26
Codling. 1	161	209	48	4·8	256	47	8·54	95	6·13
2	158	198	40	4·0	246	48	8·73	88	5·68
3	141	168	27	2·7	212	44	8·00	71	4·58
4	135	163	28	2·8	210	47	8·54	75	4·84
5	128	158	30	3·0	194	36	6·55	66	4·26
6	113	137	24	2·4	148	11	2·0	35	2·26
7	[149	189	40	4·0	...	...	...	...	...
Average,	140·7	174·6	33·9	3·39	...	...	...	...	...
	139·3	172·2	32·9	3·29	211	38·8	7·05	71·7	4·63
Common Dab.	261	276	15	1·5	286	10	1·82	25	1·61

The particulars in regard to the whiting show that the increment in the first period varied from 9mm. to 24mm., but the fish showing the small increase and another showing an increase of only 11m., were found to have the tail badly ulcerated and they were killed. Omitting these two, the mean increase was 21·3mm., or an average per ten days of 2·13mm. as compared with 16mm. and 17·7mm. in the cold tanks. In the second period the increase was on an average 13·7mm., and therefore under the average for the cold water tanks in the same period, which shows, as well as the mortality alluded to, that the conditions in this tank were not satisfactory. The mean increase over the whole period was 35mm., or $1\frac{3}{8}$ inches, the ten-day mean 2·26mm., a little higher than that for the two tanks referred to in the similar period.

Among the cod the increase ranged in the first period from 24mm. to 48mm., the average mean being 33·9mm., and the ten-day mean 3·39mm., and therefore a little less than Tank No. 1. One of the codlings, No. 7, was transferred to Tank No. 4 after this, and died four days later, like the haddock and whiting above mentioned; in this case the interval was longer. In the second period the remaining fishes increased from 11mm. to 48mm. in different cases, the average being 38·8mm., or about $1\frac{1}{2}$ inches. Omitting the smaller specimen, in which the increase was clearly anomalous, the average increase of the others was 44·4mm., or 8·1 per ten days. The increments in the length over the whole time varied from 35mm. to 95mm., the mean increase being 71·7mm., or omitting the anomalous form, 79mm., or $3\frac{1}{8}$ inches, the mean for ten days being 5·1mm.

The single common dab in this tank increased by 15mm. in the first period and by 10mm. in the second, the increment over the whole time being 25mm., or 1 inch, and the average per 10 days 1·61mm.

In tank No. 4 there was at first some mortality owing to the vicissitudes in the temperature which, as already stated, affected different fishes in different ways.

Of three haddocks put in none survived the whole period, and only one the first. One died after fifteen days; it was 285mm. and had increased to 287mm. Another died after eighty-three days, and it had increased from 279 to 295mm. The third at the end of the first period increased from 262 to 279mm., an increment of 17mm., the average per ten days being the small one of 1·7mm. It died from the high temperature a few days later without having increased in length.

Among the whitings there was less mortality, nine surviving the whole time and other two for the first period. In the first hundred days the variations in the increase were from 19mm. to 34mm., the mean being 27·5mm., or a little over an inch, the ten-day mean averaging 2·74mm. In the second period the increments ranged from 9mm. to 19mm., the mean being 15·7mm. and the average of the ten-day mean 2·85mm.

Over the whole period the increments varied from 28mm. to 52mm., the mean being 43·1mm., about $1\frac{3}{4}$ inches, the mean increase in the ten-day periods being 2·79mm.

[Table.

TANK IV.

Fish.	Length.	MEAN TEMPERATURE, 12·3° C. (54·1° F.). 100 Days later.			MEAN TEMPERATURE, 12·9° C. (55·2° F.). 55 Days later.			MEAN TEMP. 12·5° C. (54·5° F.). Increase in the 155 Days.	
		Length.	Increase. Total.	Increase. Mean per 10 Days.	Length.	Increase. Total.	Increase. Mean per 10 Days.	Total.	Mean per 10 Days.
	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.
Whiting. 1	241	260	19	1·9	269	9	1·64	28	1·81
2	208	229	21	2·1	242	13	2·36	34	2·19
3	204	225	21	2·1	239	14	2·54	35	2·26
4	177	203	26	2·6	220	17	3·09	43	2·77
5	161	193	32	3·2	209	16	2·91	48	3·09
6	157	186	29	2·9	204	18	3·27	47	3·03
7	146	180	34	3·4	197	18	3·27	52	3·36
8	140	171	31	3·1	190	19	3·45	50	3·22
9	140	174	34	3·4	192	18	3·27	52	3·36
10	164	192	28	2·8	–	–	–	–	–
11	158	186	28	2·8	–	–	–	–	–
Average,	172·4	199·9	27·5	2·75	–	–	–	–	–
	174·9	202·3	27·4	2·74	218	15·7	2·85	43·1	2·79
Codling. 1	173	225	52	5·2	278	53	9·64	105	6·77
2	126	167	41	4·1	221	54	9·82	95	6·13
3	120	166	46	4·6	220	54	9·82	100	6·45
Average,	139·7	186	46·3	4·63	239·7	53·7	9·76	100	6·45
Com. Dab. 1	245	262	17	1·7	276	14	2·55	31	2·0
2	151	186	35	3·5	207	21	3·82	56	3·61
3	147	185	38	3·8	202	17	3·09	55	3·55
4	–	206	–	–	237	31	5·64	–	–
Average,	181	211	30	3·0	228·3	17·3	3·15	47·3	3·05
Plaice,	226	258	32	3·2	277	19	3·45	51	3·29
Pogge,	127	127	–	–	–	–	–	–	–

It will be noticed from the Table that the increments of growth were much greater in the smaller forms than in the larger.

As in all the other tanks, the codlings grew rapidly. In the first hundred days the increments varied from 41mm. to 52mm., the mean being 46·3, and the mean for the ten-day periods was 4·63. In the second the increase ranged from 53 to 54mm., the increments being thus absolutely larger though the period was less and the mean temperature not much higher. The mean increase was 53·7mm., that for the ten-day period being 9·76mm. The total increase in length in the three specimens in the 155 days was respectively, 105mm., 95mm., and 100mm., the mean being exactly 100mm., or very close upon 4 inches, and the mean for the ten-day periods was 6·45mm. Of all the fishes, except the flat-fishes, the codlings appeared to be least affected by the changes in the temperature.

In this tank there were throughout three dabs and one plaice, and another dab was added at the beginning of the second period. They did well, as a rule. In the first period the increments among the dabs ranged from 17mm. to 38mm., the mean increase being 30mm., or a little over $1\frac{1}{8}$ inches, the mean for the ten days being 3·0mm. In the second period the increments varied from 14 to 31mm., the mean increase was 17·3mm., and the mean for the ten days, 3·15mm. Over the whole period the increments of the dabs in this tank varied from 31 to 56mm. ($1\frac{1}{4}$ to $2\frac{1}{4}$ inches), the average being 47·3mm., and that for the ten days, 3·05mm.

Only one plaice was made use of, and it increased in the first period from 226 to 258mm., an increment of 32mm., or a little over $1\frac{1}{4}$ inches. In the second period it increased other 19mm., the ten-day mean being 3·45mm., as compared with 3·2mm. in the first period. The total increase at the end of the experiment was 51mm., giving an average for the ten days of 3·29mm.

It may be noted that throughout the whole of the experiment none of the flat-fishes perished, so that they bore the changes in temperature much better than the round fishes.

An armed-bullhead, or pogge, was also placed in this tank, and survived over the first period, but it did not increase in length at all. Probably like the starry ray this was owing to the food not being quite suitable for it. It died shortly after the beginning of the second period, on one occasion when the temperature rose high.

These experiments show that the increase in temperature is followed by an increased rate of growth, but I do not think the data are such as to enable the ratio between the two to be determined. In such experiments there are a number of factors which influence the growth, and it is a matter of extreme difficulty to maintain a natural balance among them in the various tanks, and to have the experiments carried on under natural conditions. The influence of the vicissitudes in the temperature at different times of the day or night must be of importance, as shown by the experiments of putting fishes from the cold water into the warm water, the haddock, whiting, and codling all perishing, although at very different intervals. In order to get a more precise relation between the temperature and the growth it would be necessary to maintain the temperature nearly uniform in each of the tanks throughout, or at all events to reduce very greatly the rapidity of the alterations. The question of food is also one that would, in any circumstances, give rise to difficulty, and yet it is evidently one of much importance. It is not easy procuring the natural food of the fishes and supplying it in due proportions.

It appears that the influence of temperature is active in modifying the rate of growth by acting directly upon the metabolism of the fish, and also by affecting the rapidity of digestion. In very cold water the fishes give up feeding altogether, because the ferments upon which digestion depends do not act, or act very slowly, at low temperatures, and in fishes, as in other animals, appetite waits on digestion, and this is, on the other hand, correlated with the metabolism in the tissues. It has been shown by Krukenberg that the pepsine or analagous body in the stomach of fish acts as well at 20 C. as at 40 C., at which, among mammals, digestion is most active, and that the rapidity of its action is closely related to the temperature; and Knauthe and Zuntz have shown that the same thing applies to the metabolism in fish, the vital activities being more active in the higher temperature, as shown by the excretion of carbonic acid gas and other products of metabolism.

5. The Sprat (*Clupea sprattus*).

Comparatively few observations have been made on the rate of growth of the sprat. Cunningham appears to have been the first to publish a definite statement on the subject,* making use of a number of observations of Ewart and Matthews, contained in a paper on the nature of Thames and Forth whitebait, which appeared in the Fourth Annual Report of the Fishery Board for Scotland.† In that paper an account was given of the proportion of herrings and sprats, and their sizes, in collections obtained at different times of the year from February to August, and from a study of these Cunningham came to the conclusion that the little sprats two to three inches long obtained in February, March, April, and May were about one year old. The new brood of the year began to appear in the whitebait in June and increased to August, when they measured from 1 inch to $1\frac{1}{2}$ inch (25-38mm.). The proportion of sprats in the samples in this month was 48 per cent., but the number of the small scaleless sprats gradually increased during the month until 90 per cent. consisted of these. Of 2600 specimens of whitebait procured in samples of about two hundred each during December, January, and February in the Firth of Forth, over $99\frac{1}{2}$ per cent. were sprats measuring from $1\frac{3}{8}$ inches to $2\frac{3}{4}$ inches (35 to 70mm.). In the samples from the Thames the average size was 2 inches (50mm) in April, and $2\frac{1}{2}$ inches in May.

From the examination of the otoliths of a considerable number of sprats, partly from the North Sea and partly from the Baltic, Jenkins came to the conclusion that the growth was somewhat more rapid. He assigns a length of 75mm. (3 inches) to the sprat one year old; of 110mm. ($4\frac{3}{8}$ inches) to the sprat which has completed two years, and of 130mm. ($5\frac{1}{8}$ inches) to the sprat three years old.‡

The investigations made by myself on the rate of growth of the sprat, and described in this paper, were on material collected almost entirely in the course of the trawling investigations in the Moray Firth and Aberdeen Bay by means of a small-meshed net placed outside the cod-end of the trawl net; but some of them were obtained by the shrimp-net and tow-nets. The fact has to be kept in mind, because apart from the difference in vertical distribution at different stages, which might result in sprats of different size being taken in the bottom or surface net at the same time, the size of the mesh exerts an important influence on the sizes of the samples taken, at least as far as the smaller specimens are concerned, and there is no doubt that in several of my collections the very small slender sprats

* *Journ. Marine Biol. Assoc. II.* p. 241, 1892; "Marketable Marine Fishes," p. 167.
† P. 98, 1886.
‡ *Wissensch. Meeresuntersuch. Kiel N.F. Bd. 6 Abtheilung*, Kiel, p. 111, 1902.

escaped capture either wholly or largely by passing out through the meshes of the net, although they may have been present in the water in considerable numbers. This, however, does not entirely account for the fact which is apparent from the measurements in the tables and from the curves, that it was the rule to get only one series of sprats, with a certain range of sizes, in the same haul, while in another haul in the same locality later, or at the same time in another place, quite a different series predominated. That seems to be due to the sprats of different years keeping for the most part separate from one another.

The number of collections obtained and examined was twenty-six, some in each month of the year except February, July, and August; most of them were obtained in October and December.

From the fact that the spawning period of the sprat is definitely limited to one portion of the year it is more easy to determine its rate of growth than in the case of the herring, in which there are two well separated spawning seasons, spring and autumn, and a certain degree of spawning in the intermediate periods. The sprat appears to spawn at different parts of the coast at rather different times, or at all events the spawning period does not quite coincide. At Plymouth, Cunningham found it spawning from the end of January until the end of April, or even later.* On the west coast of Ireland Holt obtained the floating eggs in March, April, May, and June; chiefly in March and April.† Hensen and Apstein give the spawning period as the end of April and the beginning of May.‡ On the east coast of Scotland the *Garland* found the floating eggs in the Firth of Forth from towards the end of March to the middle of August, and especially in April, May, and June. In the Moray Firth I found sprats to be spawning on the 1st April and 1st June; and though the limits of the period here are not well defined, there is no reason to doubt that they are much the same as a little further down the coast, and probably the chief spawning occurs about the end of May on this stretch of coast.

From the small size of the egg and the temperature of the water at that season the hatching of the eggs takes only a few days, the length of the larva, according to Cunningham, being from 3 to 3·7mm. Probably the early part of June may therefore be taken as the period when the bulk of the larval sprats issue into the water.

The smallest specimens got after the spawning season were obtained in September and October in Aberdeen Bay and in the Moray Firth in December, in all cases by the tow-net. On the 18th September, near shore, in from seven to ten feet of water in Aberdeen Bay, sixteen were taken from 29mm. to 46mm., and on the 20th other five measuring from 29mm. to 39mm., the average size of these twenty-one specimens being 35·9mm., or $1\frac{5}{8}$ inches. On 18th October, in nine fathoms, in the same locality, four were caught which measured 31, 35, 42, and 45mm. On the 28th December in the Dornoch Firth two were taken in the tow-nets, one of which measured 39mm. and the other 48mm., while 734 were caught in the small-meshed net around the cod-end, ranging in size from 52 to 125mm. It is obvious that all the small sprats taken in these drags had been hatched in the previous spawning season, and were approximately from three to six months old.

In April, some small sprats were also got in the shrimp net in shallow water in Aberdeen Bay. On the 8th of the month three were taken which measured 45, 50, and 53mm., as well as a number from 65mm. upwards. On the 16th of the month other fifty-one were taken with the

* "The Natural History of the Marketable Marine Fishes," p. 165.
† *Rep. of Council, Roy. Dublin Soc. for* 1891, p. 265.
‡ *Wissen. Meeresuntersuch.* Kiel Commis. Neue Folge, Bd. 2 Heft 2, p. 37.

shrimp-net in the same locality, measuring from 40 to 70mm., but all except four were less than 55mm., these being—one at 56mm., two at 65mm., and one at 70mm. From the curves for the whole of the sprats in these collections it is apparent that the last and possibly those at 62mm. belong to the second group. The average size of the fifty-four sprats assigned to the first series was 48·3mm., or $1\frac{7}{8}$ inches, including the two at 62mm., and the mean size, *i.e.*, coinciding with the central point of the base line from the smallest to the largest, is also 48mm. This might appear to be the size of sprats ten or eleven months old, belonging to the previous spawning season, and it is considerably under the size assigned by Jenkins to those of one year's growth, although the amount of growth from the middle of April to the early part of June, the period I have taken as representing the maximum of hatching, would add several mm. to their length. The average agrees better with the size of the sprats from the Thames in April examined by Matthews, viz., two inches. On 12th December, however, four months earlier, a haul with the small-meshed net in the same locality in from eight to twelve fathoms furnished seventy-four sprats, of which the first series numbered forty-seven, ranging in size from 49mm. to 60mm., the average being 55·5mm., and the mean 54·5mm. This shows that the collection in April was not fully representative of the series. By combining the two collections the average size of the 98 sprats of this series is found to be 51·3mm., or 2 inches—the range in size being from 40mm. to 60mm., and the mean size 50mm. The date intermediate between the collections is about 14th February, and the size stated may be taken as approximately representing the average size of the sprats at this date. Growth is slow at this time of year and on to April, and an examination of the other curves shows that the end of the first series is about 6cm. when the sprats are about one year old, the average size being a little over 50mm., or slightly over 2 inches.

There was no collection in February, and that made at the end of March in the Dornoch Firth did not include any of the smaller forms In St. Andrews Bay M'Intosh obtained sprats on 12th March in the bottom trawl-tow-net, measuring from $1\frac{1}{4}$ to 2 inches (32 - 50mm.); and on 12th April one 2 inches long, and floating eggs of the sprat two days later.*

The older series are present in the collections in greater numbers, but as is usually the case it is frequently a matter of difficulty to fix exactly the point of division between them, owing to the overlapping of one series with another and often the small numbers of the fish of one of the series.

Taking the hauls in the order of the months, the first was on 15th January off Aberdeen, and of sixteen sprats obtained three belonged to one series with an average size of 87 mm., and the other thirteen ranged in size from 112 to 135mm. The larger of these probably belonged to a still older series., but the average for the lot was 123 mm. Another haul in January in the Cromarty Firth furnished twenty-seven sprats, of which twenty-three, measuring from 61 to 92mm., formed one series with an average size of 77·2mm., and the other four belonged to the older group, measuring from 111 to 117mm., and with an average of 114mm.

If these two January hauls are combined the first group, with a range from 61 to 92mm., has an average size of 78·3mm., and the second, with a range of from 111 to 135mm., an average of 120·9mm.

No collection was made in February, but on 31st March 870 were taken in the Dornoch Firth. Of these, 205 ranged in length from 75 to 107 mm., the average being 96·8mm.; and the other 665 formed a series from 108 to 139mm., with an average of 117·8mm. The latter series of sprats were ripe and approaching ripeness.

In April the collection in Aberdeen Bay, besides the fifty-four small

* *Eleventh Ann. Rep. Fishery Board for Scotland*, Part iii., p. 300.

ones above described, was made up of another series of fifty-four, ranging from 68 to 107mm. and with an average size of 81·5mm. There was also one sprat at 116mm., which appeared to belong to another series. In a haul of the small-meshed net made off Burghead Bay in the Moray Firth in thirty fathoms of water on 1st April seventy-four sprats were caught, two of which measured 101 and 104mm., and the others from 108 to 126mm., the average size being 118·1mm. This collection is of special interest from the fact that the sprats were spawning, as referred to below.

In May there was only one collection of sprats and it was from the Firth of Forth, where a number were taken on the ninth of the month at Station III. by means of the small-meshed net around the cod-end of the *Garland's* trawl. There were two small ones, one measuring 52mm. and the other 62mm. and it appears that these belong to the group of smallest sprats, most of which were able to escape through the meshes of the net, that is, the group about one year old. The next series was well represented, the sprats numbering 554, and ranging in size from 68 to 110mm. The average size was 83·4mm. Thirteen larger fishes pertained to an older group, measuring from 113 to 134mm., and having an average of 120·9mm.

Two hauls were made on 1st June, one in the Cromarty Firth and the other at Aberdeen. At Cromarty the sprats were found to be spawning, and with the exception of one, 124mm. in length, they seemed all to belong to the same series. The range of size was from 73 to 110mm., the average being 92·9mm.

In the collection from Aberdeen Bay the corresponding series was represented by fifty-seven fish measuring from 86 to 109mm., the average length being 96·5mm., and there was a larger one at 116mm.

On the 28th of the month eighty-one were taken at Lunan Bay near Montrose, further down the coast, and they all belonged to the same group, the range of sizes being from 86 to 117mm., with an average of 104·2mm.

When the measurements of all the sprats obtained in June are combined the following result is obtained. The first is represented by the two fishes from the Forth, 52 and 62mm.; the second consists of 689 sprats, ranging in size from 68 to 117mm. with an average of 94·4mm.; and the third by two fishes with an average of 120mm.

From the end of June to the middle of October no collections were procured with the exception of the twenty-one small ones got in the tow-nets on 18th and 20th September.

On the 18th and 20th October a number were taken in Aberdeen Bay. Four of these measured from 31 to 45mm. and have been already referred to; of the others, fifteen, ranging in size from 82 to 94mm., had an average size of 86·8mm., and ninety-two ranged from 107 to 130mm., the average being 114·5mm. On the 22nd, forty-three were caught in the Dornoch Firth, one measuring 54mm. belonging to the early group; sixteen varied from 65 to 96mm., with an average of 81·7mm., and twenty-six from 100 to 124mm., the average being 114·6. These October series when combined give three groups, one from 31 to 54mm., with an average of 41·4mm., one from 65 to 96mm., with an average of 84·1mm., and a third from 100 to 130mm., with an average of 114·5mm. The number of fishes in the first was five, in the second thirty-one, and in the third 118. It may be here said that the average of the second series is higher than it ought to be, but the number of fishes in it is small.

In November a collection was obtained in the Dornoch Firth, all three series being represented. The first consisted of thirty-three fishes measuring from 45 to 61mm., with an average of 55·6mm. The second series was predominant, the number of sprats measured being 1650. They ranged in sizes from 62 to 98mm., with an average of 75·5mm

There were also nine sprats varying from 102 to 112mm. A collection at Aberdeen on the 28th furnished fourteen sprats; one measured 87mm., and the other thirteen ranged from 113 to 125mm., the average being 120·2. The average of the twenty-two of the third series in the two hauls combined was 114·4mm.

In December a number of collections were obtained from the Moray Firth and Aberdeen Bay. In the latter, on the twelfth of the month, seventy-three were procured belonging to three series. The first comprised forty-seven fishes, the sizes of which ranged from 49 to 60mm. with an average of 55·5mm.; the second included twenty-four from 62 to 97mm. the average being 77·6mm., and there were other two measuring 101 and 102mm. On the 18th, twenty-six were obtained, of which twenty-two, measuring from 66 to 84mm., had an average size of 73·7mm., and four, ranging from 100 to 132mm., an average of 111·7mm. On the 19th, seventy-four were secured, seventy of them belonging to the second series, ranging in size from 67 to 97mm., the average being 78·7mm.; the other four measured from 104 to 111mm., with an average of 107·5mm. On the 29th, thirty-nine were taken, all belonging to the third group, the sizes varying from 98 to 128mm., and the average being 111·1mm.

A collection made in the Dornoch Firth on the 25th of the month numbered 184 fishes, all of which except sixteen belonged to the second group. They ranged in size from 72 to 98mm., the average being 86·6mm.; the other sixteen measured from 103 to 122mm., the average being 112·1mm. In a collection made on the 27th, three groups were represented; the first, comprising three fishes, had an average of 57·7mm.; the second, ranging from 63 to 97mm., and including thirty-six fishes, had an average size of 76·6mm.; the third, of fifty-four fishes, had a range of from 100 to 127mm., and an average size of 107·8mm. On the 28th a third collection numbering 722 sprats contained three series. The first, nineteen in number, ranged in size from 39 to 60mm., the average being 59·2mm. The second series comprised 575 fishes, the sizes varying from 62 to 97mm., and the average size being 79·5mm. The third series of 128 fishes ranged in size from 98 to 128mm., and the average was 109·7mm.

The larger or older group was well represented in a haul made in Burghead Bay on the 25th December. Of 536 sprats caught 520 belonged to that group, their sizes ranging from 97 to 138mm., and the average being 121·1mm. On the 28th another haul yielded a large number, the second series being the best represented on this occasion. The first group contained twenty-five fishes varying from 50 to 61mm., with an average of 55·8mm.; the second comprised 436 sprats from 63 to 91mm., and with an average of 75·2mm.; and the third series of twenty-seven ranged from 96 to 124mm., the average being 116·0mm.

When all the collections made in December are combined we have the following general results. The first series of ninety-four fish ranged in size from 39 to 60mm., the average being 55·8mm.; the second group of 1347 fishes varied in size from 62 to 97mm., and had an average size of 79·5mm.; and the third series, numbering 794 fishes, had an average size of 117·4mm., and a range from 98 to 138mm. It is probable that the larger forms in the third series belong to a still older group, but their members are so small and the difficulty of dividing them from the series immediately preceding so great that I have not attempted to group them into a fourth series. This circumstance will to a small extent raise the average of the third series higher than it naturally ought to be. It must also be said that the range assigned to the various groups may not be in all cases the precise one that exists, for it is sometimes very difficult to define the division between the series. In such cases the curves and tables of millimetre measurements must be the best guide.

It is clear, however, from the measurements that at least three annual series or groups of sprats exist in these collections, although they are rarely well represented together in any one collection, and this is obvious from the curves in the plates, and especially from the curve for the combined measurements in December (fig. 10, Pl. IX).

The first or early series has been already alluded to, and the facts show that the sprat grows slowly.

Three collections were made in which spawning sprats were got, one on the 1st April, off Burghead, one on the 1st June in the Cromarty Firth, and the third on 31st March in the Dornoch Firth. In the first named collection the seventy-two sprats forming the second series measured, as stated, from 108 to 126mm., with an average of 118·1mm. The initial sizes were as follows:—one at 101mm., one at 104mm., one at 108mm., and then the series was continuous from 110mm. onwards. Unfortunately, the condition of the reproductive organ was not examined throughout the whole series, but in eighteen males from 104mm. to 125mm. the testes were large and apparently ripe or approaching ripeness; they were examined after preservation in formaline solution. The number of female sprats examined was nineteen, varying in size from 110 to 126 mm., and they all contained either fully mature eggs or eggs approaching maturity. In those fully mature the germinal vesicle had disappeared and the yolk was translucent but still somewhat granular. It was noticed that there was not any indication of an external swelling of the belly such as is found as a rule in fishes with fully-developed reproductive organs, so that it was impossible to tell from the external examination whether the fishes were about to spawn or not. The number of the mature or nearly mature eggs was, moreover, very small compared with the number to be found in the ovaries of most other fishes with pelagic eggs—amounting only to a few thousands (*see* p. 285). I append a Table giving particulars of the weights (in grammes) and condition of the reproductive organs in some of those examined:—

Males.			Females.			
Size.	Weight.	Weight of Testes.	Size.	Weight.	Weight of Ovaries.	Condition of Eggs.
119	10·8	0·7	122	12·8	0·38	Largest yolked up to ·46 mm.
121	12·2	0·7	120	12·0	0·492	,, ,, ,, ·44 ,,
115	9·1	0·5	124	12·8	0·44	,, ,, ,, ·44 ,,
120	11·5	0·56	122	10·5	0·49	,, ,, ,, ·609 ,,
123	13·5	0·75	126	13·0	0·42	,, ,, ,, ·42 ,,
124	13	0·58	122	10·7	0·33	,, ,, ,, ·38 ,,
116	10·7	0·52	121	12·0	0·29	,, ,, ,, ·44 ,,
119	11·8	0·68	117	11·0	0·34	,, ,, ,, ·44 ,,
117	8·8	0·3	118	10·7	0·20	,, ,, ,, ·336 ,,
114	10·5	0·56	120	11·8	0·54	,, ,, ,, ·651 ,,
114	8·3	0·2	118	11·7	0·32	,, ,, ,, ·378 ,,
113	9·5	0·56	111	8·8	0·22	,, ,, ,, ·336 ,,
104	6·5	0·30	110	8·2	...	,, ,, ,, ·79 ,,

In the case of the sprats taken in the Cromarty Firth on 1st June, only a few were examined in regard to the reproductive organs, and I noted that the females over 104mm. were spawning, and males of the same size were also ripe, but it is possible that some under those sizes might also have been found ripe if a fuller examination had been made of them. The collection made on 31st March in the Dornoch Firth furnishes the best material, because a larger number of them were examined, the sexes determined, and the reproductive organs noted. Of the 870 obtained, 559 were males and 311 were females, and in some instances, males as small as 84mm. had testes sufficiently developed to indicate that they would probably spawn in the course of the season—at the close of which they would have considerably increased in length.

It was in this case, as in many others, difficult to divide the first series —only the larger members of which were present—from the second series, as is obvious from the curve (Pl. IX, Fig. 5). The millimetre measurements were as follows at and near the point selected :—

100	101	102	103	104	105	106	107	108	109	110	111	112	113
10	10	10	9	11	15	21	9	8	14	10	13	30	39

[Table

Date.	Place.	Series I.				Series II.				Series III.			
		No.	Range.	Average.	Mean.	No.	Range.	Average.	Mean.	No.	Range.	Average.	Mean.
January 10, -	Cromarty Firth, -	...	...	...	...	23	61–92	77·2	76·5	4	111–117	114·	...
,, 15, -	Off Aberdeen, - -	...	...	...	...	3	84–90	87·	...	13	112–135	123·	...
Jan. combined -		...	...	...	...	26	61–92	78·3	76·5	17	111–135	120·9	...
March 31, - -	Dornoch Firth, - -	...	...	...	...	205	75–107	96·8	91	665	108–139	117·8	123·5
April 8, 16, -	Aberdeen, - - -	54	40–65	48·3	52·5	54	68–107	81·5	87·5	1	116	...	...
,, 1, - -	Burghead, - - -	...	...	...	...	2	101, 104	...	...	72	108–126	118·1	117
May 9, - -	Forth, - - -	2	52–62	...	...	554	68–110	83·4	89	13	113–134	120·9	123·5
June 1, - -	Cromarty, - - -	...	...	...	...	551	73–110	92·9	91·5	1	124	...	...
,, 1, - -	Aberdeen, - - -	...	...	...	...	57	86–109	96·5	97·5	1	116	...	...
,, 28, - -	Lunan Bay, - -	...	...	...	...	81	86–117	104·2	101·5	...	...	...	...
June combined, -		...	...	...	...	689	73–117	94·4	92·5	2	116–124	120	...
September 18, 20,	Aberdeen, - - -	21	29–46	35·9	37·5	...	...	...	...	...	...	...	...

Date.	Place.	Series I.				Series II.				Series III.			
		No.	Range.	Average.	Mean.	No.	Range.	Average.	Mean.	No.	Range.	Average.	Mean.
October 18, 24 -	Aberdeen, - - -	4	31–45	38·3	37·5	15	82–94	86·6	88	92	107–130	114·5	118·5
,, 22, -	Dornoch, - - -	1	54	...	...	16	65–96	81·7	80·5	26	100–124	114·6	112
Oct. combined, -		5	31–54	41·4	42·5	31	65–96	84·1	80·5	118	100–130	114·5	115
November 11, -	Dornoch, - - -	33	45–61	55·6	53	1650	62–98	75·5	80	9	102–112	...	...
,, 28, -	Aberdeen, - - -	...	...	...	...	1	87	...	...	13	113–125	120·2	119
Nov. combined, -		33	45–61	55·6	53	1651	62–98	75·5	80	22	102–125	114·4	113·5
December 12, -	Aberdeen, - - -	47	49–60	55·5	54·5	24	62–97	77·6	...	2	101–102	...	...
,, 18, -	,, - - -	...	...	...	...	22	66–84	73·7	...	4	100–132	111·7	...
,, 19, -	,, - - -	...	...	...	...	70	67–97	78·7	...	4	104–111	107·5	...
,, 29, -	,, - - -	...	...	...	...	...	...	...	...	39	98–128	111·1	...
,, 25, -	Dornoch, - - -	...	...	...	...	168	72–98	86·6	85	16	103–122	112·1	112·5
,, 27, -	,, - - -	3	55–60	57·7	...	36	63–97	76·6	80	54	100–127	107·8	113·5
,, 28, -	,, - - -	19	39–60	56·2	49·5	575	62–97	79·5	79·5	128	98–125	109·7	111·5
,, 25, -	Burghead, - - -	...	...	...	...	16	79–95	86·1	87	520	97–138	121·1	117·5
,, 28, -	,, - - -	25	50–61	55·8	55·5	436	63–91	75·2	77	27	96–124	116·0	110·
Dec. combined, -		94	39–61	55·8	50·0	1347	62–98	78·9	80·0	794	96–138	117·4	117

The Table giving the particulars of the sprats obtained in the various collections is given on page 178, and a comparison may now be made between the average size indicated for the various groups.

If the difference between the average size of the groups be calculated, it will be found that the amount between the first and second series is as follows in the various months :—23·1mm. for all the December collections combined, 33·2 for April, 42·7 for October, 19·9 for November; the mean for the four being 29·7mm., or about one and three sixteenths of an inch. The difference in some of the cases is considerable, and this is owing in large measure to the very small numbers obtained, and to the fact, still more, that the great majority of the smaller specimens escaped through the meshes of the net. The large difference in the average size in October is due to the fact that the first series was represented by four specimens got in the tow-net and measuring from 31 to 45mm., and one specimen of 54mm., and, on the other hand, to the average of the few specimens in the next series being too high, as already referred to. The low average for November was caused by the opposite, and especially by the average for the first series being exceptionally high. From this circumstance, the fact that only the larger specimens of the first series were taken in the small-meshed net, comparison may also be made between what I have termed the mean, which is based on the intermediate size between the largest and the smallest in a group. This system has also its disadvantages, unless the largest and the smallest fishes present fairly represent the limits of the series, but it tends to diminish the predominance of the larger fishes in obtaining the arithmetical average. On this basis, the respective differences between the averages of the first and second groups are these :—35·0 for April, 38 for October, 27 for November, and 30 for December, the mean of the lot being 32·5mm. The presence of small fishes in the tow-net, as small as 39mm. in December, and 40mm. in April in the shrimp-net, shows that the true average is under that arithmetically calculated.

The differences between the averages of the second and third series are as follows :—March 21·0, April 36·6, May 37·5, October 30·4, November 38·9, and December 38·5, the mean of the differences being 33·8. This amount is rather above the natural difference owing to the fact adverted to, that the larger fishes, many of which no doubt belong to a fourth group, are included in the third group, and thus the average of the latter is somewhat raised. The mean of the combined differences is, calculated on the other basis, 35·2mm., or a little over $1\frac{3}{8}$ inches, and this probably represents the amount of annual growth between one series and another in the sprat.

As already stated, the imperfection of the collections of the first or younger group of fishes does not allow an accurate calculation of the size of that group to be made, but from the sizes obtained in April, December, and September it is certain that the range and the average are under what is calculated from the sizes represented. In order to throw light on the subject, I have made a curve (Pl. X), based on the measurements of the best collections, showing the gradual growth of the sprat in the different generations. From this, it appears, that at one year of age, about the beginning of June, the average size of the sprat is a little over 60mm., and when two year's old, at a corresponding period, about 93mm. There are not sufficient data to show the precise size in the next June, but, as in the end of March and the beginning of April the average size is about 118mm., it is probable that at the beginning of June the average size would be a little over 120mm. This would indicate an approximate growth of 30mm. between the first generation and the second, and 27mm. between the second and the third.

The growth of the sprat is thus slow compared to most of the Gadoids, but it is, of course, a much smaller species. Its growth is not greatly inferior to that of the Norway Pout, the smallest of the Gadoids I have dealt with.

In winter, moreover, the curves and measurements show that the growth is very much slower; most of it appears to take place between April and autumn. In this respect the sprat resembles other fishes.

There is one remarkable circumstance about the sprat, that after the third or fourth generation spawns it dies or disappears. Very few fishes seem to survive to the following year; and this forms a contrast to the conditions obtaining among the flat-fishes and most round fishes, in which many generations survive after maturity is reached and spawn in successive years.

With regard to sexual maturity and the age at which it is attained, a comparison may be made between the collections from the Cromarty Firth on 1st June and that from the Dornoch on the 31st March, or two months earlier—two months, moreover, in which growth is comparatively rapid. The curve of the former on Plate VIII (Fig. 7) shows an apparently homogeneous and symmetrical group, from 73 to 110mm., with an average of 92·9mm. As already stated, the condition of the reproductive organs in this series was only partially examined, but if the smaller resembled those of about 104mm.—and spawning, as we have seen, goes on into July, during which a considerable amount of growth occurs—then the whole group would probably spawn, and these fishes were about two years of age. The great group in the March collection, ranging from 108mm. to 139mm., were obviously all approaching ripeness or fully matured, and would all spawn in the course of the season. It is probable, also, from the condition of the reproductive organs, that the next younger generation, or those two years of age, would spawn also before the close of the season, or at all events the males would, and in that case they would come into line with the series got at Cromarty, and indicate that sexual maturity is reached at two years of age.

The average length and weight of the sprats at one, two, and three years of age, according to this research, are approximately as follows:—

	Mm	Grammes.	Increase.	
			Mm.	Grammes.
One year, - -	63	1·4	...	...
Two years, - -	93	5·0	30	3·6
Three years, -	120	12·5	27	7·5

In the investigation made by Jenkins, based on the examination of the ear-bones, three generations were also determined, but the average sizes do not correspond. His results are as follows, the weights here inserted being derived from my observations on the relation of weight to length, as described on page 145.

	Mm.	Grammes.	Increase	
			Mm.	Grammes.
First year, - -	75	2·5	..	..
Second year, -	110	9·2	35	6·7
Third year, - -	130	16·4	20	7·2

TABLE I.

MEASUREMENTS OF SPRATS IN 2MM. GROUPS.

MM.	Aberdeen Bay.														
	I. 8 April, 1904.	II. 16 April, 1904.	I. and II. Combined.	III. 1 June, 1901.	IV. 18 Sept., 1900.	V. 20 Sept., 1900.	VI. 18–24 Oct., 1901.	VII. 28 Nov., 1901.	VIII. 18 Dec., 1900.	IX. 19 Dec., 1900.	X. 17 Dec., 1901.	XI. 12 Dec., 1903.	XII. 29 Dec., 1903.	Dec.,—VIII. to XII. Combined.	XIII. 15 Jan., 1902.
28-9 -	...	...	...	...	2	1	...	...	...	...	...	...	...	...	...
30-1 -	...	...	...	...	3	...	1	...	...	...	...	...	...	...	...
2-3 -	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...
4-5 -	...	...	...	...	2	1	1	...	...	...	...	...	...	...	...
6-7 -	...	...	...	...	4	1	...	...	...	...	...	...	...	...	...
8-9 -	...	...	...	...	...	2	...	...	...	...	...	...	...	...	..
40-1 -	...	3	3	...	2	...	...	...	...	...	...	...	...	...	...
42-3 -	...	5	5	...	..	...	1	...	...	...	...	...	...	...	...
44-5 -	1	9	10	...	...	...	1	...	...	...	...	...	...	...	...
46-7 -	...	7	7	...	1	...	...	...	...	...	...	...	...	...	...
48-9 -	...	9	9	...	...	...	...	...	...	...	...	1	...	1	...
50-1 -	1	10	11	...	...	...	...	...	...	...	...	6	...	6	...
2-3 -	1	2	3	...	...	...	...	...	...	...	...	12	...	12	. .
4-5 -	...	2	2	...	...	...	...	...	...	...	...	13	...	13	...
6-7 -	...	1	1	...	...	...	...	...	...	...	...	10	...	10	...
8-9 -	...	...	...	...	...	...	...	...	...	...	...	5	...	5	...
60-1 -	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...
2-3 -	...	2	2	...	...	...	...	...	...	...	...	2	...	2	...
4-5 -	1	...	1	...	...	...	...	...	...	...	...	1	...	1	...
6-7 -	...	...	...	...	...	...	...	...	3	2	...	3	...	8	...
8-9 -	2	...	2	...	...	...	...	...	2	1	...	1	...	4	...
70-1 -	3	1	4	...	...	...	...	...	3	2	...	3	...	8	...
2-3 -	2	...	2	...	...	...	...	...	3	6	...	3	...	12	...
4-5 -	7	...	7	...	...	...	...	...	3	15	...	1	...	19	...
6-7 -	7	...	7	...	...	...	...	...	2	17	...	2	...	21	...
8-9 -	3	...	3	...	...	...	...	...	3	8	...	...	...	11	...
80-1 -	4	...	4	...	...	...	...	...	2	4	...	...	...	6	...
2-3 -	4	...	4	...	...	...	3	...	...	1	...	1	...	2	...
4-5 -	1	...	1	...	...	...	3	...	1	1	...	...	...	2	1
6-7 -	2	...	2	1	...	...	4	1	...	3	...	...	...	3	1

TABLE I.—*continued.*

MM.	Aberdeen Bay.														
	I.	II.	I. and II. Combined.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	Dec.— VIII. to XII. Combined.	XIII.
	8 April, 1904.	16 April, 1904.		1 June, 1901.	18 Sept., 1904.	20 Sept., 1904.	18–24 Oct., 1901.	28 Nov., 1901.	18 Dec., 1900.	19 Dec., 1900.	17 Dec., 1901.	12 Dec., 1903.	29 Dec., 1903.		15 Jan., 1902.
88–9 -	3	...	3	2	...	...	2	...	...	1	...	...	...	1	...
90–1 -	3	...	3	3	...	...	2	...	...	1	...	...	...	1	1
2–3 -	3	...	3	5	...	...	...	...	...	4	...	2	...	6	...
4–5 -	2	...	2	15	...	...	1	...	...	3	...	1	...	4	...
6–7 -	2	...	2	12	...	...	...	...	...	1	...	4	...	5	...
8–9 -	1	...	1	7	...	...	...	...	...	...	...	...	2	2	...
100–1 -	1	...	1	3	...	...	...	...	1	...	...	1	1	3	...
2–3 -	...	...	...	5	...	...	...	...	...	...	...	1	...	1	...
4–5 -	...	...	...	3	...	...	...	...	1	1	1	...	5	8	...
6–7 -	1	...	1	...	...	...	1	...	...	1	...	...	4	5	...
8–9 -	...	...	...	1	...	...	4	...	...	1	...	...	4	5	...
110–1 -	...	...	...	...	...	...	2	...	1	1	1	...	2	5	...
2–3 -	...	...	...	...	...	...	8	1	...	...	1	...	7	8	1
4–5 -	...	...	...	...	...	...	10	...	...	...	1	...	7	8	1
6–7 -	1	...	1	1	...	..	9	...	...	...	...	...	3	3	2
8–9 -	...	...	...	...	...	...	16	4	...	...	...	.	...	...	...
120–1 -	...	...	...	...	...	...	13	3	...	...	2	...	2	4	2
2–3 -	...	...	...	..	...	...	11	3	...	...	1	..	1	2	...
4–5 -	..	...	...	...	...	..	9	2			..	...	...	...	1
6–7 -	...	...	...	...	...	...	6	...	...	...	...	...	...	...	2
8–9 -	...	...	...	...	...	...	2	...	...	...	...	...	1	1	
130–1 -	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1
2–3 -	...	...	...	...	...	...	...	...	1	...	2	...	...	3	..
4–5 -	...	...	...	...	...	...	1	...	...	...	...	...	...	...	1
6–7 -	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8–9 -	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
140–1 -	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

TABLE I.—*continued.*

MM.	Dornoch Firth.							Off Burghead.				Cromarty Firth.		Lunan Bay.	Firth of Forth.
	I	II.	III.	IV.	V.	VI.	Dec.—IV.-VI. combined.	I.	II.	III.	Dec.—II. and III. combined.	I.	II.		
	31 Mar., 1904.	22 Oct., 1903.	11 Nov., 1903.	25 Dec., 1900.	27 Dec., 1903.	28 Dec., 1903.		1 April, 1904.	25 Dec., 1901.	28 Dec., 1903.		10 Jan., 1901.	1 June, 1901.	28 June, 1901.	9 May, 1901.
38-9	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...
40-1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2-3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4-5	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...
6-7	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...
8-9	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...
50-1	...	...	1	...	...	...	...	...	...	2	2	...	...	...	...
2-3	...	...	4	...	...	1	1	...	...	3	3	...	...	...	1
4-5	...	1	8	...	1	3	4	...	...	7	7	...	...	...	...
6-7	...	...	8	...	...	7	7	...	...	7	7	...	...	...	...
8-9	...	...	5	...	1	4	5	...	...	2	2	...	...	...	...
60-1	...	...	5	...	1	3	4	...	...	4	4	1	...	...	...
2-3	...	...	13	...	1	3	4	...	...	2	2	...	...	...	1
4-5	...	1	20	...	1	7	8	...	...	15	15	...	...	...	...
6-7	...	2	56	...	4	14	18	...	...	22	22	1	...	...	...
8-9	...	...	98	...	2	27	29	...	...	31	31	...	...	...	5
70-1	...	1	207	...	2	40	42	...	...	45	45	3	...	...	26
2-3	...	...	261	2	6	64	72	...	...	60	60	4	1	...	19
4-5	2	1	287	2	10	88	100	...	...	64	64	2	1	...	28
6-7	3	...	276	10	9	81	100	...	...	59	59	3	1	...	58
8-9	4	2	175	15	7	57	79	...	1	51	52	1	2	...	47
80-1	4	...	116	9	9	44	62	...	...	43	43	1	7	...	54
2-3	5	...	76	16	8	34	58	...	...	25	25	2	29	...	47
4-5	6	1	32	17	4	18	39	...	1	12	13	1	37	...	55
6-7	7	...	17	14	3	19	36	...	4	6	10	...	46	1	62
8-9	6	1	4	14	3	16	33	...	4	1	5	2	50	1	42
90-1	11	2	2	17	3	15	35	...	2	2	4	1	57	...	37
2-3	14	2	3	24	4	17	45	...	5	...	5	1	63	2	28
4-5	17	1	2	17	3	15	35	...	3	1	4	...	58	4	20
6-7	15	1	4	10	2	10	22	...	2	1	3	...	53	3	9
8-9	16	...	1	1	...	11	12	...	4	1	5	...	49	8	2

TABLE I.—*continued.*

MM.	Dornoch Firth.							Off Burghead.				Cromarty Firth.		Lunan Bay.	Firth of Forth.
	I.	II.	III.	IV.	V.	VI.		I.	II.	III.		I.	II.		
	31 Mar., 1904.	22 Oct., 1903.	11 Nov., 1903.	25 Dec., 1900.	27 Dec., 1903.	28 Dec., 1903.	Dec.—IV.–VI. combined.	1 April, 1904.	25 Dec., 1901.	28 Dec., 1903.	Dec.—II. and III. combined.	10 Jan., 1901.	1 June, 1901.	28 June, 1901.	9 May, 1901.
100–1 -	20	2	...	...	4	12	16	1	5	...	5	...	35	8	4
2–3 -	19	1	2	1	3	10	14	...	7	3	10	...	29	18	2
4–5 -	26	2	3	4	3	14	21	1	11	1	12	...	14	16	4
6–7 -	30	3	1	...	2	8	10	...	12	5	17	...	12	7	1
8–9 -	22	5	1	2	2	6	10	1	14	1	15	...	5	4	3
110–1 -	23	1	1	1	3	6	10	4	15	...	15	1	1	2	1
2–3 -	69	2	1	1	2	12	15	6	17	1	18	1	...	3	1
4–5 -	82	3	...	2	4	9	15	9	19	2	21	...	...	2	1
6–7 -	122	1	...	...	8	11	19	10	25	3	28	2	...	2	1
8–9 -	112	1	...	...	7	10	17	14	36	1	37	...	...	...	4
120–1 -	112	1	...	4	5	6	15	11	46	2	48	...	...	...	1
2–3 -	62	...	...	1	3	3	7	9	53	4	57	...	...	...	2
4–5 -	35	1	...	...	5	5	10	7	69	2	71	...	1	...	...
6–7 -	15	...	...	...	1	...	1	1	73	...	73	...	...	...	1
8–9 -	4	...	...	...	...	...	..	...	50	...	50	...	...	...	1
130–1 -	4	...	...	1	...	...	1	...	28	...	28	...	...	...	...
2–3 -	...	...	...	...	..	...	...	...	17	...	17	...	...	...	...
4–5 -	1	...	...	...	...	...	...	...	6	...	6	...	...	...	1
6–7 -	1	...	...	...	...	...	...	...	3	...	3	...	...	...	...
8–9 -	1	...	...	...	...	...	...	...	2	...	2	...	...	...	...
140–1 -	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2–3 -	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

6. WITCH (*Pleuronectes cynoglossus, L.*).

There now exists a considerable amount of material to show the growth of this flat-fish in the earlier period of its life, for the first few generations, young forms having been procured in the tow-nets or the fine-meshed net used with the otter-trawl.

The witch spawns rather later than most of the other pleuronectids. On the east coast of Scotland the spawning period was found by me to extend from May to August, the maximum spawning occuring about the end of June.* Cunningham found it spawning in the Clyde towards the end of June,† and Williamson obtained the floating eggs in Lochfyne in each month from April to August inclusive —sparingly in these two months, and most abundantly in June.‡ Holt found ripe specimens on the west coast of Ireland in March, April, and May, and expressed the opinion that it also spawns in June; § and Herdman and Dawson, with reference to the Irish Sea, describe this fish as spawning from May to July.||

The spawning period may therefore be regarded as extending from April into August, with a maximum towards the end of June.

The egg measures from 1·15 to 1·19mm. and according to Cunningham hatches at temperatures varying from 53° to 68° on the sixth day, and at lower temperatures on the ninth day. Holt found that the eggs fertilised by him on 14th May hatched mostly on the seventh day; some as early as the sixth and others as late as the ninth day, but the temperature of the water was not noted. The surface and bottom temperatures off the Firth of Forth, where the depth is about thirty fathoms, are approximately as follows in the months during which the witch spawns.

	April.	May.	June.	July.	August.
Surface, - -	43·3°	46·5°	51°	54·3°	55°
Bottom, - -	41·6°	44·3°	45°	48·5°	51·5°

The lower temperatures mentioned by Cunningham are not specified, and the eggs of the witch were not among those submitted to temperature-experiments by Dannevig at Dunbar. But in the experiments referred to ¶ it was found that the egg of the cod, which is larger than that of the witch, being about 1·39mm., took $15\frac{1}{2}$ days to hatch at a temperature of 42°·8, $12\frac{3}{4}$ days at 46°·4, $10\frac{1}{2}$ days at 50°, and $9\frac{2}{3}$ days at 53°·6; while the egg of the flounder, which is smaller than that of the witch, measuring 0·95 to 1·05mm. in diameter, at the same temperatures hatched in $6\frac{1}{2}$, $5\frac{1}{2}$, $4\frac{1}{2}$ and $3\frac{2}{3}$ days respectively. It may therefore be assumed that if the bulk of the eggs of the witch be spawned in the latter part of June, the majority of the larvæ hatch out about a week later, or, approximately, at the beginning of July. The hatching period, owing to the influence of temperature, will be more contracted than the period of spawning.

Eighth Ann. Report Fishery Board for Scotland, Part III., p. 263 (1890); *Ninth ibid.* p. 264; *Tenth ibid.*, pp. 234, 242.

† *Trans. Roy. Soc. Edinr.*, vol. xxxii., Pt. I., p. 101 (1887).

‡ *Seventeenth Ann. Rep. Fishery Board for Scotland, Part III.*, p. 99 (1899).

§ *Rep. to Council, Roy. Dublin Soc.* for 1851, p. 258 (1892).

|| "Fishes and Fisheries of the Irish Sea," p. 55. (1902).

¶ *Thirteenth Ann. Rep. Fishery Board for Scotland, Part III.*, p. 147.

The larval witch on escaping from the egg measures, according to Holt,* about 3·99mm., and ten days after hatching, when the yolk was exhausted, a specimen measured 5·57mm. Cunningham found that in forty-eight hours after hatching the length of the larva increased from 3·9 to 5·9mm., a rapid increase. From the very considerable length at which transformation is completed, it is evident that the pelagic stage of this species is comparatively prolonged; one, incompletely transformed, with the left eye on the ridge of the head, and measuring 40mm. in length, was taken by myself on 15th January off Aberdeen.

In the present Report (p. 270) Dr. H. C. Williamson describes the post-larval and early young stages of the witch.

In the accompanying Table I give the particulars concerning 151 post-larval witches caught in tow-nets at various depths in Aberdeen Bay and off it, in the Dornoch Firth, and in the Clyde.

* *Sci. Trans. Roy. Dubl. Soc. V.* (Ser. II.), p. 84 (1893).

[Table

Place and Date.	SIZE (Mm.).																			
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
ABERDEEN BAY.																				
1900.																				
1st October, - -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.
2nd ,, - -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	1
3rd ,, - -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
,, ,, - -	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.
8th ,, - -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.
1902.																				
15th January, -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1903.																				
16th October, -		.	.	.	.	.	2	.	.	.	.	.	2	.	.	.	.	1	.	.
,, ,, -	.	.	.	.	.	.	.	.	.	1	.	.	2	.	1	1	.	1	.	.
,, ,, -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
7th November, -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.	1	.	.
,, ,, -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
DORNOCH FIRTH.																				
1903.																				
20th October, -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.
11th November, -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
12th ,, -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
CLYDE.																				
1899.																				
7th June, - -	.	.	.	.	.	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.
14th ,, - -	2	.	7	3	10	4	2	1	.	.	.	.	.	.	.	.	.	.	.	.
15th ,, - -	.	.	1	.	3	1	4	2	2	1	.	.	.	.	.	.	.	.	.	.
,, ,, - -	.	.	.	.	.	.	2	3	2	.	.	.	.	.	.	.	.	.	.	.
,, - -	.	.	.	4	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
,, ,, - -	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.
15th July, - -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
16th ,, - -	.	.	3	4	3	1	3	1	.	2	1	.	.	.	.	.	.	.	.	.
18th ,, - -	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
19th ,, - -	.	.	.	2	2	.	.	1	1	1	.	.	1	.	.	.	.	1	.	.
1st August, - -	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.

26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Remarks.
.	.	.	.	1	.	.	.	.	2	.	.	.	.	.	Tow-net. Serial iii. 1 fm. from bottom.
1	1	2	1	1	.	1	.	.	.	1	1	.	.	.	,, 2 fms. from bottom.
.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	,, 8 fms. to 9–10 fms.
.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	,, at 14 fms.
.	.	2	.	.	1	.	.	.	.	.	.	.	.	.	,, 8–9 fms.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	30 fms. Mid-water net.
.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	Surface-net, 3 fms. from surface.
1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	Bottom tow-net, near trawl head.
.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	Small-meshed trawl. Still pelagic.
.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	Tow-net, 6 fms. below surface.
.	2	.	.	1	.	.	.	.	.	.	.	.	.	.	,, mid-water.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	,, near surface.
.	.	2	.	.	.	.	.	.	.	.	.	1	.	.	,, above bottom. Pelagic.
.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	,, ,, ,, ,,
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	,, 14 fms. Between Pladda and Ailsa Craig.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	,, 5 fms. Between Sanda and Brennan Head.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	,, 5–20 fms. Between Mull of Cantire and Corsewall.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	,, 5–15 fms. Shrimp. Stations IV., V.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	,, 20 fms. Between Ailsa Craig and Mull of Cantire.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	,, 25 fms. Between Mull of Cantire and Corsewall.
.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	,, on trawl head. Station III.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	,, 25 fms. Between Pladda and Turnberry.
.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	,, on trawl head. Station XII.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	,, 10–15 fms. Series III.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	,, 20 fms. Station IV.

They are to be found in Aberdeen Bay in October and November, and, as above stated, an odd specimen may be procured even in January. The size of those obtained ranged from 12 to 40mm. ($\frac{1}{2}$–$1\frac{5}{8}$ inches), transformation being completed and bottom-life begun as a rule about the latter size. In the Dornoch Firth a few were also obtained in October and November, from 22 to 38mm. In the Clyde, in the deep water across the mouth of the Firth, in June and July, a number were procured ranging from 6·5 to 37mm., the smaller forms being generally caught towards the surface and the larger forms deeper. On 1st August these measured 14, 15, and 17mm. I am indebted to Dr. Williamson for particulars of these.

In the absence of a complete periodic series of tow-net collections extending over the whole time from the beginning of spawning, it is not possible to tell the age of the specimens given in the Table; but if spawning ceases in August it follows that those got in Aberdeen Bay in October and November must be two months old, and may be more, and that the specimen, incompletely metamorphosed, procured on 15th January, was over four months old. The size at which metamorphosis is completed, and therefore the duration of the pelagic stage in this species, is therefore considerable.

The young forms living on the bottom were also sometimes caught in the small-meshed net, enveloping the cod-end of the otter-trawl, or in the shrimp-trawl. Thus, on 24th October, in sixty fathoms some miles off Aberdeen, nine specimens were taken, five of which measured 42mm., and one each 37, 38, 40, and 43mm. These clearly belonged to the preceding spawning season, and would be a few months old. On 28th December, in thirty fathoms, off Burghead Bay in the Moray Firth, fourteen specimens were secured which measured as follows:—

Mm.	40	41	42	43	44	45	46	47	48	49	63
	2	1	1	3	2	1	1	–	1	1	1

All these also belonged to the previous spawning season; the next largest got in the net was 137mm. (*see* below).

In the same locality, on 14th November, one measuring 56mm. ($2\frac{3}{16}$ inches) was taken, and it belongs to the same category. On 21st January, in fifty fathoms, in the Moray Firth, a specimen of 47mm. was taken; on 23rd January, in the same place, another of 45mm., the tail of which was, however, damaged, and its real length would be several millimetres greater. On 1st April, off Burghead Bay, in thirty-two fathoms, seven small witches were caught of the following sizes:—60, 65, 66, 74, 76, 77, 83mm. ($2\frac{3}{8}$–$3\frac{1}{4}$ inches), which would be, approximately, from eight to ten months old; the next largest was 144mm.

On the west coast, two were caught in Loch Long, off Ruad Dubh, in thirty-five fathoms, on 20th September, which measured 57 and 58mm. respectively; on 17th September, in Upper Loch Etive, in fifty-two fathoms, six were taken, four of which measured 47mm., one 57 mm., and one 60 mm.; on 21st April, one measuring 90mm. ($3\frac{1}{2}$ inches) was obtained seventeen miles off Corsewall Point. There seems little doubt that all these also belonged to the spawning-season immediately preceding.

Holt, on the coast of Ireland, caught specimens of 42mm. in eighty fathoms on 19th August, which he was of opinion were from eggs spawned early in the season, and were thus from four to six months old; and in July he got one in one hundred and forty-four fathoms, measuring 12.5cm., which he believed to be about one year or more old.*

In some of the hauls a number of specimens were procured belonging to a fairly well-defined older group, and these, with some others, are represented in the accompanying Table.

* *Sci Trans. Roy. Dublin Soc.* V (Ser. II.) 85

Cm.	MORAY FIRTH.											DEEP SEA.		CLYDE.															
	I.	II.				III.	IV.				V.	VI.	VII.	VIII.			IX.			X.	XI.			XII.			XIII.		
	14 Nov., 1903.	28 Dec., 1903.				23 Jan., 1904.	1 April, 1904.				Nov., 1900.	Oct., 1900.	11 Dec., 1901.	5 Sept., 1899.			5 Oct., 1899.			18–20 Dec. 1901.	8 Nov., 1901.			27–28 Nov., 1901.			24 Dec., 1901.		
		♀	♂	?	Tot.		♀	♂	?	Tot.				♀	♂	Tot.	♀	♂	Tot.		♀	♂	Tot.	♀	♂	Tot	♀	♂	Tot.
3																													
4				9	9																								
5	1			4	4	1																							
6				1	1				1	1																			
7									3	3																			
8									3	3																			
9																													
10																													
11														1	1	2													
12																		1	1										
13	1												1																
14	4			3	3	1		1		1							2	1	3										
15	2			4	4	1	11	2		13	1							1	1										
16	1			2	2	1	7	11		18				1	1	2					1	2	3						
17				1	1	3	4	4		8					2	2	1		1		2		2						
18						2	2			2				4	2	6	1	3	4		1		1						
19						1		2		2	1			2	1	3	2		2	1	1		1		1	1			
20											4	1		3	2	5		1	1			2	2					1	1
21											9	2	2	4	1	5	1	2	3			2	2				1		1
22				1	1	1		2		2	14	11	3	1	2	3	1	2	3		3	1	4						
23			2		2	1		1		1	11	6	2							1		5	5		1	1		1	1
24	3		2		2	4		4	1	5	5	12	1		1	1		3	3	1	2	6	8				1	2	3
25	1		3		3	1		4	2	6	9	21	3		2	2		2	2		2	7	9		2	2			
26	5		1		1	6			3	3	18	30			2	2				1	2	5	7	1	2	3		2	2
27	8		3		3	1		3	4	7	40	37	2	3	3	6	1	2	3	1	1	11	12		3	3	1	4	5
28	5		4		4	1		1	8	9	48	45	3	1	1	2	1	3	4		3	12	15	1	5	6	1	3	4
29	4	2	6		8	3			2	2	51	41	7	1	2	3				3	2	10	12		7	7		6	6
30	4		3		3	3			12	12	51	49	2	1	5	6		1	1	4	1	8	9	1	18	9	2	5	7
31	3		2		2	3			9	9	39	46	2	4	2	6		1	1	2	5	7	12	5	27	32	2	12	14
32	4	1	3		4	4			13	13	37	54	5	1		1	2		2	6	1	4	5	4	19	23	3	4	7
33	6	3	5		8	2			12	12	24	85	2		1	1	1		1	6				10	21	31	5	11	16
34	7		6		6	2			16	16	35	94	4				2		2	10	4	2	6	7	10	17	5	9	14
35	8	2			2	3			10	10	31	100	6							8	2	1	3	10	13	23	5	8	13
36	5	1	1		2	1			10	10	23	93	5				1		1	7				8	2	10	6	5	11
37	4		1		1	3			8	8	16	86	3				1		1	2	1		1	9	4	13	4	4	8
38	5		2		2	1			8	8	17	80	1											4	1	5	5	1	6
39	3	1	1		2	3			7	7	20	69	1											2		2	1		1
40	4					3			7	7	18	72	2								1		1	3	2	5	1	2	3
41	2	1	1		2				3	3	23	55	2																
42	3	1	1		2	1			10	10	21	56																	
43	3	1			1	2			9	9	17	34	3																
44	2								2	2	18	30	1																
45	2		1		1				4	4	7	19	1																
46	1								2	2	7	19																	
47											5	8																	
48									2	2	1	6																	
49												5																	
50												2																	
51																													
52																													
53						1																							
54																													
55																													
56																													
57																													
58						1																							
59																													
60																													
61																													
62																													

Thus, in the haul of 14th November (I) there were eight specimens between 13 and 16cm. (viz.:—132, 140, 144, 146, 148, 152, 156, 161mm.), and the next size was 242mm. In that of 28th December the group was represented by ten specimens, measuring from 137mm. to 168mm., the next largest being 215mm.; in the haul of 23rd January it was represented by nine specimens, from 138 to 186mm., the next size being 222mm., and in the haul of 1st April by fourty-four, from 144 to 191mm., the next largest being 217mm.

A consideration of the first and second series or generations in these cases throws light on the rate of growth of the fish, and the measurements may be grouped as follows, showing the smallest and largest specimens represented in each case, and the mean size:—

First Series.						
Date.	No.	Smallest.	Largest.	Range.	Arithmetic Average.	Geometric Mean.
1903.		Mm.	Mm.	Mm.	Mm.	Mm.
14th November, –	1	–	-	--	56	–
28th December, –	14	40	62	22	44·7	52·0
1904.						
23rd January, –	1	–	–	–	47·0	–
1st April, – –	7	60	83	23	71·6	71·5
Second Series.						
Date.	No.	Smallest.	Largest.	Range.	Arithmetic Average.	Geometric Mean.
1903.		Mm.	Mm.	Mm.	Mm.	Mm.
14th November, –	8	132	161	29	147·4	146·5
28th December, –	10	137	168	31	150·2	152·5
1904.						
23rd January, –	9	138	186	48	167·4	162·0
1st April, – –	44	144	191	47	166·1	167·5

The arithmetic average, it may be explained, is obtained by adding up the sizes of the fishes represented in each group and dividing by the number of fishes; it will deviate from the true average size in one direction or the other if the larger or the smaller fishes of the group predominate in numbers. The geometric mean is the middle figure between the extreme sizes, viz.:—the largest fish and the smallest; its accuracy depends upon the limits of the group being truly indicated.

Considering first the difference in size between the first series of witches and the second series, which are one year older, it is evident that the size of the single specimens of the first series obtained on 14th November and 23rd January respectively, are not representative, the former (56mm.) being too large and the latter (47mm.) too small. This is shown by the townet collections in October and November, as represented in Table A. and Plate XI, in which specimens measuring from 12mm. to 40mm. were secured. The differences between the two series on 28th December and on 1st April are these :—

	Smallest.	Largest.	Arithmetic Average.	Geometric Mean.
	Mm.	Mm.	Mm.	Mm.
28th December, -	97	104	105·5	100·5
1st April, - -	84	108	94·5	96·0

If the mean of the average sizes be taken for the two hauls, the difference between the first series and the second series is, for the arithmetic average, 100·0mm., and for the geometric, 98·3mm—and this might be taken as approximately representing the increase in growth in length in the witch at this stage in one year, *i.e.*, about $3\frac{7}{8}$ inches. It will be seen, however, as is the general rule, that the average difference in length is greater at the earlier date than at the later; in other words, that the younger fishes increase in length more rapidly than those one year older. The annual increment is therefore better represented on 1st April than on 28th December; and since 1st April is two or three months anterior to the height of the hatching season, and the more rapid growth in length of the smaller fishes continues, the true difference in length between witches which are one year old and those which are two years old is probably under 90mm. ($3\frac{1}{2}$ inches). The average length of a one-year-old witch appears to be about $3\frac{1}{2}$ inches, and that of a two-year-old somewhat under 7 inches.

The above Tables also furnish information as to the growth of the first and the second series between the dates of the collections. Thus, in the ninety-five days between 28th December and 1st April the increments of the first series of witches was as follows:—

Smallest.	Largest.	Arithmetic Average.	Geometric Mean.
Mm.	Mm.	Mm.	Mm.
20	21	26·9	19·5

In the period mentioned, therefore, the young witches grew a little over 20mm. longer—about $\frac{7}{8}$ of an inch. The second series of older fishes grew less rapidly. Comparison of the sizes at the various dates shows the following increases:—

[TABLE.

	No. of Days.	Increase.			
		Of Smallest Fish.	Of Largest Fish.	Average.	Mean.
14th November to 28th December,	44	Mm. 5	Mm. 7	Mm. 2·8	Mm. 6·0
28th December to 23rd January, -	26	1	18	17·2	9·5
23rd January to 1st April, -	69	6	5	−1·3	5·5
28th December to 1st April, -	95	7	23	15·9	15·0
14th November to 1st April, -	139	12	30	18·7	21·0

The increase in length in the ninety-five days from 28th December to 1st April amounted to about 15mm. ($\frac{5}{8}$ inch); on the 139 days from 14th November to 1st April, to about 20mm. ($\frac{3}{4}$ inch). It will be noticed, as pointed out in previous reports, that the larger fishes of an early series grow more rapidly that the smallest, *i.e.*, the variation in the sizes of the individual fishes of the group—due primarily to a difference in the time of hatching, early or late—becomes more pronounced, which is one of the causes of the coalescence of the older generations or groups. It will also be observed that, so far as these data go, growth was more rapid in December and January than in spring. This might be expected from the higher temperature of the bottom water in the depths where the witches lived during the former months, growth being closely related to temperature. Unfortunately, no observations have yet been made with sufficient frequency to enable the temperatures at these depths in the northern waters to be approximately stated for the various months of the year. Off the Firth of Forth, in thirty fathoms, according to the *Garland's* observations, the mean bottom-temperature in the months referred to were—November, 49° F.; December, 49·2°; January, 41·7°; February, 41·3°; March, 40·1°; April 43·3°.

With regard to the sizes and growth of the witches of older series, above two years, there is more difficulty, owing to the coalescence of the groups, and the different rate of growth of the males and females after sexeral maturity is attained; and there are not yet sufficient observations on the older males and females to make the matter clear. In most of the collections, as may be observed from the table, there is a general absence of specimens between the second and third groups, and it is not certain whether this gap is natural, *i.e.*, that it is caused by there being really no intermediate sizes, the grow th ofthe largest of the second series not having brought that series up to the third—or whether it is owing to the imperfect collections. A comparison of the measurements at the different dates shows that the latter factor at least partly accounts for it, inasmuch as smaller specimens of the third series were obtained in January and April than in November as shown :—

Cm.	15	15·5	16	16·5	17	17·5	18	18·5	19	19·5	20	20·5	21	21·5	22	22·5	23	23·5	24
11th Nov.,	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
28th Dec.,	2	1	1	1	-	-	-	-	-	-	-	-	-	1	-	2	-	-	2
23rd Jan.,	1	1	-	-	3	1	1	1	-	-	-	-	-	-	1	-	1	2	2
1st April,	8	11	7	8	-	2	-	1	1	-	-	-	-	1	1	-	1	2	3

In the curves of measurements there is a marked drop indicating a division between the third and the fourth series, but it does not agree in the different cases, and is based upon not very many mixed measurements of males and females. The lowest point is at 30-31cm. in November, 27cm. in January, 30-31cm. in December, and 29cm. in April. Study of the curves of the other series of measurements given in the Table shows that the fixing of the division between the third and fourth groups must be deferred. If, however, as reasoned above, a two-year-old witch measures on the average about 7 inches, and the rate of growth is slightly reduced, the average length when three years old will probably be about 10 inches, or 25cm., with a range for the group of approximately from $8\frac{1}{2}$ to $11\frac{1}{2}$ inches.

The average size and the range of size at which maturity is first reached in the males and females are not yet sufficiently elucidated. I found females ripe at 14 inches, spent at 13 inches, and nearly ripe at $12\frac{3}{4}$ inches; and males ripe at 15 inches, nearly ripe at $11\frac{1}{2}$ inches.* On the west coast of Ireland the smallest ripe female found by Holt was twelve inches, and the smallest approaching ripeness was also 12 inches; the smallest ripe male was $10\frac{1}{2}$ inches, and the smallest approaching ripeness 10 inches.†

From these facts it appears that the female witch does not spawn before the fourth year; some males may possibly become mature in their third year. It is noteworthy that in this species, under certain sizes the males are much more numerous than the females. In 2348 specimens under 16 inches, and mostly from 10 to 13 inches, the greater part of which were examined by Mr. F. G. Pearcey on board the *Garland*, 915 were females and 1833 were males, the males at these sizes being thus rather more than twice as numerous as the females. In 104 examined by myself there were sixty-seven males and thirty-seven females. Among large witches, on the other hand, from 13 or 14 inches upwards the proportions of the sexes are reversed. Of 422 examined, 306 were females (34-50cm.) and 116 males.

7. The Norway Pout (*Gadus Esmarkii*).

Since describing the observations made on the growth of this species in the Nineteenth Annual Report‡ collections have been obtained and measurements made on several occasions. Most of the fish were caught in the Moray Firth, or off Aberdeen, but in two instances collections were secured in the deep water off the Shetlands. The first haul was for forty-five minutes on 19th May, 1901, in sixty-five fathoms, about fifty-three miles S.E. by S. $\frac{1}{4}$ S. from the south point of Fetlar Island, Shetland; the bottom temperature was 42·5° C., and the surface 46·6° C. The number of Norway Pouts caught was 285, almost all belonging to one

* *Eighth Ann. Rep. Fishery Board for Scotland* Part III., p. 161) 1890); *Tenth ibid.*, p. 239.

† *Report of Council for 1891, Roy. Dublin Soc.*, p. 272.

‡ Part III., p. 155 (1901).

series, which extended from 85mm. to 129mm.. the range being thus 44mm. The arithmetic average size for the 279 in the series was 106·2mm., the mean was 107mm., and the maximum ordinate 10·5cm. (Pl. XII). The remaining six fishes, measuring from 137 to 149mm., represented part of the second series.

The next collection was obtained on 11th December, 1901, from the grounds seventy-five miles south-east of Sumburgh Head, Shetland, in seventy-five fathoms of water. The number of specimens secured in the small-meshed net was 704. Most of them belonged to one series, although three were represented. The first was not well represented, and was not cut off so sharply from the next series of larger fishes as in the hauls in September and October of the preceding year.*

The measurements, in 1cm. groupings, are given in the Table appended; and the 2mm. grouping is as follows at the point of division :—

115–6	117–8	119–20	121–2	123–4	125–6	127–8	129–30	131–2
10	11	7	5	1	4	14	21	25

This series extends from 97mm. to 122mm., a range of 25mm.; the smaller forms are no doubt absent. The arithmetic average size of the eighty-five fishes contained in it was 111·5mm., and the mean was 109·5mm. The maximum range in this series in the collections made in October 1900, which included 1553 fishes, was 50mm., and if this be applied in the present case it would make the size of the smallest belonging to it about 72mm., and the mean size on this basis would be about 97mm.

The next older group begins at 124mm., and apparently extends to 180mm. or 182mm., but it is possible it terminates at about 164mm. The two-millimetre grouping from 157mm. to the end is as follows :—

157–8	159–60	161–2	163–4	165–6	167–8	169–70	171–2	173–4	175–6	177–8
14	8	6	4	7	12	6	4	4	5	5

170–80	181–2	183–4	185–6	187–8	189–90	191–2	193–4	195–6	197–8
3	1	–	1	3	–	1	–	2	1

Taking the series as ending at 182mm., the range of the 611 fishes composing it amounts to 58mm.; the arithmetic average size is 142·3mm. and the mean 153mm. There were other eight fishes, the largest being 197mm., which evidently belong to a third series. The arithmetic average size is 190·9mm.

For comparison with the preceding collections taken in the same neighbourhood I give here the main features in tabular form, the averages being the actual arithmetical average.

Date.	1st Series.		2nd Series.		3rd Series.	
	Range.	Average.	Range.	Average.	Range.	Average.
1900.	mm.	mm.	mm.	mm.	mm.	mm.
31 August	–	–	110–162	140·2	163-213	176·8
4 September	51–92	78·7	117–155	136·0	157–200	168·9
16-19 Octr.	66–116	87·7	119–172	143·6	177–197	182·5
1901.						
19 May	85–129	106·2	–	–	–	–
11 December	97–122	111·5	124-182	142·3	185-197	190·9

* *Loc. cit.*, plate ix.

If, however, the series ends at 164mm., then the average size of the second group would be 139·9mm., the mean size 144, and the range 40mm.; the third group would have a range of 32mm., an average size of 174·1, and a mean of 181mm.

The differences between the average size of the various groups as shown above are as follows:—

1st to 2nd.	2nd to 3rd.
...	36·6
57·3	32·9
55·9	38·9
20·8 [45·3]	48·6

In the December haul the first and third series were very imperfectly represented (see Pl. XII.), and the averages given do n t correctly show the proper sizes. The figures in brackets indicate the difference of the corrected means.

Collections of the Norway Pout were also made at various times a few miles off Aberdeen in the deep water known as the Dog Hole, the depth varying from about fifty to about seventy fathoms.

The first was on 28th June, in sixty-five fathoms, eleven miles off; the bottom temperature was 48·2° F., and the surface temperature 52·5° F. The number of specimens procured was 141. One of those was a very small one, measuring 27mm., no doubt spawned some months earlier. The next series comprised 131, ranging in size from 125mm. to 172mm., the range being 47mm.; the arithmetical average size was 150·2mm., the mean 148·5mm., and the maximum ordinate 14·5cm. There were six in a third group, ranging from 178 to 194mm., with an average size of 187·2mm., the mean being 186mm. Other three probably formed a fourth series, the sizes being 210, 215, and 222mm., and the average 212·3 mm.

In the next collection, on 30th July, in sixty-two fathoms, the bottom temperature being 57° F., and the surface temperature 58·6° F., 350 specimens were taken, all belonging, apparently, to the same series. The range of sizes was from 120mm. to 184mm., or an extent of 64mm.; the arithmetical average was 155·1mm., the mean 152mm., and the maximum ordinate 15·5mm.

The third lot was got on 21st August, in fifty-eight fathoms, the surface temperature being 55·9° F., and they numbered 218 specimens. Two, possibly three, series, were present. The first comprised three fishes, measuring 67, 81, and 83mm. The second included 214, from 130mm. to 189mm., the range being thus 59mm.; the average size was 158·8mm., the mean 159·5, and the maximum ordinate 16cm.

On 3rd September, the fourth collection was made in fifty-eight fathoms in the same locality, the bottom temperature being 53° F., and the surface temperature 53·2°. Most of the fishes in the small-meshed net escaped, owing to a hole in it; the number of Norway Pouts obtained was fifteen, ranging from 132 to 168mm., the average size being 156·9mm., the mean 150mm., and the maximum ordinate 16cm.

A few days later, on 10th September, eight specimens were taken in Aberdeen Bay, measuring 76, 77, 83, 85, 87, 91, 93, 94mm. respectively. The average size was 85·7mm., the mean 85, and the maximum ordinate 9cm.

The next collection at the Dog Hole was on 16th December, in fifty-seven fathoms, the bottom temperature being 46·2° F. The number of specimens taken was fifty-four, belonging to two series. The first included seventeen fishes, measuring from 114mm. to 132mm.; the average size was 124·7mm., the mean 123mm., and the maximum ordinate between 12 and 12·5cm. The second series comprised thirty-seven fishes, ranging from 142mm. to 184mm.; the arithmetic average size was 160·8, the mean 163mm., and the maximum ordinate 15·5cm.

The particulars in regard to the specimens taken off Aberdeen may be summed up in the following Table, which also includes a number caught in the same locality by the *Garland* in October and November of the previous year:—

	1st Series.			2nd Series.				3rd Series.			4th Series.		
	Range.	Aver.	Mean.	No.	Range.	Aver.	Mean.	Range.	Aver.	Mean.	Range.	Aver.	Mean.
1900. Oct. 12,	.	.	.	26	59–107	96·3	83·0	.	.	.	.	.	.
,, 23, 24,	.	.	.	200	87–117	101·8	102·0	.	164	.	.	.	.
Nov. 7,	.	.	.	60	80–117	102·9	98·5	168–170	169	.	.	.	.
,, 9,	.	.	.	51	83–114	99·2	98·5	.	.	.	.	.	.
1901. June 28,	.	27	.	131	125–172	150·2	148·5	178–194	187·2	186	210–222	212·3	.
July 30,	.	.	.	350	120–184	155·1	152	.	.	.	.	.	.
Aug. 21,	67–83	77·0	75	214	130–189	158·8	159·5	.	201	.	.	.	.
Sept. 3,	.	.	.	15	132–168	156·9	150	.	.	.	.	.	.
,, 10,	76–94	85·7	85	.	.	.	.	.	.	.	.	.	.
Dec. 16,	114–132	124·7	123	37	142–184	160·8	163	.	.	.	.	.	.

The hauls on 9th November 1900, and 10th September 1901, were taken in Aberdeen Bay in about ten fathoms; all the others in 1900 in deeper water, from thirty-three to sixty fathoms up to ten miles from shore.

Beginning with the younger fishes, the one taken at the end of June, measuring 27mm. ($1\frac{1}{16}$ inch), was doubtless about two or three months old, and derived from the spawning in the previous spring. This series was not represented in the July collection, but in August the three measuring 67, 81, and 83mm. were no doubt large members of this group; the average size at this period is probably under what is given in the Table. On 10th September, in Aberdeen Bay, the eight specimens of this series taken had an average length of 85·7mm.; and three months later, on 16th December, the average size of seventeen was 124·7mm. This would indicate an increment of 39mm. in the period named, and 47·7mm. from 21st August, 117 days earlier, or 4·08mm. per ten days, which is too large.

In the Firth of Clyde a few collections were also obtained, but the numbers were small. On 15th July, 1899, one was taken in a few fathoms of water in Machray Bay, Arran; it measured 85mm. On 4th October, 1901, thirty-six were caught in the shrimp-net of the *Garland* between Rhuad Point and Ailsa Craig. They ranged in size from 63mm. to 97mm.; the arithmetical average size was 83·5mm., and the mean 80mm., and they no doubt belonged to the same year's spawning.

In the Moray Firth the Norway Pout is fairly common in the deeper water, and some collections were in sufficient numbers to enable curves of their measurements to be drawn. On 4th July, 1901, a small collection, consisting of sixteen specimens, was procured in fifty fathoms a few miles from Kinnaird Head. They appeared to belong to two groups, the first consisting of eleven, ranging in length from 125mm. to 172mm., with an average of 154·3mm., and the second of five specimens from 183 to 202mm., the average being 190·2mm.

On 14th November, 1903, 432 were taken in thirty fathoms off Burghead Bay, belonging to two series. The first comprised 369 specimens, varying in length from 75 to 137mm., the average size being 108·0mm., the mean 106mm., and the maximum ordinate 10·5cm. The second series, of sixty-three fishes, extended from 141mm. to 173mm., the average size being 150·5mm., the mean 157mm., and the maximum ordinate 15·5cm.

In the same locality another collection was made, in thirty fathoms, on 28th December, 1903, and 307 specimens procured, all belonging to the same series. The sizes ranged from 88mm. to 124mm., the average being 103·4mm., the mean 106mm., and the maximum ordinate 10·5cm.

A fourth collection in this locality was procured on 1st April, 1904, and apparently only one series was represented. It comprised 347 specimens, ranging in size from 93mm. to 139mm., the average being 110·2mm. or $4\frac{3}{8}$ inches, and the mean 116mm.

On 23rd January 1904, 250 specimens were procured in fifty fathoms, off Kinnaird Head, three series being represented. The first consisted of 205, ranging in size from 96mm. to 136mm.; the average was 115·3, the mean 116mm., and the maximum ordinate 12·5cm. The next group was composed of forty-four, from 145mm. to 181mm.; the average being 158·6, the mean 163mm., and the maximum ordinate 15·5cm. There was a large one measuring 203mm.

The particulars are given in the accompanying Table:—

Date and Place.	Series I.			Series II.			Series III.		
	No.	Range.	Average.	No.	Range.	Average.	No.	Range.	Average.
		Mm.	Mm.		Mm.	Mm.		Mm.	Mm.
Off Burghead,	...	...	...	...	...	...	...	...	...
14th Nov. 1903,	355	75–126	107·0	77	127–173	147·1	...	...	...
28th Dec. ,,	307	88–124	103·4	...	...	...	...	...	...
1st April 1904,	347	93–139	110·2	...	...	...	...	...	...
Off Kinnaird Head,	...	...	...	...	...	...	...	...	...
4th July 1901,	11	125–172	154·3	5	183–202	190·2	...	...	...
23rd Jan. ,,	205	96–136	115·3	44	145–181	158·6	1	203	...

In these collections it will be observed that as a rule the second series is poorly represented. The apparent annual increment of length amounting in the three cases in which comparison can be made to 40·1, 35·7, and 43·3mm., the mean of the three being 39·7mm., or $1\frac{1}{2}$ inches.

The information that may be derived from the Table as to the rate of growth from one date to the other is not very great, the successive averages irrespective of place being 107·0, 103·4, 115·3, 110·2 and 154·3. The latter is based upon only eleven specimens, and is too large, larger, indeed, than the average in November, 147·1, which deals with the measurement of seventy-seven fishes.

Information as to the size at which the Norway Pout becomes mature is scanty, the only observations, as far as I know, being those by Holt,* who found two ripe females, each $4\frac{1}{2}$ inches in length on the west coast of Ireland early in April.

I examined the condition of the reproductive organs in many of the specimens procured by me.

Seven females from the collection obtained off Burghead on 14th November, varying in size from 151 to 171mm. (6-$6\frac{3}{4}$ inches), had small ovaries, the largest eggs ranging in diameter from ·189 to ·231mm., Others on 28th December, from 95 to 118mm., had the ovaries only "slightly developed," but the size of the eggs was not determined. On 23rd January some of those caught in fifty fathoms off Kinnaird Head were examined, and both the weight of the ovary and the diameter of the largest eggs had considerably increased. The following Table exhibits the particulars, the dimensions being in millimetres, and the weight in grammes. The first six are from the November collection, and the others from that in January.

Length.	Gross Weight.	Weight of Ovary.	Diameter of Largest Eggs.
151	27·9	..	·21
152	28·2	·17	·21
157	30·9	·12	.23
158	31·2	·16	·189
164	32·6	..	·21
171	38·4	..	·21
153	24·7	·5	·44
155	26·5	·7	·46
155	28·6	1·3	·57
155	28·4	1·1	..
155	26·7	·8	..
158	31·0	1·8	..
161	31·7	1·2	·57–·63
180	41·0	1·3	·50
202	67·1	3·4	·59–·63

Those examined from the collection made off Burghead on 1st April were all "quite immature," their sizes ranging from 93 to 139mm. ($3\frac{5}{8}$–$5\frac{1}{2}$ inches) so that this circumstance together with the facts in the above Table appear to show that spawning occurs probably in February and March.

A Table giving the measurements in twenty collections, arranged in half-centimetres, is appended.

* *Roy. Dubl. Soc. Report of Council for 1891.* App., p. 291.

Cm.	Aberdeen.								Off Shetlands						Moray Firth.					Clyde.
	I.	II.	III.	VI.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.
2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
·5	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3	..	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...
·5	...	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...
4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
·5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
·5	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
6	...	...	...	...	...	...	...	...	...	...	7	...	...	...	...	...	...	...	...	1
·5	...	...	...	...	...	1	...	...	...	...	32	2	...	...	...	...	...	...	...	1
7	...	...	...	...	...	...	...	...	...	...	124	11	...	...	...	...	...	...	...	1
·5	1	...	...	...	...	...	...	...	...	...	286	68	1	...	...	...	...	2	...	8
8	1	...	1	...	...	2	...	...	...	...	161	27	2	...	...	...	...	2	...	9
·5	3	8	2	...	...	...	...	...	2	...	17	389	5	...	...	...	...	3	1	7
9	1	24	5	...	...	...	...	...	2	...	3	504	2	...	...	2	...	11	12	7
·5	9	50	17	...	...	...	...	...	11	...	...	433	1	2	6		...	35	30	2
10	5	46	10	...	...	...	...	...	43	...	...	118	...	10	14		...	72	72	...
·5	5	38	9	...	...	...	...	...	97	...	...	6	...	23	17	93	...	106	112	...
11	...	28	10	...	...	...	...	1	64	1	...	1	1	16	52	88	...	63	64	...
·5	...	6	7	...	...	...	...	1	38	...	3	1	2	26	59	58	...	42	12	...
12	...	...	...	...	2	...	...	6	15	3	27	1	1	9	34	28	...	16	4	...
·5	...	...	...	3	4	...	...	6	7	26	85	10	5	28	15	9	1	7	...	...
13	...	...	...	2	6	3	1	3	...	80	151	44	36	76	6	4	1	6	...	...
·5	...	...	...	9	9	6	...	...	1	120	119	78	51	137	2	1	...	4	...	...
14	...	...	...	15	31	11	...	1	...	114	71	78	52	132	...	...	...	10	...	...
·5	...	...	...	34	40	23	2	4	5	63	26	80	52	98	2	...	...	15	...	...
15	...	...	...	29	55	24	2	4	...	28	14	45	28	46	9	...	3	10	...	...
·5	...	...	...	21	86	38	3	10	...	20	12	19	8	30	15	...	2	19	...	...
16	...	1	...	13	60	42	5	6	...	7	15	9	5	14	12	...	1	4	...	...
·5	...	...	1	4	38	38	2	5	...	15	19	8	4	23	4	...	2	3	...	...
17	...	...	1	1	11	18	...	3	...	25	15	2	...	11	...	...	1	2	...	...
·5	...	...	...	1	6	9	...	3	...	12	13	4	...	12	1	...	...	...	...	...
18	...	...	...	1	3	1	...	1	...	14	3	1	...	2	1	...	1	...	...	...
·5	...	...	...	2	...	1	...	...	...	5	2	1	...	4	...	...	2	...	...	...
19	...	...	...	2	...	...	...	...	...	6	2	1	...	1	...	...	1	...	...	...
·5	...	...	...	...	..	...	...	...	...	1	1	1	...	3	...	...	...	...	...	...
20	...	...	...	...	...	...	...	...	...	1	...	...	...	...	1	...	1	...	...	...
·5	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	..
21	...	...	...	1	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
·5	...	...	...	1	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...
22	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
·5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

I. Aberdeen Bay, 12th October, 1900.
II. ,, 23rd October, 1900.
III. ,, 7th November, 1900.
IV. Dog Hole, off Aberdeen, 28th June. 1901.
V. ,, ,, 30th July, 1901.
VI. ,, ,, 21st August, 1901.
VII. ,, ,, 3rd September, 1901.
VIII. ,, ,, 16th December, 1901.
IX. Deep Water, off Shetlands, 19th May, 1901.
X. ,, ,, 31st August, 1900.
XI. ,, ,, 4th September, 1900.

XII. Deep Water, off Shetlands, 16th October, 1900.
XIII. ,, ,, 19th October, 1900.
XIV. ,, ,, 11th December, 1901.
XV. Deep Water, Moray Firth, off Kinnaird, 23rd January, 1904.
XVI. Moray Firth, off Burghead, 1st April, 1904.
XVII. ,, off Kinnaird, 4th July, 1901.
XVIII. ,, off Burghead, 14th November, 1903.
XIX. ,, ,, 28th December, 1903
XX. Firth of Clyde, between Rhuad Point and Ailsa Craig, 4th October, 1901.

8. The Sharp-Tailed Lumpenus (*Lumpenus lampetriformis.*)

Fairly large numbers of this fish are taken in the small meshed-net around the otter-trawl, more especially in the deeper parts of the Moray Firth, as off Kinnaird Head, and at the mouth of the Firth of Forth, and some of the collections have been measured. The best of these was one got at Station V. in the Firth of Forth, on 10th May, 1901, which comprised 255 specimens. They ranged in length from 127mm. to 345mm. (5 - 13½ inches). The measurements, grouped in half centimetres, are appended, and the curve is given in Plate XI. It is apparent from these that at least three series, and possibly five, are represented in the collection. What appears to be a first series is indicated by two specimens, measuring 127mm. and 128mm., the next size being 138mm. On the 16th May, on the same ground, a still smaller one was captured, viz., at 123mm., the next measuring 172mm. In a haul on 31st August, off Sumburgh Head, in sixty-five fathoms, the smallest I have obtained was taken, viz., 84mm. ($3\frac{5}{16}$ inches), the next largest in the small collection being 154mm. I am inclined to think that the specimens in the Forth collection referred to were the larger members of an early series, the smaller individuals probably escaping through the meshes of the net; the specimen at 138mm. might also belong to this series.

The second group begins at 138 or 146mm., its division from the third series being fairly well defined at 190mm. The range is thus 52mm., the average size of the thirty-three specimens, 167·8mm. ($6\frac{5}{8}$ inches), and the mean, with the first-named limit, 164mm., and with the series beginning at 146mm., 168mm.

The next group begins at 197mm., and it appears to terminate at 263mm., a range of 66mm. In the curve based on the half-centimetre grouping of the measurements, there is a depression at 23cm.; it does not seem, however, to represent a division between series, but only irregular representation. The number of fishes composing the second series was 127, the arithmetical average size was 235·2mm., and the mean 230mm.

The next series begins at 264mm., and extends to 312mm., a range of 48mm. It comprised seventy-eight fishes, whose average length was 288·9mm., the mean size being 288mm.

The other fifteen fishes in the collection probably belong to an older group. They measure from 315mm. to 345mm., the average size being 325·7mm., and the mean size 330mm.

The averages and limits above given are based on the supposition that five series are represented; but on the assumption that the smaller fishes belong to the same series as the second group, then the extent of the latter would be from 127mm. to 190mm., a range of 63mm., and the average size of the thirty-five fish would be a little less, viz., 165·4mm., the mean being 158·5. If the fifteen larger fishes be included with the preceding series the range would be extended from 264 to 345mm., a difference of 81mm.—obviously too great—and the average size would become 294·9mm., the mean being 304·5mm. Looking at the curve there seems little doubt of the presence in the collection of members of a fourth series, and scarcely less of the presence of the early one.

The amount of annual growth between the series as determined above are as follows:—

	1st to 2nd.	2nd to 3rd.	3rd to 4th.	4th to 5th.
Mm. -	40·3	67·4	53·7	36·8
Inches, -	$1\frac{5}{8}$	$2\frac{11}{16}$	$2\frac{1}{8}$	$1\frac{7}{16}$

If the two smallest fishes be included in the second group, the difference between the latter and the next older one is 69·8mm.

Some other collections of *Lumpenus* were measured, the largest being one procured off Burghead in thirty-two fathoms on 1st April, and which comprised 365 specimens. These, after being preserved in formaline, were measured by the Laboratory attendant, and the measurements are included in the Table appended. On preparing a curve, however, it is apparent that either the series was irregularly represented, or the measurements faulty, since the divisions between the groups are not marked. Four series, however, at least, seem to be indicated.

With regard to the age of these groups, it is necessary first of all to decide as to the period of spawning, about which little is known. In specimens taken off the Shetlands on 31st August and 4th September, the females, ranging in size from 234mm. to 286mm., had large ovaries, with large eggs from 1·1mm. to 1·44mm. in diameter, the ovaries themselves measuring from 25mm. to 35mm. long.* These specimens were evidently on the eve of spawning.

In a collection procured in the deep water off Kinnaird Head, Moray Firth, on 23rd January, the sizes ranging from 153 mm. to 284 mm., the ovaries were small and lax, and the tissue contained a great number of small dark-brown bodies scattered throughout them, apparently eggs or blood in the process of disintegration and absorption; they appeared to be spent. The same condition was noted in the ovaries of the specimens taken off Burghead on 1st April. On the other hand, in a few specimens procured in the Firth of Forth on 16th August, measuring from 236 mm. to 283 mm., the eggs were well developed, the largest ranging in diameter from 1·1 mm. to 1·4 mm.; the yolk spheres were large and small oil-globules were present.

From these observations it may be concluded that *Lumpenus* spawns in the late part of the autumn or the early part of winter, and it is probable that the eggs—which appear to be demersal—do not hatch until early in spring, which may therefore be taken as the period from which to date the rate of growth.

Looking to the rate of growth between the series as shown above, it is probable that the smaller specimens in May, measuring 123, 127, and 128 mm., were a little over one year of age, the specimen obtained off the Shetlands at the end of August, 84 mm. in length, being probably six or seven months old. The average size of *Lumpenus* when one year old is obviously less than these sizes, the smaller forms having escaped capture.

The information as to the size at which maturity is reached is very scanty, the number of specimens approaching ripeness which were examined having been small. In August the smallest in that condition were 236, 239, 241mm., and they evidently belonged to the same group as the third (197-263mm.) represented in the curve for the May measurements. The probability therefore is that *Lumpenus* spawn when three years of age. It may be noted that many of the largest specimens procured are males. This sex therefore does not, as with the flat-fish, grow at a slower rate after maturity than the females. A Table of measurement of some of the collections is appended.

* *Nineteenth Ann. Report Fishery Board for Scotland, Part III.*, p. 287.

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	Cm.	I.	II.	III.	IV.	V.	VI.	VII.
8	...	...	...	...	1	...	...	23	4	...	...	...	1	5	19
·5	...	...	...	...	...	...	...	·5	16	1	...	2	...	8	17
9	...	...	...	...	...	...	...	24	11	...	1	1	...	4	30
·5	...	...	...	...	...	...	...	·5	18	2	1	...	...	2	19
10	...	...	...	...	...	...	...	25	13	1	1	...	...	...	20
·5	...	...	...	...	...	...	...	·5	14	...	2	...	1	1	23
11	...	...	...	...	...	...	...	26	4	...	2	...	...	...	11
·5	...	...	...	...	...	...	...	·5	4	...	1	...	1	...	17
12	...	1	...	...	...	...	...	27	9	...	1	1	2	...	10
·5	2	...	...	...	...	...	...	·5	8	...	...	...	1	1	10
13	...	...	...	...	...	...	...	28	8	...	...	1	1	1	15
·5	1	...	...	...	...	...	...	·5	10	...	1	1	1	...	12
14	...	...	...	...	...	...	...	29	8	...	1	...	...	...	5
·5	1	...	...	...	...	...	...	·5	10	...	...	...	...	...	2
15	2	...	...	...	1	1	...	30	9	...	...	...	1	...	4
·5	5	...	...	...	...	...	2	·5	10	...	...	...	...	...	1
16	4	...	...	...	...	1	4	31	1	...	1	...	...	...	...
·5	8	...	...	...	...	1	3	·5	4	...	...	...	...	...	...
17	2	1	...	...	...	2	9	32	2	...	2	...	...	...	...
·5	4	1	...	...	...	1	4	·5	6	...	...	...	...	...	...
18	2	...	...	...	...	2	10	33	2	...	...	...	1	...	...
·5	3	...	...	...	...	1	11	·5	...	...	...	...	...	...	...
19	1	1	1	...	...	3	8	34	...	...	1	...	...	...	...
·5	2	1	1	...	...	3	7	·5	1	...	...	...	...	...	...
20	2	1	...	...	...	2	13	35	...	...	...	...	...	...	...
·5	9	3	...	1	...	4	7	·5	...	...	...	...	...	...	...
21	9	...	...	...	...	6	18	36	...	...	...	...	...	...	...
·5	6	1	...	...	...	7	14	·5	...	...	...	...	...	...	...
22	10	...	...	...	...	4	17	37	...	...	...	...	...	...	...
·5	10	2	1	...	...	5	23	·5	...	..	...	...	...	...	...

I. Firth of Forth, 10th May, 1901.
II. ,, ,, 16th ,, ,,
III. ,, ,, 23rd, 24th July, 1901.
IV. ,, ,, 16th August, 1901.
V. Off Shetlands, 31st August, 1900.
VI. Moray Firth, off Kinnaird Head, 23rd January.
VII. Moray Firth, off Burghead, 1st April.

TABLE A.—SHOWING RLATION BETWEEN LENGTH AND WEIGHT.

PLAICE.

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
4·2	1$\frac{5}{8}$	0·64	...	...	...	1
4·5	$\frac{3}{4}$	·79	.77	·71– ·85	...	3
4·7	$\frac{7}{8}$	·89	92	·76– ·98	...	4
5·0	2	1·09	1·17	·85– 1·48	$\frac{1}{26}$	19
·5	...	1·53	1·51	1·31– 1·77	...	21
6	$\frac{3}{8}$	1·92	1·96	1·51– 2·41	...	29
·5	...	2·44	2·50	1·77– 2·83	...	19
7	...	3·15	3·12	2·9 – 3·6	...	7
7·5	...	3·77	3·90	3·3 – 4·17	...	9
8	3$\frac{1}{8}$	4·77	4·78	3·87– 5·3	...	17
·5	...	5·8	5·72	4·53– 6·34	...	38
9	$\frac{9}{16}$	6·58	6·82	5·2 – 7·4	...	35
·5	...	8·09	8·11	6·6 – 8·9	...	34
10	3$\frac{15}{16}$	9·68	9·62	7·99– 10·9	$\frac{1}{3}$	34
·5	...	11·08	11·20	9·86– 12·8	...	20
11	4$\frac{5}{16}$	12·84	12·93	11·8 – 14	...	16
·5	...	14·86	14·80	13·0 – 16·8	...	15
12	4$\frac{3}{4}$	16·69	17·35	15·6 – 18·7	...	9
·5	$\frac{15}{16}$	20·49	19·90	17·7 – 24·5	...	11
13	5$\frac{1}{8}$	22·53	22·41	19·7 – 25·1	...	11
·5	...	24·2	25·46	22·2 – 27·0	...	5
14	$\frac{1}{2}$	29·64	27·67	28·3 – 30·9	...	2
·5	...	29·17	31·10	27·4 – 30·2	...	4
15	$\frac{7}{8}$	34·5	34·06	32 – 40·1	1·2	6
·5	...	38·5	37·90	35·4 – 40·1	...	3
16	6$\frac{5}{16}$	40·7	41·03	37·2 – 44·4	1·4	6
·5	...	43·9	44·83	41·1 – 45	...	6
17	$\frac{11}{16}$	...	49·55	...	...	...
·5	...	54·9	53·78	47·4 – 58	...	5
18	7$\frac{1}{8}$	54·6	57·79	...	1·9	1
·5	...	65·0	62·2	...	...	1
19	7$\frac{1}{2}$	...	67·63	...	...	...
·5	...	69·0	71·54	...	...	1
20	$\frac{7}{8}$	78·0	77·10	...	2·7	1
·5	...	84·3	86·1	78 – 92	...	5
21	8$\frac{1}{4}$	...	95·2	...	...	...
·5	...	104·0	104·6	99 –107	...	3
22	$\frac{11}{16}$	114·7	112·8	113 –120	...	4
·5	...	119·7	119·9	115 –127	...	4
23	9$\frac{1}{8}$	125·2	125·7	115 –142	...	10
·5	...	132·3	133·0	122 –139	...	9
24	$\frac{7}{16}$	141·6	140·6	127 –154	...	17

PLAICE—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	147·9	151·4	134– 158	...	9
25	⅞	164·6	161·0	153– 184	5·8	8
·5	...	170·6	172·2	152– 187	...	8
26	10¼	181·5	181·4	175– 190	...	4
·5	...	192·0	195·2	...	...	1
27	⅝	212·0	207·0	192– 233	...	9
·5	...	217·0	219·7	204– 225	...	5
28	11	230·0	233·7	224– 236	...	2
·5	...	251·0	248·1	210– 278	...	13
29	$\frac{7}{16}$	260·2	266·0	247– 276	...	4
·5	...	283·7	280·6	256– 306	...	10
30	$\frac{13}{16}$	298	299·1	288– 318	10·5	8
·5	...	315·5	316·9	286– 341	...	8
31	12$\frac{3}{16}$	337·1	332·8	319– 368	...	9
·5	...	345·8	343·3	324– 375	...	10
32	⅝	347	355·4	...	...	1
·5	...	373·5	382	356– 404	...	13
33	13	425·6	411·2	380– 474	...	5
·5	...	434·5	433·4	324– 502	...	14
34	⅜	440·2	444·5	397– 496	...	13
·5	...	458·8	464·3	417– 530	...	12
35	13¾	494	484·6	432– 558	16·7	20
·5	...	501	509	456– 558	...	9
36	14$\frac{3}{16}$	532	527	481– 580	...	10
·5	...	549	550	510– 623	...	10
37	$\frac{9}{16}$	568	566	503– 679	...	17
·5	...	582	585	538– 673	...	7
38	$\frac{15}{16}$	605	605	564– 644	...	11
·5	...	628	626	540– 708	...	7
39	15⅜	644·6	649·9	568– 701	...	10
·5	...	677	678	644– 708	...	6
40	¾	711·6	708	673– 807	25·1	10
·5	...	735	739	708– 792	...	9
41	16⅛	743·7	770	735– 782	...	4
·5	...	831	818	708–1104	...	10
42	$\frac{9}{16}$	880·8	864	835– 956	...	6
·5	...	879	899	835– 970	...	9
43	$\frac{15}{16}$	936	916	835–1126	...	8
·5	...	935	939	842–1019	...	8
44	17⅜	947	954	864–1048	...	7
·5	...	982	993	948–1048	...	6
45	¾	1049	1026	932–1168	37·3	10
·5	...	1057	1076	991–1118	...	6
46	18⅛	1122	1092	913–1388	...	16
·5	...	1098	1131	1005–1175	...	4

PLAICE—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
47	½	1174	1166	1005–1317	...	9
·5	...	1217	1228	1161–1288	...	4
48	⅞	1293	1282	1182–1373	...	4
·5	...	1336	1334	1218–1533	...	6
49	19 5/16	1373	1375	1338–1409	...	2
·5	...	1417	1404	1253–1494	...	8
50	11/16	1423	1429	1381–1466	50·2	3
·5	...	1446	1459	1366–1614	...	4
51	20 1/16	...	1508	...	...	...
·5	...	1465	1575	...	...	1
52	7/16	1621	1624	1529–1713	...	2
·5	...	1675	1685	1437–1869	59·2	6
53	⅞	1759	1746	1643–1876	...	2
·5	...	1805	1784	1727–1883	...	2
54	21¼	...	1802	...	...	...
·5	...	1784	1816	1585–1911	...	4
55	⅝	1861	1820	1826–1897	...	2
·5	...	...	1881	...	...	...
56	22 1/16	1940	1963	...	...	1
·5	...	...	2005	...	...	...
57	7/16	2150	2073	1969–2528	...	3
·5	...	2053	2122	...	...	1
58	13/16	2163	2142	2047–2279	...	2
·5	...	2209	2223	...	...	1
59	23¼	...	2297	...	...	...
·5	...	2445	2371	2435–2464	86·3	3
60	⅝	2372	2468	2175–2514	...	3
·5	...	2587	...	2096–3079	...	2
61	24	...	...	...	...	...
·5	...	...	...	...	...	...
62	3/16	2952	...	2733–3172	...	2
·5	...	...	...	...	...	...
63	⅝	...	...	...	...	...
·5	...	...	...	...	...	...
64	25	3681	...	...	...	1
·5	...	...	...	...	...	...
65	⅜	...	...	...	...	...
·5	...	2981	...	...	101·7	1
66	¾	...	...	...	...	...
·5	...	...	...	...	...	...
67	26 3/16	...	...	...	...	...
·5	...	...	...	...	...	...
68	9/16	3575	...	3058–4092	...	2
·5	...	3653	...	3498–3809	129	2
69	15/16	...	...	...	...	...

PLAICE—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	...	...	...	...	...
70	$27\frac{3}{8}$	3908	...	...	...	1
·5	...	...	...	...	...	...
71	$\frac{3}{4}$	...	...	...	...	...
·5	...	4481	...	...	158·2	1
72	$28\frac{1}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
73	$\frac{9}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
74	$\frac{15}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
75	$29\frac{5}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
		LEMON.				
6	$2\frac{3}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
7	$\frac{3}{4}$	...	...	...	...	...
·5	...	3·35	...	...	...	1
8	$3\frac{1}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
9	$\frac{9}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
10	$\frac{15}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
11	$4\frac{5}{16}$	...	...	...	...	...
·5	...	14·77	...	...	...	1
12	$\frac{3}{4}$	...	...	...	...	...
·5	...	18·9	...	17·35– 20·5	·66	2
13	$5\frac{1}{8}$	20·0	21·3	18·8 – 20·97	...	3
·5	...	23·8	23·0	23 – 24·7	...	6
14	$\frac{1}{2}$	26·0	26·1	22·6 – 29	...	8
·5	...	...	28·5	...	...	...
15	$\frac{7}{8}$	31·15	32·3	26· – 35·5	1·1	4
·5	...	36·1	36·1	34·5 – 37·9	...	6
16	$6\frac{5}{16}$	41·2	40·5	38·5 – 44·	...	2
·5	...	44·9	44·9	40·2 – 51·6	...	9
17	$\frac{11}{16}$	48·6	48·3	44·3 – 53·1	...	6
·5	...	51·7	51·8	47·5 – 57·7	...	4
18	$7\frac{1}{8}$	...	55·0	...	...	...
·5	...	58·4	61·4	54·3 – 62·4	...	2
19	$\frac{1}{2}$	67·8	68·9	...	...	1

LEMON—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	...	79·4	...	...	...
20	7/8	91·0	89·3	84·9 – 99·1	3·2	4
·5	...	99·2	98·0	...	...	1
21	8¼	105·0	...	102 –106·8	...	3
·5	...	...	...	...	...	...
22	11/16	...	...	...	...	...
·5	...	...	...	...	...	...
23	9⅛	...	...	...	...	...
·5	...	157	...	...	...	1
24	7/16	...	...	...	...	...
·5	...	...	...	...	...	...
25	7/8	...	...	...	...	...
·5	...	170	...	...	...	1
26	10¼	214	...	...	...	1
·5	...	...	...	...	...	...
27	5/8	228·8	...	...	...	1
·5	...	...	...	...	...	...
28	11	...	...	...	...	...
·5	...	262	...	241– 283	...	2
29	7/16	...	...	...	...	...
·5	...	340	...	326– 354	...	2
30	13/16	...	...	...	...	...
·5	...	346	363	319– 361	12·2	3
31	12 3/16	354	...	...	...	1
·5	...	...	...	...	...	...
32	5/8	453	...	...	...	1
·5	...	434	...	411– 474	...	3
33	13	...	...	...	...	...
·5	...	484	...	445– 524	...	2
34	3/8	468	482	432– 481	...	3
·5	...	493	514	439– 559	...	5
35	3/4	582	561	552– 616	20·5	4
·5	...	598	586	518– 630	...	4
36	14 3/16	579	595	538– 658	...	4
·5	...	608	611	566– 651	...	2
37	9/16	647	638	559– 694	...	4
·5	...	658	678	559– 715	...	7
38	15/16	718	697	616– 779	...	5
·5	...	715	736	651– 779	...	4
39	15⅜	775	754	757– 821	...	4
·5	...	772·6	763	644– 871	...	7
40	3/4	740	788	694– 786	26·1	2
·5	...	852	829	729– 991	...	9
41	16⅛	896	872	835– 991	...	7
·5	...	868	894	793– 942	...	4

LEMON—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
42	$\frac{9}{16}$	917	922	871– 963	...	2
·5	...	982	...	935–1026	...	3
43	$\frac{15}{16}$	...	1038	...	...	...
·5	...	...	...	...	...	...
44	$17\frac{3}{8}$	1094	...	1062–1126	38·6	2
·5	...	...	1096	...	...	...
45	$\frac{3}{4}$	1076	...	...	...	1
·5	...	1119	...	...	...	1
46	$18\frac{1}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
47	$\frac{1}{2}$	...	...	...	...	...

WITCH.

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
4	$1\frac{9}{16}$	·19	...	·18– ·21	...	3
·5	...	·28	·30	·21– ·32	...	9
5	2	...	·45	...	...	...
·5	...	·64	·60	...	...	1
6	$\frac{3}{8}$	·71	·77	·7 – ·72	...	2
·5	...	·95	·93	·9 – 1·0	...	2
7	$\frac{3}{4}$	...	1·14	...	...	...
·5	...	1·33	1·31	1·2 – 1·5	...	3
8	$3\frac{1}{8}$	...	1·46	...	...	...
·5	...	1·6	...	...	...	1
9	$\frac{9}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
10	$\frac{15}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
11	$4\frac{5}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
12	$\frac{3}{4}$	...	...	...	...	...
·5	...	8·4	...	...	...	1
13	$5\frac{1}{8}$	10·6	9·87	...	...	1
·5	...	10·6	10·87	...	...	1
14	$\frac{1}{2}$	11·4	11·7	9·4 – 12·8	...	5
·5	...	13·0	12·9	11·7 – 14·3	...	7
15	$\frac{7}{8}$	14·3	14·07	13·0 – 15·1	·5	7
·5	...	14·9	15·53	13· – 18·4	...	10
16	$6\frac{5}{16}$	17·4	16·9	16·2 – 18·8	...	5
·5	...	18·4	18·37	15·6 – 20	...	9
17	$\frac{11}{16}$	19·3	20·07	17·1 – 21·1	...	4
·5	...	22·5	21·4	18·1 – 22·3	...	6
18	$7\frac{1}{8}$	22·4	23·3	...	...	1
·5	..	25·1	25·3	23· – 26·1	...	5

WITCH—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
19	$\frac{1}{2}$	28·3	28·3	27·5 – 29·	...	2
·5	...	31·38	31·6	28·45– 34·3	...	2
20	$\frac{7}{8}$	35·2	35·4	35 – 35·5	1·2	2
·5	...	...	39·7	...	...	...
21	$8\frac{1}{4}$	47·2	44·0	47·5 – 46·9	...	2
·5	...	45·0	47·7	43 – 47	...	2
22	$\frac{11}{16}$	50·9	51·3	41 – 56·3	...	5
·5	...	57·9	58·9	...	...	1
23	$9\frac{1}{8}$	68	63·9	...	...	1
·5	...	65·9	69·2	60 – 84	...	4
24	$\frac{7}{16}$	73·7	73·6	70 – 78	...	3
·5	...	78·0	80·3	70 – 88	...	9
25	$\frac{7}{8}$	89·1	86·1	79·3 – 69·5	3·1	5
·5	...	97·3	95·0	89·5 –108	...	4
26	$10\frac{1}{4}$	98·	99·3	88·3 –108	...	4
·5	...	102	106·2	89 –109·5	...	6
27	$\frac{5}{8}$	118	117·0	111 –127	...	4
·5	...	130·9	127·7	103 –150	...	10
28	11	134·2	137·0	127 –140	...	6
·5	...	146	144·1	132·3 –157	...	3
29	$\frac{7}{16}$	152·2	153·7	137·4 –163	...	10
·5	...	162·8	164·3	144 –189	...	6
30	$\frac{13}{16}$	178	170·4	164 –186	6·3	6
·5	...	170·4	179·8	160·8 –178	...	4
31	$12\frac{1}{4}$	191	192·9	163 –216	...	6
·5	...	217·3	210·4	208 –231	...	3
32	$\frac{5}{8}$	222·8	224·0	219 –234	...	6
·5	...	232	229·8	206 –255	...	5
33	13	234	237·7	213 –263	...	6
·5	...	247·3	249·7	212 –277	...	10
34	$\frac{3}{8}$	267·7	262	236 –297	...	4
·5	...	271·0	274·9	255 –298	...	10
35	$\frac{3}{4}$	285·9	283·5	262 –326	10·1	11
·5	...	293·5	297·2	255 –343	...	9
36	$14\frac{3}{16}$	312·2	308	305 –361	...	13
·5	...	318·2	320·1	314 –340	...	8
37	$\frac{6}{16}$	330·0	337·1	312 –361	...	7
·5	...	363·1	353	326 –396	...	14
38	$\frac{15}{16}$	366·0	370	312 –425	...	13
·5	...	381	391	305 –467	...	15
39	$15\frac{3}{8}$	426·2	414	397 –460	...	6
·5	...	435	440	397 –489	...	8
40	$\frac{3}{4}$	458·5	458	418 –500	16·2	4
·5	...	481	476·3	459 –531	...	3
41	$16\frac{1}{8}$	480	487·3	418 –574	...	12

WITCH—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	501·5	501·1	411 –630	...	8
42	$\frac{9}{16}$	521·7	517·	489 –592	...	4
·5	...	527·8	547·8	447 –417	...	4
43	$\frac{15}{16}$	594·0	577	574 –651	...	13
·5	...	608·3	608	573 –680	...	6
44	$17\frac{3}{8}$	620	624·7	581 –659	...	2
·5	...	646	648	588 –733	...	7
45	$\frac{3}{4}$	678	677	630 –729	23·9	4
·5	...	707·5	706	677 –744	...	4
46	$18\frac{1}{8}$	733	732·7	694 –772	...	2
·5	...	758	760	658 –871	...	6
47	$\frac{1}{2}$	789	780	758 –821	...	2
·5	...	793	781	758 –842	...	3
48	$\frac{7}{8}$	763	791	727 –800	26·9	2
·5	...	818	...	751 –885	...	2
49	$19\frac{5}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
50	$\frac{11}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...

COMMON DAB.

1	...	...	...	...	...	...
·5	...	...	...	...	...	...
2	...	...	...	...	...	...
·5	...	...	...	...	...	...
3	$1\frac{3}{16}$	·17	...	...	...	6
·5	...	·35	·31	·22– ·45	...	9
4	$\frac{9}{16}$	·42	·50	·35– ·54	...	11
·5	...	·72	·69	·56– ·84	...	18
5	2	·94	·97	·75– 1·2	...	21
·5	...	1·26	1·32	1·1 – 1·5	...	21
6	$\frac{3}{8}$	1·75	1·85	1·4 – 2·2	...	10
·5	...	2·33	2·27	2·0 – 2·8	...	12
7	$\frac{3}{4}$	2·74	2·77	2·6 – 3·1	...	8
·5	...	3·25	3·43	2·7 – 3·7	...	13
8	$3\frac{1}{8}$	4·21	4·12	3·8 – 4·7	...	12
·5	...	4·9	5·11	4·2 – 5·5	...	10
9	$\frac{9}{16}$	...	6·21	...	...	...
·5	...	7·24	7·32	6·4 – 8·1	...	5
10	$\frac{15}{16}$	8·5	8·72	7·5 – 9·3	0·3	7
·5	...	...	10·53	...	...	...
11	$4\frac{}{16}$	12·6	12·31	11·6 –16 7	...	4

COMMON DAB—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	13·8	13·7	12·1 –15·9	...	8
12	$\frac{3}{4}$	14·6	14·7	13·0 –16	...	11
·5	...	16·6	16·4	14·5 –18·5	...	24
13	5$\frac{1}{8}$	18·0	18·4	16·5 –20·1	...	10
·5	...	20·6	20·9	19 –22 5	...	8
14	$\frac{1}{2}$	24·2	23·7	20·5 –27·8	...	6
·5	..	26·4	26·2	23·5 –33·7	...	12
15	$\frac{7}{8}$	28·0	28·1	23·5 –32	1	8
·5	...	30·0	30·5	25 –34·1	...	6
16	6$\frac{5}{16}$	33·4	34·3	21 –37	...	11
·5	...	39·4	39·0	36 7 –44·6	...	9
17	$\frac{11}{16}$	44·1	43·1	42·4 –47·1	...	3
·5	...	46·0	46·3	40·5 –59	...	10
18	7$\frac{1}{8}$	48·9	50·4	41·5 –59·2	...	4
·5	...	56·2	56·7	52 –64	...	4
19	$\frac{1}{2}$	65·0	62·4	59 –78	...	7
·5	...	66·0	69·2	64 –69	...	4
20	$\frac{7}{8}$	76·6	74·7	73 –85	2·7	9
·5	...	81·6	82·7	71 –90	...	7
21	8$\frac{1}{4}$	90·0	90·3	77 –99	...	4
·5	...	99·4	99·4	82 –136	...	11
22	$\frac{11}{16}$	108·7	104·9	91 –135	...	10
·5	...	106·6	115·1	98 –129	...	9
23	9$\frac{1}{8}$	129·9	123·5	120 –141	...	8
·5	...	133·9	136·2	111–149	...	15
24	$\frac{7}{16}$	144·9	142·3	123–173	...	11
·5	...	148·0	153·6	131–172	...	7
25	$\frac{7}{8}$	167·9	163·8	148–191	5·9	8
·5	...	174·4	177·6	141–198	...	9
26	10$\frac{1}{4}$	190·5	186·9	170–219	...	16
·5	...	195·8	198·7	171–219	...	5
27	$\frac{5}{8}$	209 9	210·9	170–247	...	8
·5	...	217·6	224·3	189–262	...	11
28	11	240·7	238·9	191–276	...	6
·5	...	257·3	254·0	205–297	...	9
29	$\frac{7}{16}$	269·0	266·4	247–291	...	7
·5	...	285·4	280·5	262–318	...	8
30	$\frac{13}{16}$	279·8	296·4	255–290	9·8	5
·5	...	311	305·3	247–347	...	7
31	12$\frac{3}{16}$	327	315·3	304–368	...	5
·5	...	323·5	333·4	311–333	...	4
32	$\frac{5}{8}$	335	338·4	304–383	...	6
·5	...	370·7	353·2	304–396	...	6
33	13	336	379·9	325–347	...	2
·5	...	...	402·8	...	...	..

COMMON DAB—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
34	$\frac{3}{8}$	455	422·9	450–460	...	2
·5	...	474·5	449·4	439–510	...	2
35	$\frac{3}{4}$	445·7	469·8	389–481	15·1	3
·5	...	468·7	479·1	389–573	...	4
36	$14\frac{3}{16}$	505	487	446–559	...	3
·5	...	...	501·2	...	...	...
37	$\frac{9}{16}$	514·3	522·9	446–552	...	3
·5	...	517	549·3	...	...	1
38	$\frac{15}{16}$	...	577	...	...	...
·5	...	637	...	...	...	1
39	$15\frac{3}{8}$	...	...	...	...	...
·5	...	...	693·5	...	...	...
40	$\frac{3}{4}$	...	...	...	...	...
·5	...	750	...	...	26·5	1
41	$16\frac{1}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
42	$\frac{9}{16}$	...	...	...	...	...

FLOUNDER.

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
11	$4\frac{5}{16}$	...	...	...	...	...
·5	...	...	...	...	...	..
12	$\frac{3}{4}$	...	...	...	...	...
·5	...	...	...	...	...	...
13	$5\frac{1}{8}$	...	...	...	...	..
·5	...	...	...	...	...	...
14	$\frac{1}{2}$	...	...	...	...	...
·5	...	...	...	...	...	...
15	$\frac{7}{8}$	31·3	...	...	...	1
·5	...	...	...	..	...	...
16	$6\frac{5}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
17	$\frac{11}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
18	$7\frac{1}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
19	$\frac{1}{2}$	...	...	...	...	...
·5	...	...	...	...	...	...
20	$\frac{7}{8}$	...	...	...	...	...
·5	...	78·7	...	66– 85	2·8	3
21	$8\frac{1}{4}$	...	85·4	...	...	...
·5	...	92	93·5	...	...	1
22	$\frac{11}{16}$	...	103	..	...	...
·5	...	124	118	144–134	...	2

FLOUNDER—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
23	$9\frac{1}{8}$	...	126·7	...	...	...
·5	...	...	135·5	...	...	..
24	$\frac{7}{16}$	...	141·2	...	...	..
·5	...	147	150	137–157	...	2
25	$\frac{7}{8}$	...	162	...	5·7	...
·5	...	...	170	...	...	...
26	$10\frac{1}{4}$	177	176	170–184	...	2
·5	...	...	184	...	...	...
27	$\frac{5}{8}$	191	197·7	170–212	...	2
·5	...	219·5	209·3	219–220	...	2
28	11	218	223·1	184–234	...	4
·5	...	...	235·6	...	...	...
29	$\frac{7}{16}$	245·7	247·7	241–248	...	3
·5	...	...	261·8	...	...	...
30	$\frac{13}{16}$	276	279·4	...	9·8	1
·5	...	276	294·4	...	...	1
31	$12\frac{3}{16}$	313·7	309·3	297–340	...	3
·5	...	...	324·4	...	...	...
32	$\frac{5}{8}$	308	340·5	304–312	...	2
·5	...	...	355·5	...	...	...
33	13	403	372·3	347–481	...	3
·5	...	...	400·9	...	...	...
34	$\frac{3}{8}$	420	410·2	382–453	...	3
·5	...	415·7	425·1	354–481	...	4
35	$\frac{3}{4}$	449·5	440·1	439–460	15·9	2
·5	...	...	458 2	...	...	...
36	$14\frac{3}{16}$	467	482·8	...	...	1
·5	...	...	523·3	...	...	...
37	$\frac{9}{16}$	...	543·1	...	...	...
·5	..	580	561·1	538–623	...	2
38	$\frac{15}{16}$	588	583·9	...	...	1
·5	...	...	606·6	...	...	...
39	$15\frac{3}{8}$	...	625·3	...	...	...
·5	...	...	643·9	...	...	...
40	$\frac{3}{4}$	662·5	683·5	560–765	23·4	2
·5	...	...	702·2	...	...	...
41	$16\frac{1}{8}$	...	741·7	...	...	...
·5	...	...	781·3	...	...	..
42	$\frac{9}{16}$	821	...	...	...	1
·5	...	...	...	...	...	...

LITTLE SOLE.

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
6	$2\frac{3}{8}$	...	...	...	...	...
·5	...	2·72	...	2·4– 3·0	·09	4
7	$\frac{3}{4}$	3·22	3·5	3·0– 3·4	...	6
·5	...	4·28	4·23	3·8– 4·8	...	9
8	$3\frac{1}{8}$	5·18	5·20	4·3– 5·8	·18	5
·5	...	6·15	6·34	5·0– 7·3	...	2
9	$\frac{9}{16}$	7·7	7·53	6·9– 9·2	...	11
·5	...	8·75	9·18	7·8–10·0	·3	11
10	$\frac{15}{16}$	11·0	10·77	...	...	1
·5	...	12·57	12·96	12·1–13·2	...	3
11	$4\frac{5}{16}$	14·4	13·96	...	...	1
·5	...	14·9	...	...	·5	1
12	$\frac{3}{4}$	...	...	...	...	...
·5	...	...	...	...	...	..
13	...	...	...	...	...	...
·5	...	...	...	...	...	...

TURBOT.

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
25	$9\frac{7}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
26	$10\frac{1}{4}$	...	...	...	...	...
·5	...	...	...	...	...	...
27	$\frac{3}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
28	11	...	...	...	...	...
·5	...	...	...	...	...	...
29	$\frac{7}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
30	$\frac{13}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
31	$12\frac{1}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
32	$\frac{5}{8}$	...	...	...	...	...
·5	...	...	...	..	..	...
33	13	...	...	...	..	...
·5	...	810·5	...	750–871	...	2
34	$\frac{3}{8}$	828	...	...	29·2	1
·5	...	...	890	..	...	..
35	$\frac{3}{4}$	...	...	...	...	..
·5	...	951	...	828–1090	..	3
36	$14\frac{3}{16}$	...	971	...	...	..
·5	...	991	1000	...	..	1

TURBOT—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
37	9/16	...	1039	...	...	...
·5	...	1034	1072	...	...	1
38	15/16	1143	1108	1090–1289	...	4
·5	...	1147	1155	...	...	1
39	15 3/8	1175	...	...	...	1
·5	...	...	...	...	...	...
40	3/4	...	...	...	...	...
·5	...	...	...	...	...	...
41	16 1/8	...	...	...	...	...
·5	...	...	...	...	...	...
42	9/16	...	...	...	...	...
·5	...	...	...	...	...	...
43	15/16	...	...	...	...	...
·5	...	...	...	...	...	...
44	17 3/8	1827	...	...	64·5	1
·5	...	...	...	...	...	...
45	3/4	...	...	...	...	...
·5	...	...	...	...	...	...
46	18 1/8	...	2173	...	...	...
·5	...	...	...	...	...	...
47	1/2	...	...	...	...	..
·5	...	...	...	...	...	...
48	7/8	...	...	...	...	...
·5	...	2520	...	...	...	1
49	19 5/16	...	2613	...	..	...
·5	...	...	...	...	...	...
50	11/16	2706	...	...	95·5	1
·5	...	...	...	...	...	...
51	20 1/16	...	...	...	...	...
·5	...	...	3052	...	...	...
52	7/16	...	...	...	...	...
·5	...	...	...	...	...	...
53	7/8	...	...	...	...	...
·5	...	3399	...	...	...	1
54	21 1/4	...	...	...	...	...
·5	...	...	3441	...	..	...
55	5/8	...	...	...	..	...
·5	...	...	...	...	...	...
56	22 1/16	3483	...	...	12·3	1
·5	...	...	...	...	...	...
57	7/16	...	...	...	...	...
·5	...	...	...	...	...	...
58	13/1	...	4300	...	...	...
·5	...	...	...	...	...	...
59	23 1/4	...	...	...	...	...

TURBOT—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	...	...	...	...	...
60	5/8	...	...	...	...	...
·5	...	5117	...	...	...	1
61	24	...	...	...	...	...
·2	...	...	...	...	...	...
62	3/16	...	5217	...	...	...
·5	...	...	...	...	...	...
63	5/8	...	...	...	...	...
·5	...	5317	...	5268–5367	187·7	2
64	25	...	...	...	...	...
·5	...	...	...	...	..	...
65	3/8	...	...	...	...	...
.5	...	...	...	...	...	...
66	3/4	...	...	...	...	...
·5	...	...	6376	...	...	...
67	26 3/16	...	...	...	...	...
·5	...	...	...	...	...	..
68	9/16	...	...	...	...	...
·5	...	...	...	...	...	...
69	15/16	6301	...	...	...	1
·5	...	...	7435	...	...	...
70	27	8569	...	...	...	1
·5	...	...	...	...	...	...
71	3/4	...	8745	...	...	...
·5	...	...	...	...	...	...
72	28 1/8	8921	...	...	315	1
·5	...	...	...	...	...	...
73	9/16	...	...	...	...	...
·5	...	...	...	...	...	...
74	15/16	...	...	...	...	...
·5	...	...	...	...	...	...
75	29 5/16	...	10227	...	...	...
·5	...	...	...	...	...	...
76	7/8	...	...	...	...	...
·5	...	...	...	...	...	...
77	...	...	...	...	...	...
·5	...	...	...	...	...	...
78	30 3/4	...	...	...	...	...
·5	...	11533	...	10323–12121	407	4
79	...	...	...	...	...	...
·5	...	...	...	...	...	...
80	...	...	...	...	...	...
·5	...	...	...	...	...	...
81	...	...	...	...	...	...
·5	...	...	...	...	...	...
82	...	...	...	...	...	...
·5	...	...	...	...	...	...

BRILL.

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
25	...	...	...	...	...	...
·5	...	...	. .	...	...	...
26	$10\frac{1}{4}$	...	...	...	...	...
·5	...	248	...	...	...	1
27	$\frac{5}{8}$	301	283·7	243– 339	...	4
·5	...	...	302·2	...	...	...
28	11	315	320·6	312– 319	...	2
·5	...	344·7	337·1	319– 368	...	3
29	$\frac{7}{16}$	351·7	344·1	326– 389	...	3
·5	...	336	351·9	311– 361	...	2
30	$\frac{13}{16}$	368	360·5	347– 396	13·0	3
·5	...	377·5	380·9	328– 432	...	4
31	$12\frac{3}{16}$	397·3	406·4	318– 481	...	6
·5	...	444·4	440·3	396– 552	...	5
32	$\frac{5}{8}$	478·4	471·0	411– 516	...	8
·5	...	490·2	495·3	474– 410	...	4
33	13	517·4	517·6	460– 552	...	5
·5	...	545·2	542	524– 580	...	4
34	$\frac{3}{8}$	...	562·9	...	...	...
·5	...	580·7	587·9	566– 595	...	3
35	$\frac{3}{4}$	...	622	...	...	...
·5	...	659·3	655	583– 729	23·3	3
36	$14\frac{3}{16}$	...	683	...	...	...
·5	...	708	720	701– 715	...	2
37	$\frac{9}{16}$	...	769	...	...	...
·5	...	830	824	821– 839	...	3
38	$\frac{15}{16}$	...	873	...	...	...
·5	...	...	...	...	...	...
39	$15\frac{3}{8}$	917	912	879– 962	...	4
·5	...	947	953	874– 984	...	4
40	$\frac{3}{4}$	995	978	935–1055	35·1	2
·5	...	991	1022	977–1005	...	2
41	$16\frac{1}{8}$	1079	1052	1019–1140	...	2
·5	...	1085	...	981–1189	...	2
42	$\frac{9}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
43	$\frac{15}{16}$	1169	...	1097–1281	41·3	7
·5	...	...	...	...	...	...
44	$17\frac{3}{8}$	...	...	...	...	...
·5	...	1373	...	...	...	1
45	$\frac{3}{4}$	...	...	...	...	...
·5	...	...	...	...	...	...
46	$18\frac{1}{8}$	1503	...	1451–1557	53·1	3
·5	...	...	...	...	...	...
47	$\frac{1}{2}$	...	...	...	...	...

BRILL—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	1565	...	...	...	1
48	$\frac{7}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
49	$19\frac{5}{16}$	1940	...	1699–2181	68·5	2
·5	...	...	...	...	...	...
50	$\frac{11}{16}$	...	...	...	...	...
·5	...	2145	...	...	...	1
51	$20\frac{1}{16}$	...	...	...	...	...
·5	...	2117	...	...	...	1
52	$\frac{7}{16}$	2145	...	...	...	1
·5	...	...	...	...	...	...
53	$\frac{7}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
54	$21\frac{1}{4}$	...	...	...	...	...
·5	...	...	...	...	...	...

HALIBUT.

In Cm.	In Inches.	Average.	Smoothed Average.	Range.	Average Weight in Ounces.	No. of Fish.
21	$8\frac{1}{4}$	...	...	...	...	...
·5	...	...	...	...	...	...
22	$\frac{11}{16}$	84	...	...	3·0	1
·5	...	...	...	...	...	...
23	$9\frac{1}{8}$	...	...	...	...	...
·5	...	...	113·5	...	...	...
24	$\frac{7}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
25	$\frac{7}{8}$	143	...	...	5·0	1
·5	...	...	148	...	...	...
26	$10\frac{1}{4}$	153	...	...	...	1
·5	...	...	169·2	...	...	...
27	$\frac{5}{8}$	...	...	...	...	...
·5	...	171	...	...	...	1
28	11	196	190·3	192–201	6·9	2
·5	...	204	...	...	...	1
29	$\frac{7}{16}$	...	238	...	...	...
·5	...	...	...	...	...	...
30	$\frac{13}{16}$	272	...	...	9·6	1
·5	...	...	...	...	...	...
31	$12\frac{3}{16}$	...	...	...	..	...
·5	...	...	...	...	...	...
32	$\frac{5}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
33	13	...	355·5	...	...	...
·5	...	...	...	...	...	...
34	$11\frac{3}{8}$	...	...	...	...	...

HALIBUT—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	...	...	...	...	...
35	$\frac{3}{4}$	439	...	...	15·5	1
·5	...	...	...	...	...	...
36	14$\frac{3}{16}$	...	502·5	...	...	...
·5	...	...	...	...	...	...
37	$\frac{9}{16}$	...	...	...	...	...
·5	...	...	...	...	...	..
38	$\frac{15}{16}$	566	...	...	19·9	1
·5	...	...	...	...	...	...
57	22$\frac{7}{16}$	...	...	...	...	...
·5	...	1820	...	...	67·8	1
58	$\frac{13}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
63	24$\frac{5}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
64	25	2350	...	...	83	1
·5	...	...	...	...	...	...
72	28$\frac{1}{8}$	...	...	...	...	...
·5	...	3811	...	...	...	1
73	$\frac{9}{16}$	...	4017	...	...	...
·5	...	...	...	...	...	...
74	$\frac{15}{16}$	4223	...	...	149·4	1
·5	...	...	...	...	...	...
75	29$\frac{5}{16}$	...	...	...	...	...
·5	...	...	4622	...	...	...
76	$\frac{7}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
77	...	...	...	...	...	...
·5	...	5022	...	...	177·3	1
78	30$\frac{3}{4}$	...	...	...	...	...
88	34$\frac{3}{4}$	...	...	...	...	...
·5	...	6754	...	...	..	1
89	...	...	7341	...	259·2	...
·5	...	7929	...	...	...	1
90	35$\frac{1}{2}$	...	...	...	...	1
·5	...	...	...	...	...	...
95	...	...	...	...	...	...
·5	...	9289	...	...	...	1
96	37$\frac{3}{4}$	...	9600	...	339	...
·5	...	9912	...	...	...	1
97	...	8552	...	...	...	1
·5	...	...	...	...	...	..
98	...	...	...	...	...	...
·5	...	9685	...	...	...	1
99	...	...	...	...	...	...

HALIBUT—*continued.*

Length. In Cm.	Length. In Inches.	Weight in Grammes. Average.	Weight in Grammes. Smoothed Average.	Weight in Grammes. Range.	Average Weight in Ounces.	No. of Fish.
·5	...	...	...	...	...	...
100	39⅛	...	...	...	372	1
·5	...	10534	10501	...	...	...
101	...	...	...	10478–11385	...	3
·5	...	9230	10468	...	...	1
102	40⅛	10591	...	...	...	1
·5	...	...	...	...	...	...
103	...	...	...	...	...	...
·5	...	...	12597	...	444·8	...
104	40⅞	...	...	...	...	...
·5	...	...	...	...	...	...
105	...	...	...	...	...	...
·5	...	14726	...	...	...	1
112	44⅛	...	...	...	...	...
·5	...	14839	...	...	524	1
113	...	...	...	...	...	...
119	...	...	...	...	...	...
·5	...	18271	...	17252–19291	...	2
120	47¼	20787	20152	...	...	1
·5	...	...	20399	...	...	...
121	...	20844	20979	...	736	1
·5	...	21693	21399	...	...	1
122	48	...	22090	...	...	...
·5	...	...	22288	...	...	...
123	...	22487	...	...	..	1
126	49¼	...	...	...	...	...
·5	...	28150	...	...	...	1
134	52⅜	25375	...	...	...	1
·5	...	...	27414	...	968	...
135	...	29453	...	...	...	1

LONG ROUGH DAB.

Length. In Cm.	Length. In Inches.	Weight in Grammes. Average.	Weight in Grammes. Smoothed Average.	Weight in Grammes. Range.	Average Weight in Ounces.	No. of Fish.
4	1$\frac{9}{16}$	·33	...	...	...	1
·5	...	·51	...	·49– ·53	...	2
5	2	...	...	...	...	...
·5	...	·97	...	·89– ·1	...	4
6	⅜	1·2	1·3	1·1 – 1·4	·04	5
·5	...	1·6	1·53	1·2 – 1·85	...	9
7	¾	1·86	1·93	1·7 – 2·0	...	15
·5	...	2·26	2·31	1·9 – 2·8	...	18
8	3⅛	2·76	2·68	2·4 – 3·1	·09	16

LONG ROUGH DAB—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	3·1	3·55	2·9 – 3·7	...	7
9	9/16	4·35	3·9	3·9 – 5·0	...	6
·5	...	4·8	4·97	4·1 – 6·0	...	11
10	15/16	5·6	5·7	4·6 – 6·8	·2	17
·5	...	6·6	6·5	5·4 – 7·8	...	20
11	4 15/16	7·3	7·85	5·6 – 8·6	...	20
·5	...	9·1	8·41	6·8 – 10·5	...	13
12	3/4	9·5	10·5	7·9 – 11·7	...	14
·5	...	11·9	11·6	9·9 – 13·6	...	14
13	5 1/8	13·8	13·3	12·9 – 15·6	...	11
·5	...	14·8	15·5	12·2 – 18·2	...	16
14	1/2	17·3	16·5	14·2 – 19·7	...	12
·5	...	18·2	20·0	17 – 20	...	5
15	7/8	22·8	21·6	18·3 – 24·9	·8	5
·5	...	25·0	25·3	23·7 – 26·4	...	9
16	6 5/16	27·9	27·2	25·4 – 33·1	...	7
·5	...	29·38	30·1	25·6 – 32·7	...	10
17	11/16	32·3	32·4	27·4 – 38	...	14
·5	...	35·2	35·9	32 – 39·2	...	5
18	7 1/8	39·5	40·4	34·7 – 47·4	1·4	9
·5	...	45·7	43·8	41·9 – 50·7	...	5
19	1/2	48·1	50·5	45 – 52·1	...	6
·5	...	55·3	53·7	42 – 58·5	...	8
20	7/8	59·4	58·5	56 – 61·4	2·1	4
·5	...	61·7	...	56·9 – 66·5	...	2
21	8 1/4	...	68·6	...	...	...
·5	...	77·8	74·2	...	...	1
22	11/16	86·8	83·6	81·4 – 96	...	5
·5	...	89·4	96·4	81·8 – 97	...	2
23	9 1/8	106·0	103·2	105 –107	...	2
·5	...	117	114·0	...	...	1
24	7/16	122	...	121 –123	4·3	2
·5	...	...	...	...	...	...
25	7/8	...	...	...	...	...
·5	...	...	...	...	...	...
26	10 1/4	168	...	...	5·9	1
·5	...	170	...	...	...	1
27	5/8	...	...	...	...	...
·5	...	...	...	...	...	...
28	11	...	...	...	...	...
·5	...	...	...	...	...	...
29	7/16	...	...	...	...	...
·5	...	...	...	...	...	...

WHITING.

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
6	$2\frac{3}{8}$	1·5	...	...	...	1
·5	...	...	...	...	...	...
7	$\frac{3}{4}$	...	..	...	...	...
·5	...	3·4	...	...	...	1
8	$3\frac{1}{8}$	...	...	...	...	...
·5	...	4·3	...	3·9 – 4·6	...	4
9	$\frac{9}{16}$	5·1	5·1	4·4 – 5·8	...	7
·5	...	6·0	5·8	5·4 – 6·4	...	12
10	$\frac{15}{16}$	7·4	7·1	6·8 – 8·8	·26	5
·5	...	8·0	8·2	7·3 – 8·5	...	8
11	$4\frac{5}{16}$	9·25	9·2	8·0 –11·12	...	6
·5	...	10·4	10·8	9·8 –10·9	...	8
12	$\frac{3}{4}$	12·8	12·4	11·4 –17·6	...	7
·5	...	·14·1	14·1	13 3 –15·4	...	7
13	$5\frac{1}{8}$	15·5	15·8	13·4 –17·5	...	11
·5	...	17·7	17·4	16·5 –20·2	...	11
14	$\frac{1}{2}$	19·0	19·3	17·1 –20·5	...	10
·5	...	21·1	21·1	17·6 –24	...	10
15	$\frac{7}{8}$	23·3	23·8	22 –27	.8	6
·5	...	27·0	26·6	24 –33·5	...	6
16	$6\frac{5}{16}$	29·6	29·3	26·5 –33·5	...	7
·5	...	31·4	32·2	29·5 –34·8	...	3
17	$\frac{11}{16}$	35·6	35·2	32 –38·5	...	4
·5	...	38·6	38·2	33 –44	...	5
18	$7\frac{1}{8}$	40·5	41·3	36·4 –47	...	8
·5	...	...	44·1	...	...	...
19	$\frac{1}{2}$	47·1	47·8	40·5 –52	...	5
·5	...	...	50·7	...	...	...
20	$\frac{7}{8}$	53·2	54·0	49·5 –58·6	1·5	5
·5	...	58·6	57·7	50·7 –71	...	4
21	$8\frac{1}{4}$	61·3	62·1	52 – 68·6	...	11
·5	...	66·5	67·3	66 – 67	...	2
22	$\frac{11}{16}$	74·1	72·7	64 – 85	...	9
·5	...	77·4	79·1	65 – 88	...	19
23	$9\frac{1}{8}$	85·7	85·6	72 – 95	...	14
·5	...	94·1	93·9	82 –101	...	19
24	$\frac{7}{16}$	102·4	102·4	83 –111	...	12
·5	...	110·6	110·6	101 –133	...	9
25	$\frac{7}{8}$	118	118·2	102 –134	4·2	15
·5	...	125·2	127·3	107 –149	...	14
26	$10\frac{1}{4}$	137·7	136·1	121 –158	...	10
·5	...	145·4	146·1	136 –157	...	9
27	$\frac{5}{8}$	155·1	157·6	154 –177	...	12
·5	...	172·4	168·1	148 –190	...	14
28	11	176·9	178·1	157 –213	...	14

WHITING—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	185·2	187·7	159 –205	...	6
29	$\frac{7}{16}$	191·0	193·8	165 –205	...	14
·5	...	205·1	202·2	199 –213	...	7
30	$\frac{13}{16}$	210·6	213·6	188 –228	7·6	11
·5	...	225	225	223 –255	...	7
31	$12\frac{3}{16}$	239·4	237	217 –276	...	13
·5	...	247	252·5	252 –273	...	9
32	$\frac{5}{8}$	271	264	242 –331	...	8
·5	...	274	272	256 –312	...	10
33	13	270	279	...	...	4
·5	...	293	292	263 –354	...	9
34	$\frac{3}{8}$	312	309	306 –361	...	6
·5	...	...	322	...	...	...
35	$\frac{3}{4}$	332	332	298 –411	12·0	8
·5	...	...	341	...	...	...
36	$14\frac{3}{16}$	351	357	...	...	...
·5	...	378	378	341 –432	...	8
37	$\frac{9}{16}$	...	...	...	...	...
·5	...	...	392	...	...	...
38	$\frac{15}{16}$	407	407	...	...	2
·5	...	430	428	400 –524	...	4
39	$15\frac{3}{8}$	446	462	404 –524	...	5
·5	—	509	504	474 –545	...	2
40	$\frac{3}{4}$	513	...	...	...	1
·5	...	538	542	...	...	1
41	$16\frac{1}{8}$	546	...	...	...	7
·5	...	...	586	..	...	...
42	$\frac{9}{16}$	...	...	...	...	...
·5	...	613	...	517 –680	...	4
43	$\frac{15}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
44	$17\frac{3}{8}$	569	...	...	...	1
·5	...	...	...	...	...	...
45	$\frac{2}{4}$	...	...	...	...	...
·5	...	...	...	...	...	...
46	$18\frac{1}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
47	$\frac{1}{2}$	903	...	...	...	1
·5	...	859	893	723 –977	...	3
48	$\frac{7}{8}$	984	...	...	...	1
·5	...	...	..	...	...	...
49	$19\frac{5}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...

HADDOCK.

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
6	$2\frac{3}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
7	$\frac{3}{4}$	...	...	...	...	...
·5	...	...	...	...	...	...
8	$3\frac{1}{8}$	...	...	...	...	...
·5	...	4·6	...	...	·16	1
9	$\frac{9}{16}$	...	5·3	...	...	...
·5	...	6·1	6·3	5·6 – 6·6	·22	5
10	$\frac{15}{16}$	7·2	7·8	7·0 – 7·4	·25	2
·5	...	9·1	8·8	8 – 9·8	...	8
11	$4\frac{5}{16}$	10·2	10·8	9·6 – 11·5	...	4
·5	...	12·0	11·9	11·1 – 12·7	...	12
12	$\frac{3}{4}$	13·5	13·6	12·1 – 14·5	...	9
·5	...	15·4	15·4	14·6 – 16·5	...	8
13	$5\frac{1}{8}$	17·2	17·6	16 – 18·2	...	10
·5	...	20·1	19·8	18·2 – 23·6	...	12
14	$\frac{1}{2}$	22·1	22·6	20 – 25·5	...	8
·5	...	25·5	25·2	22·9 – 31·2	...	17
15	$\frac{7}{8}$	28·0	28·3	24 – 30·3	·99	16
·5	...	31·4	31·0	29·8 – 35	...	16
16	$6\frac{5}{16}$	33·7	33·8	31·6 – 35·1	...	12
·5	...	36·3	36·6	32·3 – 40·3	...	16
17	$\frac{11}{16}$	39·8	39·7	36·6 – 43·5	...	21
·5	...	43·0	44·0	38 – 48·5	...	19
18	$7\frac{1}{8}$	49·2	48·3	44 – 53·5	...	22
·5	...	52·7	53·0	48·1 – 59	...	28
19	$\frac{1}{2}$	57·2	56·5	51·8 – 61	...	18
·5	...	59·7	61·4	55·2 – 68·3	...	13
20	$\frac{7}{8}$	67·4	65·7	64·2 – 73	2·4	11
·5	...	70·1	70·3	68·6 – 71	...	3
21	$8\frac{1}{4}$	73·3	75·4	72·4 – 76	...	6
·5	...	...	82·8	...	...	...
22	$\frac{11}{16}$	92·7	91·4	91·6 – 94·5	...	3
·5	...	98·8	97·4	90·5 –106·3	...	3
23	$9\frac{1}{8}$	100·7	102·6	96·5 –105	...	2
·5	...	108·3	109·3	99·5 –122·5	...	10
24	$\frac{7}{16}$	119·0	118·3	112 –127	...	3
·5	...	127·6	128·7	114·5 –135·6	...	7
25	$\frac{7}{8}$	142·5	140·2	126 –162	5·03	15
·5	...	150·5	150·2	131·6 –177	...	23
26	$10\frac{1}{4}$	157·5	157·3	138 –184	...	24
·5	...	164·0	165·6	148 –184	...	23
27	$\frac{3}{8}$	175·3	174·6	161–206	...	30
·5	...	184·4	184·1	162–206	...	19
28	11	192·7	194·9	176–219	...	17

HADDOCK—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	207·7	205·5	170–229	...	17
29	$\frac{7}{16}$	216·0	217·2	198–238	...	13
·5	...	227·8	228·4	207–267	...	14
30	$\frac{13}{16}$	241·4	243·3	213–269	8·5	18
·5	...	260·7	256·0	241–284	...	14
31	$12\frac{3}{16}$	265·8	271·7	238–304	...	9
·5	...	288·5	281·4	240–347	...	9
32	$\frac{5}{8}$	289·9	293·0	255–307	...	8
·5	...	300·6	305·1	247–347	...	19
33	13	324·8	319·0	276–368	...	13
·5	...	332·7	336·1	297–385	...	9
34	$\frac{3}{8}$	350·9	349·9	311–412	...	20
·5	...	366·2	367·2	325–432	...	15
35	$\frac{3}{4}$	384·5	381·0	318–432	13·6	12
·5	...	402·3	405·8	325–496	...	12
36	$14\frac{3}{16}$	430·7	425·2	361–517	...	14
·5	...	442·5	445·0	389–510	...	10
37	$\frac{9}{16}$	461·8	465·9	420–509	...	10
·5	...	493·3	485·9	432–588	...	12
8	$\frac{15}{16}$	502·5	515·6	417–559	...	12
·5	...	550·9	542·1	467–616	...	7
39	$15\frac{3}{8}$	572·8	571·6	523–637	...	5
·5	...	591	579·1	530–641	...	7
40	$\frac{3}{4}$	573·5	591·6	573–574	20·25	2
·5	...	610·3	604·9	523–696	...	11
41	$16\frac{1}{8}$	631	636·4	549–736	...	5
·5	...	667·9	681·2	566–782	...	10
42	$\frac{9}{16}$	...	698·8	...	...	...
·5	...	744·7	731·5	722–785	...	3
43	$\frac{15}{16}$	751·7	750·1	715–864	...	9
·5	...	754	767·9	750–759	...	2
44	$17\frac{3}{8}$	798	777·6	730–892	...	4
·5	...	780	802·3	715–850	...	4
45	$\frac{3}{4}$	...	828·2	...	29·2	...
·5	...	878	854·1	...	...	1
46	$18\frac{1}{8}$	856	873·8	...	...	1
·5	...	887	934·4	729–1027	...	3
47	$\frac{1}{2}$	1060	1013·5	870–1191	...	3
·5	...	...	1046	...	...	...
48	$\frac{7}{8}$	1033	1042	976–1090	...	2
·5	...	...	1048	...	...	...
49	$19\frac{5}{16}$	1063	1095	948–1182	...	4
·5	...	...	1117	...	...	...
50	$\frac{11}{16}$	...	1171	...	41·3	...
·5	...	...	...	...	...	...

HADDOCK—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
51	20 1/16	...	1205	...	...	...
·5	...	1212	1228	1076–1295	...	5
52	7/16	1338	1303	1281–1387	...	3
·5	...	...	1358	...	...	...
53	7/8	1379	...	1345–1451	...	5
·5	...	...	...	...	...	...
54	21 1/4	...	...	...	...	...
·5	...	...	...	...	...	...
55	5/8	...	...	...	...	...
·5	...	...	...	...	...	...
56	22 1/16	1440	...	1387–1501	50·8	3
·5	...	...	...	...	...	...
57	7/16	1628	...	...	...	1
·5	...	1635	...	...	...	1
58	13/16	...	...	...	...	...
·5	...	...	...	...	...	...
59	23 1/4	...	...	...	...	...
·5	...	1915	...	...	...	2
60	5/8	...	...	...	...	...
·5	...	...	...	...	...	...
61	24	...	...	...	...	...
·5	...	...	...	...	...	...
62	3/16	2110	...	...	...	1
·5	...	...	...	...	...	...
63	5/8	...	...	...	...	...
·5	...	...	...	...	...	...
64	25	...	...	...	...	...
.5	...	...	...	...	...	...
65	3/8	...	...	...	...	...
·5	...	3214	...	..	113	1
66	3/4	...	...	...	...	...
·5	...	...	...	...	...	...
67	26 3/16	...	...	...	...	...
·5	...	...	...	...	...	...
68	9/16	...	...	...	...	...
·5	...	...	...	...	...	...
69	15/16	...	...	...	...	...
·5	...	...	...	...	...	...
70	27 3/8	...	...	...	...	...
·5	...	...	...	...	...	...
71	3/4	...	...	...	...	...
·5	...	...	...	...	...	...
72	28 1/8	...	...	...	...	...
·5	...	...	...	...	...	...
73	9/16	...	...	...	...	...

HADDOCK—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	...	...	...	...	...
74	15/16	3691	...	3002–4290	...	3
·5	...	...	...	...	...	...
75	29 5/16	...	...	...	...	...

COD.

In Cm.	In Inches.	Average.	Smoothed Average.	Range.	Average Weight in Ounces.	No. of Fish.
2	13/16	...	...	...	...	...
·5	...	·11	...	...	...	1
3	1 3/16	·18	...	...	...	1
·5	...	·37	...	...	...	1
4	9/16	·65	...	·63– ·67	...	2
·5	...	...	...	...	...	...
5	2	1·04	...	1·01 1·07	...	2
·5	...	...	...	...	...	...
6	3/8	...	...	...	...	...
·5	...	...	...	...	...	...
7	3/4	...	...	...	...	...
·5	...	...	...	...	...	...
8	3 1/8	4·4	...	4·3 – 4·4	...	3
·5	...	4·65	5·01	4·6 – 4·7	...	2
9	9/16	6·0	5·78	5·4 – 6·8	...	4
·5	...	6·7	6·83	6·2 – 7·6	...	8
10	15/16	7·8	7·93	7·1 – 8·9	0·3	7
·5	...	9·3	9·47	8·4 – 10·2	...	4
11	4 5/16	11·3	11·10	10·3 – 11·9	...	12
·5	...	12·7	13·1	11·7 – 13·5	...	9
12	3/4	15·2	15·0	14·3 – 16·5	...	5
·5	...	17·1	17·3	16·2 – 17·8	...	11
13	5 1/8	19·7	19·7	16·8 – 20·7	...	9
·5	...	21·3	21·8	19 – 22·4	...	11
14	1/2	24·6	24·6	21 – 29	...	7
·5	...	27·8	27·8	24·6 – 30·6	..	10
15	7/8	31·1	30·7	30 – 31·6	1·1	4
·5	..	33·3	34·0	30·2 – 35·5	...	4
16	6 5/16	37·6	37·5	34 – 40·5	..	4
·5	...	41·7	41·2	40·5 – 43	..	2
17	11/16	44·4	45·4	40·4 – 47·8	..	5
·5	...	50·0	49·3	45·6 – 54·5	..	2
18	7 1/8	53·5	54·0	50 – 56	..	3
·5	...	58·5	57·9	58 – 59	...	2
19	1/2	61·7	62·9	59·4 – 64	...	2
·5	...	68·5	66·8	68 – 69	...	2

COD—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
20	$\frac{7}{8}$	70·1	71·1	66·5 – 73·8	2.5	2
·5	...	74·6	75·9	...	...	1
21	$8\frac{1}{4}$	83	83·0	83 – 83	...	2
·5	...	...	90·2	...	...	...
22	$\frac{11}{16}$	...	97·4	...	...	...
·5	...	...	103·5	...	...	...
23	$9\frac{1}{8}$	111·8	110·7	105–119·3	...	3
·5	...	...	116·8	...	...	...
24	$\frac{7}{16}$	121·8	123·1	...	...	1
·5	...	135·6	135·1	...	...	1
25	$\frac{7}{8}$	...	146·5	...	5.2	...
·5	...	157·8	158·3	...	...	6
26	$10\frac{1}{4}$	170·6	169·1	149–184	...	4
·5	...	179	179	175–184	...	2
27	$\frac{5}{8}$	...	189	...	...	...
·5	...	187·7	198·5	177–198	...	4
28	11	218·8	210·7	194–248	...	7
·5	...	209	217·8	191–219	...	3
29	$\frac{7}{16}$	225·5	231·8	219–232	...	2
·5	...	261	252·5	233–284	...	9
30	$\frac{13}{16}$	271·5	271·8	255–304	9·6	6
·5	...	...	283	...	...	...
31	$12\frac{3}{16}$	296	294·1	278–311	...	5
·5	...	303·5	306·1	297–313	...	4
32	$\frac{5}{8}$	319	324·1	290–333	...	6
·5	...	349·8	350·4	318–389	..	5
33	13	382	366·9	368–396	...	2
·5	...	...	380·7	...	...	...
34	$13\frac{3}{8}$	394·5	392·9	382–404	...	4
·5	...	403·5	410	382–425	...	2
35	$\frac{3}{4}$	...	420	...	14·8	...
·5	...	...	432	...	...	...
36	$14\frac{}{16}$	429·7	441·9	396–456	...	4
·5	...	...	462·2	...	...	...
37	$\frac{9}{16}$	494·7	482·9	466–516	...	4
·5	...	491·8	493·5	467–538	...	6
38	$\frac{15}{16}$	494	520·8	460–528	...	2
·5	...	576 5	547·8	573–580	...	2
39	$15\frac{3}{8}$	573	585·8	...	...	1
·5	...	608	599·2	...	...	1
40	$\frac{3}{4}$	616·7	614·3	595–637	21·8	2
·5	...	618·2	620·6	536–680	...	4
41	$16\frac{1}{8}$	592·5	641·2	581–604	...	2
·5	...	675·5	658·5	615–736	...	2
42	$\frac{9}{16}$	658·7	671·1	581–779	...	3

COD—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	679	700·4	...	...	1
43	$\frac{15}{16}$	...	763·4	...	...	...
·5	...	864	820·8	...	...	1
44	$17\frac{3}{8}$	835	859·4	...	...	1
·5	...	...	879·3	...	...	...
45	$\frac{3}{4}$	920·4	906·6	843–963	32·5	5
·5	...	920	938	...	...	1
46	$18\frac{1}{8}$	973	965	941–1005	...	2
·5	...	1002	968	...	...	1
47	$\frac{1}{2}$	963	986	...	...	1
·5	...	1026	1005	991–1062	...	2
48	$\frac{7}{8}$	1004	1013	963–1097	...	3
·5	...	1010	1044	935–1100	...	7
49	$19\frac{5}{16}$	1117	1080	1068–	...	7
·5	...	...	1113	...	...	...
50	$\frac{11}{16}$	1114	1139	1054–1175	39·3	2
·5	...	1189	1182	...	...	1
51	$20\frac{1}{16}$	1243	1232	1232–1254	...	2
·5	...	1265	1295	1246–1281	...	3
52	$\frac{7}{16}$	1378	1346	1253–1572	...	3
·5	...	1395	1373	1303–1536	...	3
53	$\frac{7}{8}$	1347	1374	1274–1451	...	3
·5	...	1381	1405	1345–1402	...	4
54	$21\frac{1}{4}$	1486	1466	1416–1557	...	2
·5	...	...	1532	...	...	...
55	$\frac{5}{8}$	1702	1608	1670–1734	60	2
·5	...	1589	1660	1458–1826	...	7
56	$22\frac{1}{16}$	1689	1646	1451–1820	...	4
·5	...	1661	1680	1494–1791	...	4
57	$\frac{7}{16}$	1691	1719	...	...	1
·5	...	1805	1792	1805–1805	...	2
58	$\frac{13}{16}$	1880	1865	1763–1997	...	2
·5	...	...	1910	...	...	...
59	$23\frac{1}{4}$	1964	1940	1798–2209	...	4
·5	...	...	2020	...	...	...
60	$\frac{5}{8}$	2108	2057	2025–2224	74·4	3
·5	...	2043	2088	1812–2293	...	4
61	24	2113	2129	2004–2290	...	3
·5	...	2231	2174	...	...	1
62	$\frac{3}{16}$	...	2177	...	...	...
·5	...	2124	2207	2004–2208	...	4
63	$\frac{5}{8}$	...	2357	...	...	...
·5	...	...	...	...	...	...
64	25	2524	2499	2259–2790	...	2
·5	...	2517	2528	2400–2761	...	4

COD—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
65	$\frac{3}{8}$	...	2569	...	90·7	...
·5	...	2588	2598	2153–2838	...	3
66	$25\frac{3}{4}$	2638	2680	...	...	...
·5	...	...	2744	2471–2818	...	3
67	$26\frac{3}{16}$	2914	2878	2740–3151	..	4
·5	...	...	2975	...	...	...
68	$\frac{9}{16}$	3037	3027	2945–3144	...	4
·5	...	...	3069	...	...	...
69	$\frac{15}{16}$	3101	3116	...	...	1
·5	...	3179	3233	3038–3384	...	3
70	$27\frac{3}{8}$	3420	3380	...	120·7	1
·5	...	...	3488	...	...	...
71	$\frac{3}{4}$	3557	3581	3413–3639	...	3
·5	...	...	3697	...	...	...
72	$28\frac{1}{8}$	3738	3865	...	...	1
·5	...	4161	...	3646–4418	...	4
73	$\frac{9}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
74	$\frac{15}{16}$	...	..	...	...	...
·5	...	4074	...	3951–4149	...	3
75	$29\frac{5}{16}$	4000	...	3823–4178	141	2
·5	...	...	...	...	...	...
76	...	...	...	...	...	...
·5	...	...	...	...	...	...
77	...	4602	...	4276–4928	...	2
·5	...	...	...	...	...	...
78	...	...	...	...	...	...
·5	...	...	...	...	...	...
79	...	4985	...	4312–5607	...	7
·5	...	...	...	...	...	...
80	...	...	...	...	...	...
·5	...	...	...	...	...	...
81	...	...	...	...	...	...
·5	...	5501	...	4027–6542	...	3
82	...	...	...	...	...	...
·5	...	6514	...	...	230	1
83	...	...	...	...	...	...
·5	...	...	...	..	...	...
84	...	...	...	...	...	...
·5	...	6655	...	6202–7193	...	3
85	...	...	...	...	...	...
·5	...	...	...	...	...	...
86	...	...	...	...	...	...
·5	...	6542	...	6485–6599	...	2
87	...	...	...	...	...	...

COD—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	6806	...	6287–7816	...	4
88	...	...	...	...	...	...
·5	...	7558	...	7045–8071	...	2
89	...	...	...	...	...	...
·5	...	7208	...	6061–8581	...	5
90	...	...	...	...	...	...
·5	...	7866	...	6797–8935	278	3
91	...	...	...	...	...	...
·5	...	...	...	...	...	...
92	...	...	...	...	...	...
·5	...	...	...	...	...	...
93	...	8347	...	7944–8836	...	4
·5	...	...	...	...	...	...
94	...	9144	...	8440–10025	...	4
·5	...	...	...	...	...	...
95	...	...	...	...	...	...
·5	...	...	...	...	...	...
96	...	8776	...	7590–10053	...	4
·5	...	...	...	...	...	...
97	...	...	...	...	...	...
·5	...	9424	...	9134–9713	...	2
98	...	...	...	...	...	...
·5	...	9702	...	8156–10642	...	5
99	...	...	...	...	...	...
·5	...	...	...	...	...	..
100	...	10194	...	8326–11455	360	5
·5	...	9942	...	9318–10253	...	3
101	...	10506	...	9742–11753	...	3
·5	...	...	...	...	...	...
102	...	10947	...	9914–11420	...	4
·5	...	11158	...	...	...	1
103	...	10936	...	10181–11899	...	5
·5	...	...	...	...	...	...
104	...	11361	...	10082–12489	...	3
·5	...	...	...	...	...	...
105	...	...	...	...	...	...
·5	...	11300	...	...	...	1
106	...	12141	...	10930–13410	429	5
·5	...	11328	...	...	...	1
107	...	...	...	...	...	...
·5	...	...	...	...	...	...
108	...	12239	...	10404–14075	...	2
·5	...	...	...	...	...	...
109	...	...	...	...	...	...
·5	...	..	...	...	...	...

COD—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average	Range.		
110	...	...	...	...	...	...
·5	...	...	...	...	...	...
111	...	...	...	...	...	...
·5	...	...	...	...	...	...
112	...	...	...	...	...	...
·5	...	...	...	...	...	...
THE NORWAY POUT.						
3	$1\frac{3}{8}$	·315	...	·29– ·34	...	2
·5	...	...	...	...	...	...
4	$1\frac{9}{16}$	...	...	...	...	...
·5	...	...	...	...	...	...
5	2	...	...	...	...	...
·5	...	...	...	...	...	...
6	$\frac{3}{8}$	...	...	...	...	...
·5	...	...	...	...	...	...
7	$\frac{3}{4}$	2·5	...	...	·09	1
·5	...	2·9	2·84	...	...	1
8	$3\frac{1}{8}$	3·13	3·19	...	...	1
·5	...	3·55	3·75	3·2 – 3·8	...	4
9	$\frac{9}{16}$	4·58	4·56	3·2 – 5·3	...	13
·5	...	5·55	5·49	4·7 – 6·4	...	13
10	$\frac{15}{16}$	6·35	6·69	5·5 – 7·0	·2	11
·5	...	7·18	7·38	5·3 – 8·7	...	19
11	$4\frac{5}{16}$	8·6	8·10	7·3 – 9·6	...	14
·5	...	9·7	9·7	7·3 –10·9	...	17
12	$\frac{3}{4}$	10·8	10·87	10·3 –11·8	·3	9
·5	...	12·1	12·41	10·9 –12·9	...	7
13	$5\frac{1}{8}$	14·34	13·81	12·7 –15·2	...	5
·5	...	15	15·81	12·4 –17·2	...	11
14	$\frac{1}{2}$	18·1	17·87	17·2 –19·2	...	8
·5	...	20·5	20·57	17·8 –26·5	...	14
15	$\frac{7}{8}$	23·1	23·5	18·0 –28·2	·8	15
·5	...	27·0	26·27	23·6 –20·9	...	10
16	$6\frac{5}{16}$	28·7	29·1	23·1 –31·7	...	16
·5	...	31·5	31·8	28·7 –35·8	...	7
17	$\frac{11}{16}$	35·1	34·98	38 –38·4	...	3
·5	...	38·34	37·9	35·7 –41·4	...	5
18	$7\frac{1}{8}$	40·3	41·2	33·3 –47·0	1·4	5
·5	...	44·9	44·6	...	...	1
19	$\frac{1}{2}$	48·7	50·3	47·4 –50·1	...	2
·6	...	57·2	...	572· –57·3	...	2
19·8	...	60·0	...	...	2·1	1
20·2	...	67·1	...	...	...	1

GURNARD.

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
4	1 9/16	...	...	...	...	...
·5	...	·71	...	·65– ·77	...	2
5	2	...	·48	...	...	...
·5	...	1·25	1·13	1·2 – 1·3	·04	2
6	3/8	...	1·65	...	...	...
·5	...	2·05	2·19	...	...	1
7	3/4	2·87	2·64	2·75– 3·0	...	2
·5	...	3·0	3·27	2·9 – 3·1	...	2
8	3 1/8	3·93	...	3·6 – 4·2	...	3
·5	...	...	...	...	...	...
9	9/16	...	...	...	...	...
·5	...	5·93	...	5·6 – 6·6	...	3
10	15/16	6·3	6·97	...	·2	1
·5	...	8·7	8·3	...	...	1
11	5/16	10·0	9·87	...	...	1
·5	...	10·9	...	10·2 – 12·0	·38	3
12	3/4	...	...	...	...	...
·5	...	...	...	...	...	...
13	5 1/8	..	...	...	...	...
·5	...	...	...	...	...	...
14	1/2	...	...	...	...	...
·5	...	...	...	...	...	...
15	7/8	...	...	...	...	...
·5	...	...	...	...	...	...
16	6 15/16	...	...	...	...	...
·5	...	...	...	...	...	...
17	11/16	...	...	...	...	...
·5	...	49·3	...	44 – 54	1·7	3
18	7 1/8	..	...	...	...	...
·5	...	...	...	...	...	...
19	1/2	61	...	...	...	1
·5	...	...	...	...	...	...
20	7/8	...	...	...	...	...
·5	...	...	...	...	...	...
21	8 1/4	82	...	...	...	1
·5	...	85	83·3	85 – 85	3·0	2
22	11/16	83·5	85·8	79 – 88	...	2
·5	...	...	89	...	...	...
23	9 1/8	95	93	...	...	1
·5	...	95	101	...	...	1
24	7/16	113·5	112	107 –120	...	2
·5	...	...	124	...	...	...
25	7/8	135	132	...	4·7	1
·5	...	...	138	...	...	...
26	10 1/4	141	...	132 –148	...	3

GURNARD—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	…	…	157·7	…	…	…
27	$\frac{5}{8}$	…	…	…	…	…
·5	…	174·7	…	163 –183	…	3
28	11	…	177·1	…	…	…
·5	…	179·6	…	170 –186	…	5
29	$\frac{7}{16}$	…	…	..	…	…
·5	…	…	…	…	…	…
30	$\frac{13}{16}$	227·0	…	205 –255	8·0	5
·5	…	237	235	…	…	1
31	$12\frac{3}{16}$	241	249	…	…	1
·5	…	…	269	…	…	…
32	$\frac{5}{8}$	297	289·7	…	…	1
·5	…	…	303	…	…	…
33	13	309	312	285 –333	…	2
·5	…	324·3	…	307 –361	11·4	5
34	$\frac{3}{8}$	…	…	…	…	…
·5	…	…	…	…	…	…
35	$\frac{3}{4}$	…	…	…	…	…
·5	…	…	…	…	…	…
36	$14\frac{3}{16}$	337	…	…	…	1
·5	…	…	..	…	…	…
37	$\frac{9}{16}$	…	..	…	…	…
·5	…	…	…	…	…	…
38	$\frac{15}{16}$	…	…	…	…	…
·5	…	…	…	…	…	…
39	$15\frac{3}{8}$	…	…	…	…	…
·5	…	…	…	…	…	…
40	$\frac{3}{4}$	…	…	…	…	…
·5	…	…	…	…	…	…
41	$16\frac{1}{8}$	573	…	…	20·2	1
·5	…	…	…	…	…	…
42	$\frac{9}{16}$	…	…	…	…	…
·5	…	…	…	…	…	…
HERRING.						
1·86	$\frac{3}{4}$	0·0131	…	…	…	48
2·91	$1\frac{1}{8}$	0·0582	..	…	…	14
4·3	$1\frac{11}{16}$	·32	…	·31– ·34	·01	4
4·8	$1\frac{7}{8}$	·42	..	·38– ·47	…	11
8·0	$3\frac{1}{8}$	2·98	…	2·7 – 3·2	·1	5
·5	…	3·8	3·63	3·5 – 4·0	…	3
9	$\frac{9}{16}$	4·1	4·27	3·4 – 4·9	…	8
·5	…	4·9	4·97	4·4 – 5·5	…	11
10	$\frac{15}{16}$	5·9	5·90	5·3 – 7·1	·2	5

HERRING—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	6·9	7·0	6·0 – 8·2	...	9
11	4 5/16	8·2	8·2	7·6 – 9·4	...	11
·5	...	9·5	9·4	8·4 – 11·4	...	23
12	3/4	10·9	10·6	9·5 – 12	...	12
·5	...	11·9	12·1	10·2 – 13	...	21
13	5 1/8	14·0	13·8	13· – 14·7	...	9
·5	...	15·6	15·8	15 – 15·9	...	6
14	1/2	17·9	17·7	16·2 – 18	...	9
·5	...	19·5	19·9	18·6 – 20·7	...	6
15	7/8	22·4	23·4	21·8 – 22·8	·7	9
·5	...	28·4	26·0	...	...	1
16	6 5/16	27·3	29·1	26 – 28	...	3
·5	...	31·5	30·8	30 – 33	...	4
17	11/16	33·6	34·1	31 – 35	...	7
·5	...	37·1	36·8	36 – 38·7	...	6
18	7 1/8	39·6	40·3	37 – 42·5	...	10
·5	...	43·2	43·4	38 – 47	...	14
19	1/2	47·3	47·5	44 – 52	...	7
·5	...	52·1	51·1	49·5 – 57	...	6
20	7/8	53·9	55·1	52·8 – 55	1·9	2
·5	...	59·3	60·0	57·1 – 63·2	...	5
21	8 1/4	66·7	66·9	60·8 – 72·6	...	4
·5	...	74·8	75·9	72 – 85	...	5
22	11/16	86·3	81·5	83 – 89	...	3
·5	...	...	88·4	...	...	...
23	9 1/8	91·5	94·2	82 –101	...	4
·5	...	101·2	98·8	93 –113	...	8
24	7/16	103·6	106·1	85·5 –114	...	11
·5	...	113·6	110·8	108 –117	...	7
25	7/8	115·2	119·8	113 –118	4·0	4
·5	...	130·5	126·3	120 –143	...	6
26	10 1/4	133·3	136·2	118 –160	...	17
·5	...	144·8	143·9	126 –168	...	17
27	5/8	153·7	153·9	141 –186	...	22
·5	...	163·2	163·3	151 –188	...	11
28	11	172·9	174·0	149 –195	...	14
·5	...	185·9	185·2	158 –213	...	16
29	7/16	196·9	194·8	185 –218	...	8
·5	...	201·7	208·8	178 –212	...	12
30	13/16	227·9	219·5	188 –253	8·0	12
·5	1	...	229·4	...	...	...
31	12 3/16	236·7	236·8	204 –280	...	7
·5	...	244·3	248·0	228 –259	...	3
32	5/8	263	...	260 –266	9·3	2

SPRAT.

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm.	In Inches.	Average.	Smoothed Average.	Range.		
4	$1\frac{9}{16}$	...	...	...	...	...
·5	$1\frac{3}{4}$	·50	...	...	...	1
5	2	·67	·67	·63– ·75	·02	8
·5	...	·84	·88	·7 – 1·0	...	28
6	$\frac{3}{8}$	1·14	1·17	·92– 1·3	·04	20
·5	...	1·53	1·57	1·1 – 2	...	15
7	$\frac{3}{4}$	2·04	2·02	1·6 – 2·3	·07	21
·5	...	2·48	2·59	2·0 – 2·8	...	33
8	$3\frac{1}{8}$	2·90	3·05	2·4 – 3·6	...	38
·5	...	3·76	3·72	3·3 – 4·3	...	14
9	$\frac{9}{16}$	4·59	4·63	3·8 – 5·3	...	11
·5	...	5·53	5·56	4·9 – 6·5	...	14
10	$\frac{15}{16}$	6·55	6·76	5·5 – 8	·23	12
·5	...	8·2	8·08	7·1 – 9·2	...	20
11	$4\frac{5}{16}$	9·5	9·48	7·8 –11·8	...	27
·5	...	10·75	10·86	9·7 –12·9	...	28
12	$\frac{3}{4}$	12·34	12·46	10·8 –14·2	·4	33
·5	...	14·27	14·34	12·2 –15·4	...	15
13	$5\frac{1}{8}$	16·4	...	...	...	1

LUMPENUS.

15	$5\frac{7}{8}$	...	...	...	...	...
·5	...	4·4	...	...	·15	1
16	$6\frac{5}{16}$	...	...	...	...	...
·5	...	5·0	..	...	...	1
17	$\frac{11}{16}$	5·17	5·32	4·2 – 6	...	3
·5	...	5·8	5·91	...	...	1
18	$7\frac{1}{8}$	...	6·41	...	...	...
·5	...	7·17	6·86	...	...	3
19	$\frac{1}{2}$	7·25	7·5	7·2 – 7·3	...	2
·5	...	8·1	7·65	7·4 – 8·7	...	3
20	$\frac{7}{8}$	7·6	8·07	7·5 – 7·6	·27	2
·5	...	8·5	8·7	...	...	1
21	$8\frac{1}{4}$	...	9·38	...	...	...
·5	...	9·9	10·09	8·8 – 10·7	...	6
22	$\frac{11}{16}$	10·45	10·68	10·4 – 10·5	...	2
·5	...	11·7	11·45	10·4 – 13·1	...	2
23	$9\frac{1}{8}$	12·2	12·45	10·3 – 14·7	...	5
·5	...	13·4	12·93	12·3 – 13·8	...	4
24	$\frac{7}{16}$	13·2	13·77	12·8 – 13·7	...	2
·5	...	14·7	...	13·8 – 15·6	·52	2
25	$\frac{7}{8}$	...	...	...	...	...

LUMPENUS—*continued.*

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm	In Inches.	Average.	Smoothed Average.	Range.		
·5	...	...	...	...	...	...
26	10¼	16·2	...	...	...	1
·5	...	...	..	...	...	...
27	⅝	...	...	...	...	...
·5	...	...	...	...	...	...
28	11	20·2	...	18 – 22·4	·71	2
·5	...	...	...	...	...	...
29	7/16	...	...	...	...	...
·5	...	...	...	...	...	...
30	...	...	...	...	...	...

POGGE.

Length.		Weight in Grammes.			Average Weight in Ounces.	No. of Fish.
In Cm	In Inches.	Average.	Smoothed Average.	Range.		
5	...	...	...	...	...	...
·5	...	...	...	...	...	...
6	...	...	...	...	...	...
·5	...	...	...	...	...	...
7	...	...	...	...	...	...
·5	...	...	...	...	...	...
8	3⅛	3·72	...	3·42– 3·93	·13	6
·5	...	4·5	4·47	3·93– 4·94	...	12
9	9/16	5·2	5·46	4·45– 5·83	...	12
·5	...	6·48	6·34	5·15– 6 85	...	14
10	15/16	7·34	7·36	6·88– 7·66	·26	3
·5	...	8·25	8·74	7·87– 8·64	...	2
11	4 5/16	10·62	10·55	...	...	1
·5	...	12·77	12·30	...	...	1
12	¾	13 52	13·80	12·71–14·63	·48	4
·5	...	15·12	15·38	15 –15·25	...	2
13	5⅛	...	17·51	...	...	...
·5	...	21·27	19·64	...	·75	1
14	½	20·13	...	..	...	1
·5	...	...	...	...	...	...
15	⅞	...	...	...	...	...

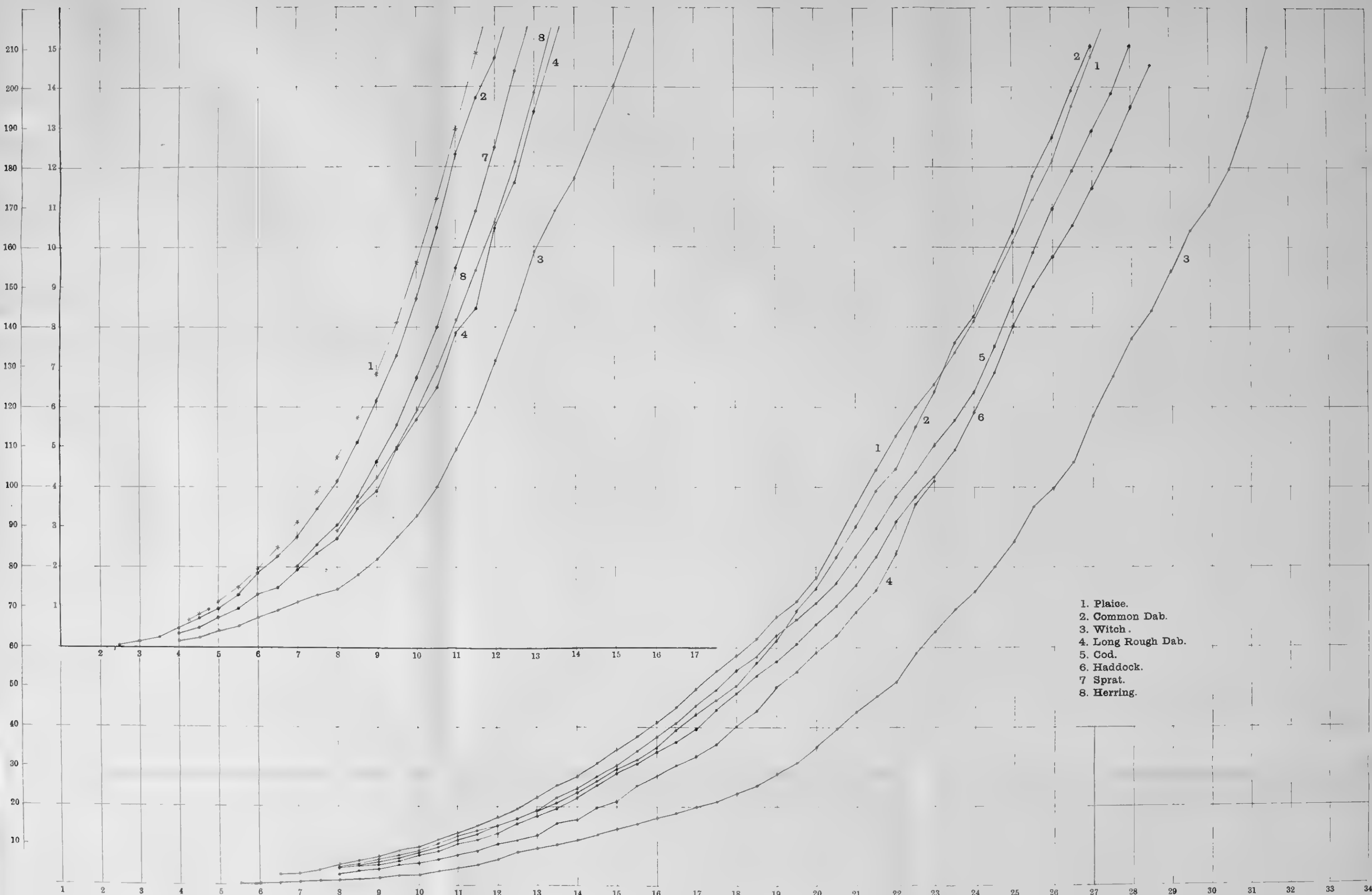
PLAICE.

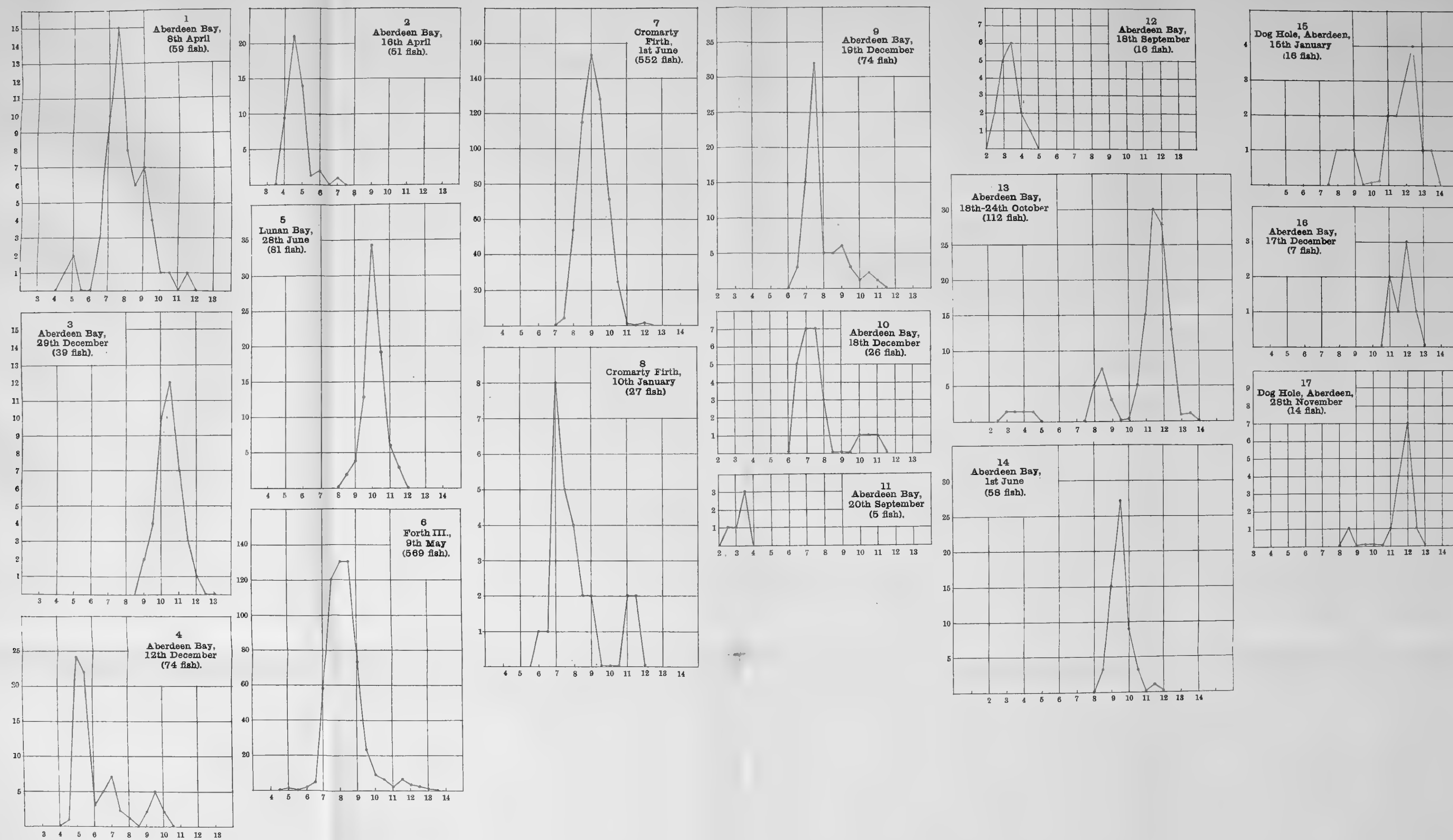
SHOWING THE CALCULATED WEIGHT AT VARIOUS SIZES.

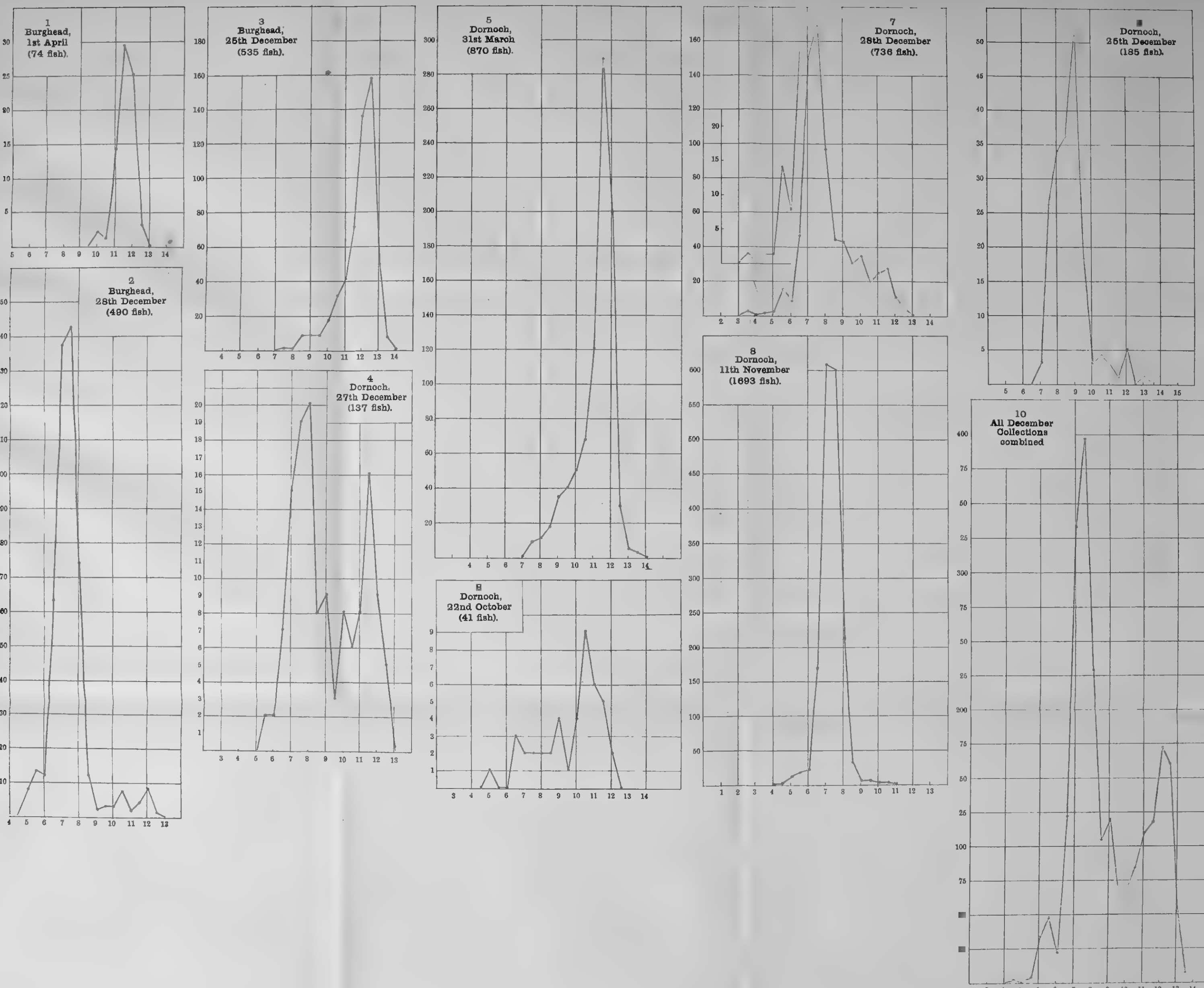
Length in *Centimetres.*	Weight in *Grammes.*	Length in *Centimetres.*	Weight in *Grammes.*
1	·009	36	435·632
2	·075	37	472·947
3	·252	38	512·336
4	·598	39	553·861
5	1·167	40	597·500
6	2·017	41	643·515
7	3·252	42	702·346
8	4·78	43	742·357
9	6·807	44	795·360
10	9·338	45	850·838
11	12·428	46	908·824
12	16·134	47	969·398
13	20·513	48	1032·600
14	26·013	49	1115·295
15	31·509	50	1167·200
16	38·240	51	1238·436
17	45·868	52	1312·856
18	54·454	53	1390·065
19	64·042	54	1470·249
20	74·700	55	1553·443
21	87·793	56	1648·160
22	99·420	57	1729·147
23	113·603	58	1821·760
24	129·075	59	1917·624
25	145·900	60	2016·792
26	164·107	61	2119·322
27	183·781	62	2225·269
28	208·102	63	2370·411
29	227·720	64	2447·360
30	252·072	65	2564·174
31	278·159	66	2684·344
32	305·920	67	2808·225
33	335·543	68	2935·552
34	366·944	69	3068·281
35	406·450	70	3251·592


Common Dab.
Flounder
Gurnard.
Turbot
Brill
Lemon Dab.
Witch.
Whiting.
Haddock
Plaice
Cod
Sprat
Herring
Norway Pout.

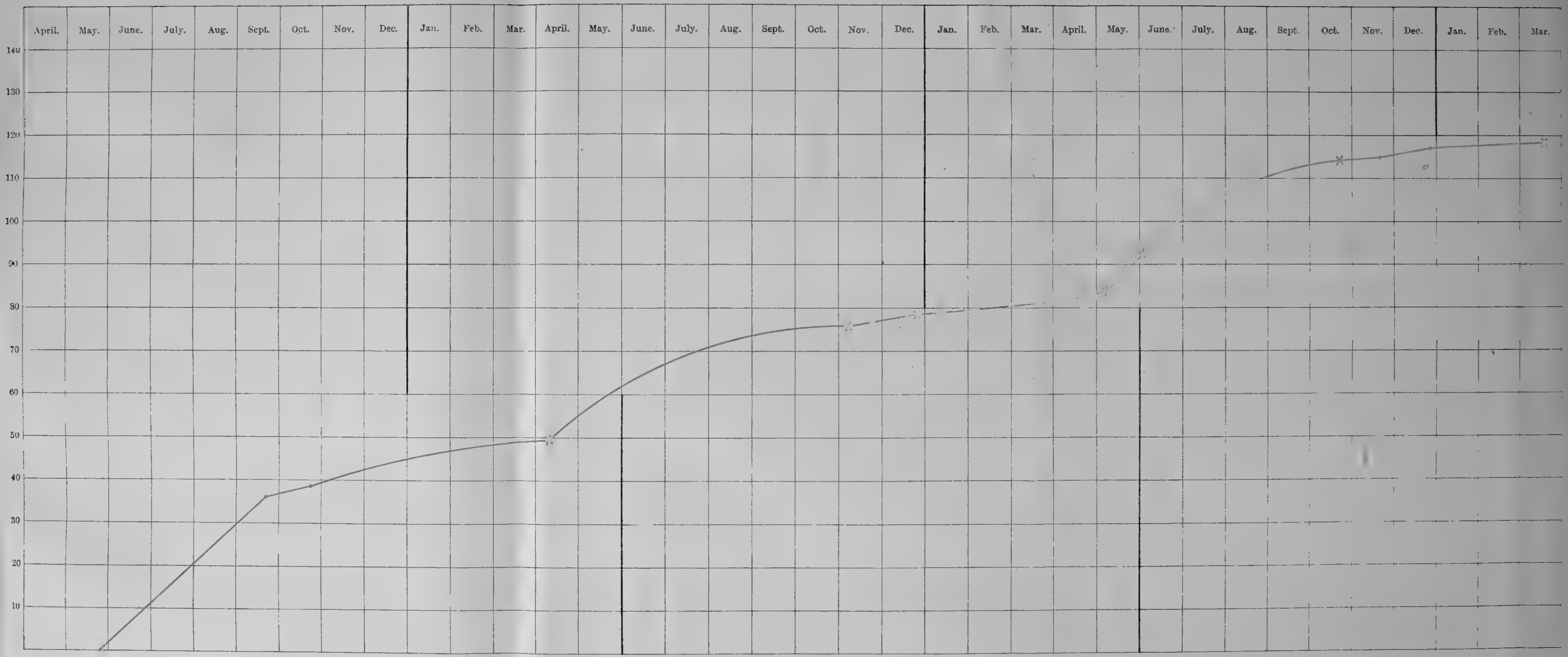
PLATE VII.

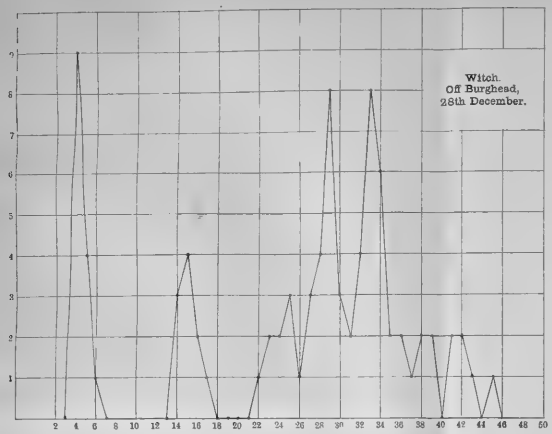

1. Plaice.
2. Common Dab.
3. Witch.
4. Long Rough Dab.
5. Cod.
6. Haddock.
7 Sprat.
8. Herring.

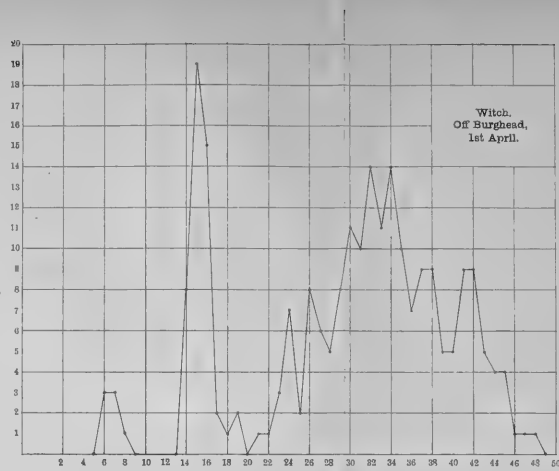

1
Aberdeen Bay,
8th April
(59 fish).
2
Aberdeen Bay,
16th April
(51 fish).
3
Aberdeen Bay,
29th December
(39 fish).
4
Aberdeen Bay,
12th December
(74 fish).
5
Lunan Bay,
28th June
(81 fish).
6
Forth III.,
9th May
(569 fish).
7
Cromarty
Firth,
1st June
(552 fish).
8
Cromarty Firth,
10th January
(27 fish)
9
Aberdeen Bay,
19th December
(74 fish)
10
Aberdeen Bay,
18th December
(26 fish).
11
Aberdeen Bay,
20th September
(5 fish).
12
Aberdeen Bay,
18th September
(16 fish).
13
Aberdeen Bay,
18th-24th October
(112 fish).
14
Aberdeen Bay,
1st June
(58 fish).
15
Dog Hole, Aberdeen,
15th January
(16 fish).
16
Aberdeen Bay,
17th December
(7 fish).
17
Dog Hole, Aberdeen,
28th November
(14 fish).

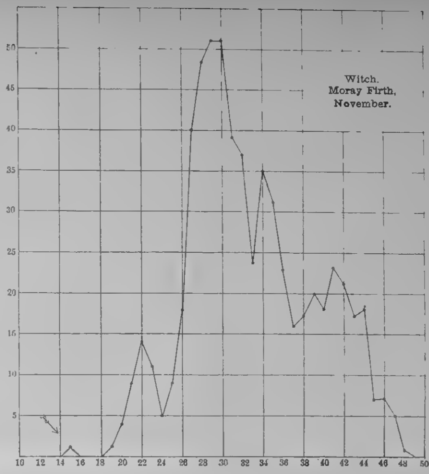

1 Burghead, 1st April (74 fish).
2 Burghead, 28th December (490 fish).
3 Burghead, 25th December (535 fish).
4 Dornoch, 27th December (137 fish).
5 Dornoch, 31st March (870 fish).
Dornoch, 22nd October (41 fish).
7 Dornoch, 28th December (736 fish).
8 Dornoch, 11th November (1693 fish).
Dornoch, 25th December (185 fish).
10 All December Collections combined

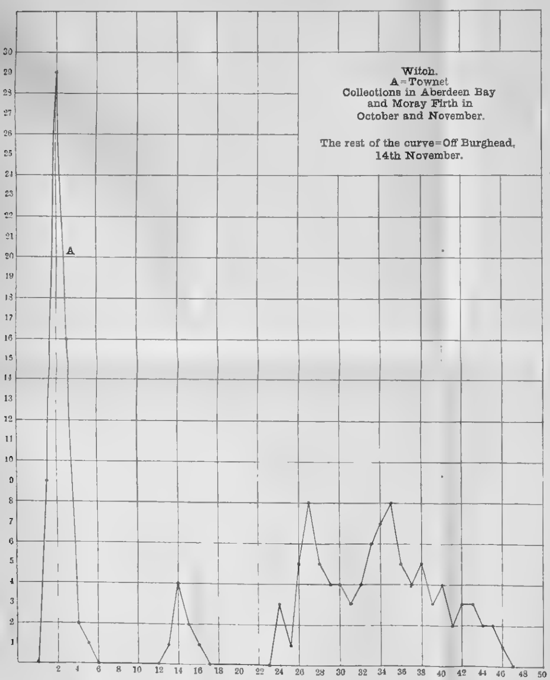
SPRAT

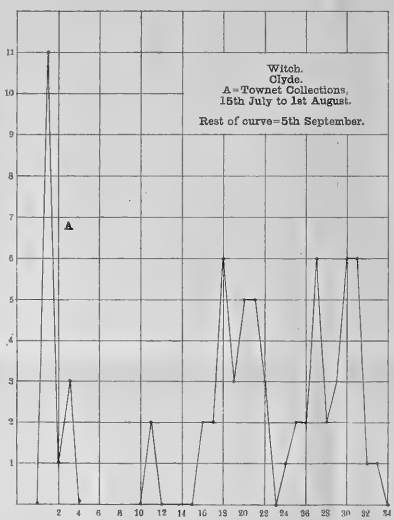

April. May. June. July. Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. April. May. June. July. Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. April. May. June. July. Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar.
140
130
120
110
100
90
80
70
60
50
40
30
20
10


Witch.
Off Burghead,
28th December.


Witch.
Off Burghead,
1st April.


Witch.
Moray Firth,
November.


Witch.
A = Townet
Collections in Aberdeen Bay
and Moray Firth in
October and November.
The rest of the curve = Off Burghead,
14th November.
A


Witch.
Clyde.
A = Townet Collections,
15th July to 1st August.
Rest of curve = 5th September.
A

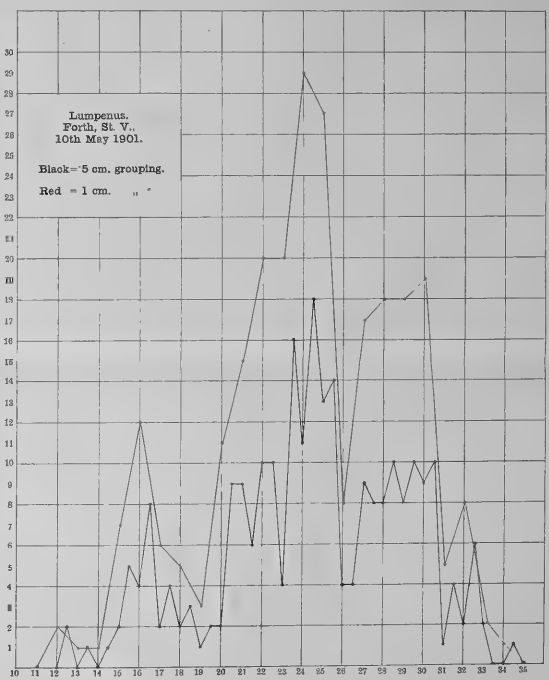
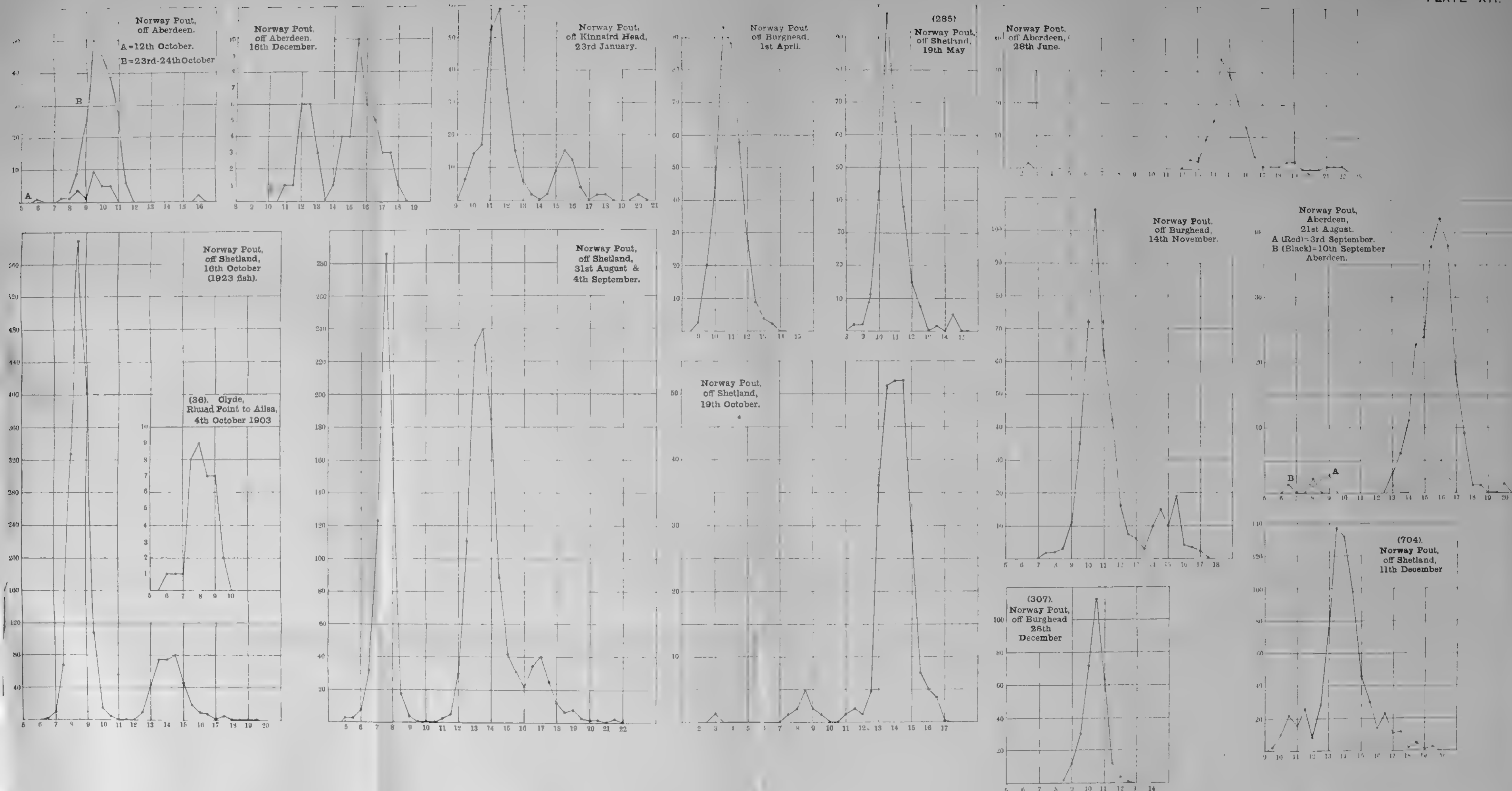

Lumpenus.
Forth, St. V.,
10th May 1901.
Black = ·5 cm. grouping.
Red = 1 cm. " "

PLATE XII.


Norway Pout, off Aberdeen.
A = 12th October.
B = 23rd-24th October
Norway Pout, off Aberdeen. 16th December.
Norway Pout, off Kinnaird Head, 23rd January.
Norway Pout, off Burghead. 1st April.
(285) Norway Pout, off Shetland, 19th May
Norway Pout, off Aberdeen, 28th June.
Norway Pout, off Shetland, 16th October (1923 fish).
(36). Clyde, Rhuad Point to Ailsa, 4th October 1903
Norway Pout, off Shetland, 31st August & 4th September.
Norway Pout, off Shetland, 19th October.
Norway Pout, off Burghead, 14th November.
Norway Pout, Aberdeen, 21st August.
A (Red) = 3rd September.
B (Black) = 10th September Aberdeen.
(307). Norway Pout, off Burghead 28th December
(704). Norway Pout, off Shetland, 11th December

HADDOCK.

SHOWING THE CALCULATED WEIGHT AT VARIOUS SIZES.

Length in *Centimetres.*	Weight in *Grammes.*	Length in *Centimetres.*	Weight in *Grammes.*
1	·008	36	367·200
2	·063	37	398·639
3	·213	38	431·846
4	·504	39	467·023
5	·984	40	503·733
6	1·700	41	542·408
7	2·700	42	583·073
8	4·030	43	625·720
9	5·738	44	670·449
10	7·870	45	717·188
11	10·476	46	766·034
12	13·600	47	817·087
13	17·297	48	870·400
14	22·566	49	914·465
15	26·563	50	983·800
16	32·239	51	1043·963
17	38·665	52	1107·018
18	45·900	53	1171·662
19	53·980	54	1239·300
20	62·967	55	1309·470
21	72·884	56	1444·332
22	83·806	57	1457·468
23	95·754	58	1535·531
24	108·800	59	1616·333
25	122·974	60	1700·000
26	138·377	61	1786·340
27	154·913	62	1875·641
28	180·529	63	1967·870
29	191·941	64	2063·290
30	212·500	65	2162·144
31	234·455	66	2262·764
32	257·911	67	2367·005
33	282·846	68	2474·580
34	309·322	69	2585·366
35	337·440	70	2699·524

IV.—NOTES ON SOME RARE AND INTERESTING MARINE CRUSTACEA.

By THOMAS SCOTT, LL.D., F.L.S.

(Plates XIII.-XV)

CONTENTS.

PRELIMINARY REMARKS.

In the following notes I have described a number of minute Crustaceans belonging to the Monstrillidæ and the Choniostomatidæ—two families of Copepoda containing aberrant and parasitic forms of more than usual interest. A few forms belonging to other groups more or less rare in the Scottish seas are also recorded here.

The species recorded here belonging to the Monstrillidæ are as follows:—

Monstrilla grandis, Giesbrecht.
,, *longicornis*, I. C. Thompson.
,, *gracilicauda*, Giesbrecht.
,, *anglica*, Lubbock.
,, *dubia*, T. Scott, sp. n.
Thaumaleus thompsoni, Giesbrecht.
,, *rigidus* (I. C. Thompson).
,, *zetlandicus*, T. Scott, sp. n.
,, *rostratus*, T. Scott, sp. n.

The following are the names of the seven species belonging to the Choniostomatidæ which are also described :—

Stenothocheres egregius, Hansen, new to British Fauna.
Sphæronella paradoxa, Hansen, ,, ,, ,,
,, *minuta*, T. Scott, sp. n.
,, *callisomæ*, T. Scott, sp. n.
,, *cluthæ*, T. Scott, sp. n.
,, *pygmæa*, T. Scott, sp. n.
,, *amphilochi*, Hansen.

A description is furnished of each of the species mentioned above, and this is illustrated by drawings which have been prepared by my son, Mr. A. Scott, A.L.S., who also prepared most of the dissections required. The preparing of these dissections was in some cases rendered more difficult when the species happened to be represented by only a single specimen whose appendages were not very obvious even with a moderately high magnification.

Some moderately rare species of Amphipoda and Sympoda are recorded at the end of the paper, the names of which are as follows:—

Hyperia medusarum (O. F. Muller).
Tryphana malmi, Boeck.
Anonyx nugax (Phipps).
Hoplonyx cicada (Fabr.).
Harpinia pectinata, G. O. Sars.
Metopa borealis, G. O. Sars.
Paratylus falcatus (Metzger).
Megaluropus agilis, Norman
Idothea neglecta, G. O. Sars.
Eudorellopsis deformis, Kryöer.
Pseudocuma similis, G. O. Sars.

The following are the descriptions of the various species referred to:—

COPEPODA.

Fam. Monstrillidæ

Genus *Monstrilla*, Dana, 1848.

Monstrilla grandis, Giesbrecht. Pl. xiii., fig. 11, 12; pl. xiv., fig. 9–11; pl. xv., fig. 1, 2.

1892. *Monstrilla grandis*, Giesb., Pelag. Copep. des Golfes v. Neapel, p. 588, pl. 46, fig. 2, 8, 11, 17, 19, 24, 25, 35, 39.

Description of the Female:—In this species the antennules of the female, which are moderately stout, are scarcely equal to one-fourth the length of the animal; their structure is somewhat similar to that of the antennules of *M. gracilicauda*, but the articulations are rather more distinct (fig. 9, pl. xiv.).

The fifth pair of thoracic feet are sub-cylindrical, about twice as long as broad, and with a somewhat bi-lobed extremity (fig. 10, pl. xiv.); the exterior lobe bears three setæ, the inner one is small but the other two are elongated. The inner lobe appears to be furnished with only a single apical seta, but our dissection shows what appears to be the base of a seta on the inner margin of this lobe, the seta itself having probably been broken off; the position of this seta is indicated on the drawing by dotted lines.

The abdomen consists of three segments, but the first, which is larger than the next two combined, is divided into two portions by a pseudo-articulation as shown by the drawing (fig. 11, pl. xiii., and fig. 11, pl. xiv.); the second and third segments are sub-equal and are together much smaller than the first segment.

The furcal joints are each provided with six setæ, one being situated on the outer edge near the base of the joint while the others spring from the apex (fig. 11, pl. xiv.); one of the apical setæ near the inner edge is very small.

The female represented by the drawing (fig. 11, pl. xiii.) measures 4·25 mm. (about $\frac{1}{6}$ of an inch).

Description of the Male:—The male is much smaller than the female; the specimen represented by the drawing (fig. 12, pl. xiii.) measures only 2 mm. ($\frac{2}{25}$ of an inch).

The antennules of the male, which are proportionally rather longer than those of the female, are five-jointed, the last joint being hinged to the preceding one (fig. 1, pl. xv.).

The first and second segments of the male abdomen are not coalescent as in the female, but otherwise the two sexes are nearly alike.

The armature of the furcal joints (fig. 2, pl. xv.) is similar to that of the female.

The fifth pair of feet resemble very closely the fifth pair of the male of *M. longiremis.*

Habitat.—Head of Loch Fyne (Firth of Clyde), November 28, 1899, one female, and January 30, 1901, a male and a female.

Professor G. S. Brady records a *Monstrilla*, obtained at Cullercoats in July, 1900, which he thinks may be the male of *M. grandis*, Giesbrecht,* and I. C. Thompson mentions the occurrence of the same species in the vicinity of the Channel Islands.†

Monstrilla longicornis, I. C. Thompson. Pl. xiii., fig. 1–7.

1890. *Monstrilla longicornis*, I. C. Thompson, Trans. L'pool. Biol. Soc., vol. iv., p. 119, pl. iv., figs. 1, 2, and 4 (♂).
1892. *Monstrilla longiremis*, Giesb., Pelagischen Copepoden des Golfes von Neapel, p. 589, pl. 46, figs. 10, 14, 22, 37, and 41 (♀).
1902. *Monstrilla longiremis*, T. Scott, 20th Rept. Fishery Board for Scotland, pt. iii., p. 469, pl. xxv., figs. 3 and 4 (♀).

The antennules in both the female and male are elongated and slender, being in some examples nearly half as long as the cephalothorax and abdomen combined; but their length seems to vary to some extent in different individuals, and those of the male appear to be proportionally rather longer than in the female. The male antennules are composed of six joints, and the articulation between the fifth and sixth is so hinged that the sixth joint can be folded inwards; the second and last joints are of nearly equal length and considerably longer than any of the others (fig. 6). In the female antennules all the joints except the first appear to be coalescent, so that each antennule is apparently only two-jointed (fig. 3).

The fifth thoracic feet of the female consist each of a sub-cylindrical plate, but the proximal half of the leg is rather wider than the lower half and is defined from it by a distinct notch on the inner margin, and from this notch there springs a moderately long seta; three other setæ spring from the distal extremity of the leg, but the innermost one is short while the other two are elongated; all the setæ appear to be more or less plumose (fig. 4).

The fifth feet of the male are somewhat rudimentary, each being represented by a single moderately long plumose seta which springs from a small tubercle near the lower ventral margin of the last thoracic segment. The genital appendages are narrow and spiniform (fig. 7).

The furcal joints in the female are each furnished with five moderately long setæ, but there are only four setæ to each of the furcal joints in the male. This appears to be the only British species of *Monstrilla* in which the number of furcal setæ in the female is five.

The male of *Monstrilla longicornis* does not appear to have been previously recorded except by I. C. Thompson.

* *Nat. Hist. Trans. Northumb., Durham, and Newcastle*, vol. xiv., p. 64, pl. iv., fig. 1–3.
† *Journ. Marine Zool. and Microscopy*, vol. ii., p. 97 (No. 8, December, 1897).

The following are the localities whence I have obtained this species and the dates when the different specimens were collected :—

Firth of Forth, between Fidra and the Bass Rock, October 18, 1890 (♀).
Firth of Forth, east of Inchkeith, August 14, 1891 (♀ & ♂).
Firth of Forth (locality not stated), 1893 (♀ & ♂).
Firth of Forth, Station V. (to the west of May Island), August 30, 1894 (♀ & ♂).
Firth of Forth, Station V., July 24, 1901 (♀).
Firth of Tay, at Buddon, December 5, 1902 (♀).
Thirty-five miles east of May Island (per s.s. "Glenogle," of Aberdeen), August 20, 1903 (♀ & ♂).
Off Aberdeen about ten miles, November 11, 1901 (♀).
Firth of Clyde, off the Ayrshire coast, November (date not stated), 1895 (♀).
Firth of Clyde, head of Loch Fyne, December 11, 1897 (♀).
Firth of Clyde, Whitefarland Bay, Arran, July 6, 1899 (♂).
Solway Firth, Luce Bay (per Andrew Scott), November 26, 1901 (♀).
Larne Harbour, Ireland (per Andrew Scott), January 14, 1904.

The female represented by the drawing (fig. 1) measured 3·1 mm., which is similar to the size given by Dr. Giesbrecht; the length of the male which the drawing represents (fig. 2) is 2 mm.

One or two of the more obvious characters by which *M. longicornis* may be distinguished from other forms are the long and somewhat slender antennules, the form and armature of the fifth pair of thoracic feet, and the number of the furcal setæ. The structure of the abdomen appears also to differ to some extent from the other species of *Monstrilla* recorded here.

It may be remarked further that the integument in this species when examined with the microscope and under a moderately high power is seen to have a granular appearance not observed in other species (*see* the drawings, figs .1 and 2).

That I. C. Thompson's *Monstrilla longicornis* is identical with *M. longiremis*, Giesbrecht, must, I think, be admitted. The long antennules, the granular appearance of the integument, the number of furcal setæ, and the structure of the abdomen show that it can be nothing else, and as Thompson's name was published two years before that of Dr. Giesbrecht it must be restored. Thompson does not appear to have seen the female or Dr. Giesbrecht the male of this species.

Monstrilla gracilicauda, Giesbrecht. Pl. xiii., fig. 8–10; pl. xiv., fig. 15.

1892. *Monstrilla gracilicauda*, Giesb., op. cit., p. 587, pl. 46, figs. 9, 16, 18, 29, 32, 43.

In the female of *Monstrilla gracilicauda* the antennules are rather shorter than in the species just described. They appear to be four-jointed, the first three being small, while the end joint is equal to the entire length of the other three (fig. 8, pl. xiii.).

The fifth pair of thoracic feet (fig. 15, pl. xiv.) are sub-quadrate in outline, rather longer than broad, and somewhat gibbous at the distal end as shown in the drawing; each foot is furnished with three plumose setæ, one on the outer aspect and two at the apex, the feathering is very delicate and can only be seen by using a moderately high magnification.

The abdomen consists of four segments, the first segment, which appears to consist of two coalescent segments, is of a sub-cylindrical form but tapers slightly towards the distal extremity; it is about one-third longer than the breadth at the widest part and nearly twice the entire length of the next segments. The third segment is only about half the length of the second one.

The furcal joints are each provided with six setæ arranged as shown in the drawing (fig. 10, pl. xiii.), but one of the setæ is very small.

The length of the specimen represented by the drawing is 3·1 mm., which is somewhat larger than that stated by Dr. Giesbrecht. No males of this species have been observed hitherto.

M. gracilicauda has been collected at the following places :—

Firth of Forth, above Queensferry, June 26, 1890 (♀).
Firth of Forth, off Musselburgh, September 29, 1892 (♀).
*35 miles east of May Island, Firth of Forth (per s.s. "Glenogle"), August 20, 1903 (♀).
Firth of Clyde, Whitefarland Bay, Arran, July 6, 1899 (♀).
Firth of Clyde, near head of Loch Fyne, November 28, 1899 (♀).

Monstrilla anglica, Lubbock. Pl. xiii., fig. 13; pl. xiv., fig. 12–14.

1857. *Monstrilla anglica*, Lubbock. Ann. and Mag. Nat. Hist. (2), vol. xx., p. 409, pl. x., fig. 7, 8.
1900. *Monstrilla* (?) *danæ*, Scott, 18th Ann. Rept. Fishery Board for Scotland, pt. iii., p. 398, pl. xiii., fig. 15–20.

Description of the Female.—The specimen represented by the drawing measures 3·2 mm. (nearly $\frac{1}{8}$ of an inch); it has a general resemblance in size and structure to *Monstrilla longicornis*, but is scarcely so robust (fig. 13, pl. xiii.).

The antennules are elongated and slender and indistinctly three-jointed; the basal joint is as usual very short; the next, which is not very clearly defined, is also small, but longer than the basal joint; the remaining portion consists of a single piece which may be made up of two or three coalescent joints (fig. 12, pl. xiv.).

The fifth pair of thoracic feet are sub-cylindrical in outline, and nearly twice as long as broad; each foot is furnished with two elongated apical setæ, and the inner margin, which is nearly straight and shorter than the outer margin, terminates in a small rounded process, beyond which the distal portion of the foot becomes narrower as shown in the drawing (fig. 13, pl. xiv.).

The genital filaments are scarcely equal in length to the furcal setæ.

The abdomen appears to consist of three segments; the first segment is about twice the length of the second, while the second is about one and a half times the length of the third.

The furcal joints are each furnished with six setæ (fig. 14, pl. xiv.).

Habitat.—Firth of Forth, west of May Island, July 26, 1901; thirty-five miles east of May Island, August 20, 1903, per s.s. "Glenogle." Females only were observed in both gatherings.

This species resembles *M. longicornis* in size, in the elongate antennules, and to some extent in the structure of the abdomen, but differs very distinctly in the armature of the fifth pair of thoracic feet, and in possessing six instead of five furcal setæ; and the integument appears to want the minutely granulated structure observed in *M. longicornis*.

The specimens recorded by me in Part III. of the Eighteenth Annual Report of the Fishery Board for Scotland from the Firth of Clyde appear to belong to Lubbock's *Monstrilla anglica*; these specimens were

* This specimen was of a fine green colour.

apparently imperfect as regards the furcal hairs, and no doubt helped to disguise their relationship with the species named. Having now obtained specimens in fairly good condition, I am enabled to give a few accurate figures of the female which may be of interest as supplementing Dr. Bourne's very fine drawings of the male. (*See* the Quarterly Journ. of Micros. Science, vol. xxx., pt. 4, new series, Feb. 1890.)

Monstrilla dubia, T. Scott, sp. n. Pl. xiii., fig. 14; pl. xiv., fig. 16–18.

Description of the Female.—Body moderately slender; length of the specimen represented by the drawing is 3·3 mm. (fully $\frac{1}{8}$ of an inch). The cephalothoracic segment is about one and a half times the entire length of the remaining thoracic segments and abdomen.

The abdomen is composed of three segments; the first segment is about equal in size to the last segment of the thorax, the second is smaller than the next, while the second and third are together scarcely as long as the first segment (fig. 14, pl. xiv.).

The antennules are moderately stout and about half as long as the cephalothoracic segment, and composed of four joints; the first and third joints are small, the second is about half as long again as the third, while the fourth is equal to the entire length of the three joints (fig. 16, pl. xiv.)

The fifth pair of thoracic feet are moderately slender; each foot is narrow and sub-cylindrical at the proximal end, but becomes wider distally and terminates in two lobes; the outer lobe is larger than the inner and is furnished with three moderately long setæ, the inner lobe is narrow and appears to be devoid of setæ as shown in the drawing (fig. 17, pl. xiv.).

The furcal joints are each provided with four elongated hairs, one of them springs from near the base of the outer margin, two spring from the apex, while the fourth is attached on the inner aspect and near the middle of the joint, as seen in the drawing (fig. 18, pl. xiv.).

Habitat.—Firth of Forth, east of Inchkeith, August 14, 1891; and head of Loch Fyne (Firth of Clyde), November 11, 1897, and November 28, 1899. No males have been observed.

Remarks.—The Copepod of which I have just given a description does not agree with any described species known to me. The characters by which it may be distinguished are the following three: first, the structure of the abdomen, the first segment of which is as large as the segment of the thorax next to it; second, the peculiar form of the fifth pair of thoracic feet; and, third, the number and arrangement of the furcal setæ.

Monstrilla dubia as described and figured here has a somewhat close resemblance to the female of *M. danæ* as represented by the beautiful drawings of Professor Claparède,* and especially by figure 3, taf. xvi., which shows the female from the under side; the proportional lengths of the abdominal and of the posterior thoracic segments are almost identical, but the furcal joints are represented with only three setæ; there is also a slight difference in the length of the second joint of the antennules. Had a separate drawing of the fifth pair of thoracic feet of the female been given by that author the identification of the species would have been rendered more certain.

* Beobachtungen uber Anatomie und Entwicklungsgeschichte wirbelloser thier an der küste von Normandie, Angestellt, p. 95, taf. xvi., fig. 1–6 (1863).

Genus *Thaumaleus* Kröyer, 1849.

Thaumaleus thomsoni, Giesb. Pl. xiv., fig. 1–4.

1892. *Thaumaleus thomsoni,* Giesb., Pelag. Copep. des Golfes v. Neapel, p. 584, pl. 46, fig. 7, 27, 31, 36, 40.
1902. *Thaumaleus thompsoni,* Scott, 20th Ann. Rept. Fishery Board for Scotland, pt. iii., p. 470, pl. xxv., fig. 5, 6.

In Part III. of the Twentieth Annual Report of the Fishery Board for Scotland, I published a description with figures of the male of *Thaumaleus thompsoni* taken in Lerwick Harbour, Shetland. Recently, when examining a small collection of *Monstrillas* that had been captured from time to time during the past twelve or fifteen years, I found a single female of the same species that had been taken in a tow-net sample collected off Scarborough on July 9, 1893, during some investigations on behalf of the Fishery Board for Scotland; this specimen I will now briefly describe, and illustrate the description with figures showing a few of its more characteristic features.

The specimen referred to was elongated and very slender, and measured 4·8 mm. in length (about $\frac{1}{5}$ of an inch). The cephalothoracic segment was about equal to twice the entire length of the remaining segments of the thorax and abdomen combined (fig. 1, pl. xiv.).

The antennules are short and stout, and appear to consist of four joints; but the third, which is small, seems to be partly coalescent with the second (fig. 2, pl. xiv.).

The fifth pair of thoracic feet are moderately large, foliaceous, and are abruptly wider at the distal extremity, the result of a lobe-like process on the inner distal aspect; each foot carries three apical setæ, the innermost of which is considerably shorter than the other two, as shown in the drawing (fig. 3, pl. xiv.).

The abdomen consists of two segments; the first is fully half as long as the last segment of the thorax, and larger and more dilated than the second segment. The short furcal joints carry three moderately elongated setæ (fig. 4, pl. xiv.).

The structure of the fifth pair of thoracic feet, and the form of the abdomen referred to above, seem to be characteristic of this species.

Thaumaleus rigidus (I. C. Thompson). Pl. xiii., fig. 15–17; pl. xiv, fig. 19.

1888. *Cymbasoma rigida,* I. C. Thompson. Linn. Soc. Journ. Zool., vol. xx., p. 154, pl. xiii., fig. 1–4.
1890. *Monstrilla rigida,* Bourne. Quart. Journ. Micros. Science, vol. xxx., pl. xxxvii., fig. 8, 11, 12.
1892. *Thaumaleus claparèdii,* Giesb., op. cit., pp. 381–385, taf. 46, fig. 5, 15, 21, 26.

Description of the Female.—Length of the specimen represented by the drawing (fig. 15, pl. xiii.), 2·7 mm. ($\frac{1}{9}$ of an inch). The cephalothorax is moderately stout, rather wider near the anterior end, and nearly twice as long as the entire length of the remaining segments. The abdomen is composed of two segments; the first is about one and a half times the length of the last segment of the thorax, and the proximal half is more or less dilated; the second segment, which is smaller than the first, is probably composed of two coalescent segments, as a slight constriction, dividing the segment into two portions as shown by the drawing (fig. 15, pl. xiii., and fig. 19, pl. xiv.), is observable in all the specimens examined.

The antennules are short and stout and appear to be four-jointed, the first and third joints being very small (fig. 16, pl. xiii.).

The fifth pair of thoracic feet are rather longer than broad, the terminal portion being distinctly small and wider than the proximal half; each foot carries three moderately long apical setæ, as shown in the drawing (fig. 17, pl. xiii.).

The furcal joints, which are of moderate length, are each furnished with three setæ (fig. 19, pl. xiv.).

Habitat.—Mauchrie Bay, Arran, Firth of Clyde, September 17, 1886. St. Andrews Bay, August 7, and off St. Monans, Firth of Forth, September 6, 1890. Dornoch Firth (Moray Firth district), July 30, 1895. Whitefarland Bay, Arran, Firth of Clyde, July 6, and between Arran and the Ayrshire coast, November 9, 1899. All the specimens obtained were females.

Remarks.—I have adopted I. C. Thompson's name for this form in preference to that of Dr. Giesbrecht, as I am convinced, after examining a number of individuals and comparing them with the descriptions and figures of Thompson and Bourne, that *Thaumaleus rigidus* (I. C. Thompson) and *T. claparèdii* are identical. The antennules of the female in both are short and stout, and although Thompson's figure indicates a greater number of articulations than is observed in *T. claparèdii*, this may be due perhaps to certain constrictions having been mistaken for joints; but what I rely on chiefly is the structure of the abdomen and the form and armature of the fifth pair of thoracic legs of the female, which, so far as they are represented by both Thompson's and Bourne's figures, are practically the same as the similar parts of *T. claparèdii* represented by the drawings of Dr. Giesbrecht.

Thaumaleus zetlandicus, T. Scott, sp. n. l. xiii., fig. 18, 19; pl. xiv., fig. 20–22; pl. xv., fig. 3, 4.

Description of the Female.—Body moderately stout and elongated; length of the specimen represented by the drawing (fig. 18, pl. ii.), 4·8 mm. (nearly $\frac{1}{5}$ of an inch). The cephalothoracic segment is about one and a half times the entire length of the remaining segments of the thorax and abdomen.

The abdomen is composed of three segments; the first segment is distinctly larger than the last segment of the thorax and about twice the entire length of the next two abdominal segments; these two segments are sub-equal, but the second is slightly the longer of the two (fig. 22, pl. xiv.).

The antennules, which are short and moderately stout, are composed of four joints; the first and third joints are smaller than the others, while the end joint is about equal to the entire length of the other three (fig. 20, pl. xiv.).

The fifth pair of thoracic feet are short and broadly foliaceous and terminate in two broad rounded sub-equal lobes, the outer one of which is provided with three moderately long setæ; the inner lobes do not appear to carry any setæ (fig. 21, pl. xiv.).

A male belonging apparently to the same species as the female described above is considerably smaller than it, and the cephalothoracic segment is only slightly longer than the combined lengths of the other thoracic segments (fig. 19, pl. xiii.). The length of this male, which is represented by the drawing just referred to, is 2·6 mm. (or nearly $\frac{1}{10}$ of an inch). The antennules are five-jointed and longer than those of the female (fig. 3, pl. xv.); the abdomen appears to consist of four segments, the first two are sub-equal and are each distinctly smaller than the last segment of the thorax, while the last two are together only a little longer than the preceding segment. The number of furcal hairs is the same as in the female (fig. 2, pl. xv.).

Habitat.—Lerwick Harbour, Shetland, October 15, 1901.

Remarks.—The more obvious characters by which this species may be distinguished are: the structure and lengths of the female antennules, the three-segmented abdomen, together with the proportional difference in the size of the first segment with the preceding segment of the thorax and the other two abdominal segments; and lastly, the peculiar form of the fifth pair of thoracic feet, as indicated by the various figures.

Thaumaleus rostratus, T. Scott, sp. n. Pl. xiv., fig. 5–8.

Description of the Female.—The length of the specimen represented by the drawing (fig. 5) is 3·9 mm. (about $\frac{2}{13}$ of an inch); the first cephalothoracic segment is moderately stout, tapering gradually in front into a blunt pointed rostrum; while posteriorly the body becomes gradually narrower towards the distal extremity (fig. 5, pl. xiv.).

The abdomen is composed of three segments; the first segment is as large as the next two together, but the second is very small.

Each of the furcal joints is provided with three setæ of moderate lengths, arranged as shown in the drawing (fig. 8, pl. xiv.).

Antennules short and moderately stout, four-jointed and sparingly setiferous; the first and third joints are small, the second is about one and a half times the length of the third, while the last is equal to the entire length of the other three joints (fig. 6, pl. xiv.).

The fifth pair of thoracic feet are short and foliaceous, and each terminates in two unequal lobes; the outer lobe, which is narrower than the inner and projects somewhat beyond it, is furnished with three moderately long setæ; the inner lobe is broadly rounded and provided with a single seta (fig. 7, pl. xiv.).

Habitat.—Lerwick Harbour, Shetland, October 15, 1901. Three or four specimens were obtained, all of which were females.

Remarks.—The form just described is readily distinguished by the produced forehead and by the form and armature of the fifth pair of thoracic feet.

Fam. CHONIOSTOMATIDÆ, Hansen (1887).

Genus *Stenothocheres*, Hansen (1897).

Stenothocheres egregius, H. J. Hansen. Pl. xv., fig. 5–10.

1897. *Stenothocheres egregius*, Hansen, The Choniostomatidæ, p. 89, pl. i., fig. 1 a-e.

The *Sphæronella*-like form which I ascribe to *Stenothocheres egregius* was obtained in the marsupium of *Metopa borealis*, G. O. Sars. The female represented by the drawing (fig. 5) measured about ·68 mm. in length (nearly $\frac{1}{37}$ of an inch); the body was almost sphærical in shape, but was rather longer than the height.

The antennules are small (fig. 7), and the end joint, which is furnished with two moderately long spine-like terminal setæ, is about one and a half times as long as the preceding one.

The antennæ are very minute and composed of two sub-equal joints, and they are each armed with a comparatively stout terminal spine (fig. 8).

The maxillipeds were damaged while being removed for the purpose of mounting, but the second pair, so far as they could be made out, appear to be moderately strong with stout terminal claws as indicated in figure 6.

The first pair of feet, though very small, are comparatively stout and two-branched, and both branches appear to be two-jointed; the inner branches are furnished with three apical spines, the middle one being moderately elongated, while the other two are short; the outer branches, on the other hand, are provided with one terminal spine which is moderately stout (fig. 9).

The second pair appear to be more slender than the first, and the inner branches are only one-jointed and bear a single moderately long apical spine; the outer branches, which are two-jointed, are only armed with a very short spine at the apex (fig. 10).

The abdomen is very small and provided with two furcal joints which bear a few minute setæ.

The Amphipod on which the parasite was observed occurred in a surface tow-net gathering collected in Aberdeen Bay on October 16, 1903. The parasite agrees very closely with the description and drawings of *S. egregius*, Hansen, as given in that author's Monograph of the Choniostomatidæ referred to above, and therefore, though the Amphipod on which it was found (*Metopa borealis*, G. O. Sars) is a different species from that mentioned by Dr. Hansen as the host *S. egregius*, I am satisfied that the parasite I have described belongs to that species.

The Amphipod on which Dr. Hansen obtained his specimens of *S. egregius* belonged to *Metopa bruzelii* (Goës.).

Sphæronella paradoxa, H. J. Hansen. Pl. xv., fig. 17–19.

1897. *Sphæronella paradoxa*, Hansen, The Choniostomatidæ, p. 118, pl. iii., fig. 4 a-l; pl. iv., fig. 1 a-h.

The female of this *Sphæronella* represented by the drawing (figs. 16 and 17) is smaller than those described by Dr. Hansen, being only ·57 mm., whereas the smallest of the specimens mentioned by that author was ·71 mm. But with the exception of the difference in size the specimen recorded here agrees very well with the species to which it is referred. The specimen was found in the marsupium of *Bathyporeia pelagica* (Bate). The figure representing a side view of the parasite shows the posterior thread-like attachment considerably twisted upon itself and terminating in a sucker disc; the only other appendages visible are at the anterior end, and comprise a pair of antennules and a pair of powerful maxillipeds.

Six specimens of *Bathyporeia* were found to be infested with *Sphæronella*, and all the parasites observed appeared to be adult females. The body of the female, represented by the drawings, is seen to be nearly globular, particularly when viewed from above.

The antennules are three-jointed, the end joint being the longest one and the penultimate joint the smallest; they are each provided with a few setæ (fig. 18).

The maxillipeds (fig. 19) appear also to be three-jointed; the first joint is very large, but the other two are smaller; the third is armed with a moderately stout terminal claw, and as the articulation between the first and second joints forms a hinge, the last two joints, together with the terminal claw, can be folded upon the first, and this allows the maxillipeds to be used as powerful grasping organs.

No males were observed.

Habitat.—In the marsupium of *Bathyporeia pelagica* (Spence Bate), collected off Lossiemouth, Moray Firth, December 29, 1903.

Sphæronella minuta, T. Scott, sp. n. Pl. xv., fig. 11–15.

An adult *Sphæronella* was obtained in the marsupium of a specimen of *Perioculodes longimanus* (Spence Bate) from the Dornoch Firth, collected by the bottom tow-net on December 28, 1903. Dorsal and side views of the specimen are represented by fig. 12, 11. The length of the specimen is ·48 mm. (about $\frac{1}{52}$ of an inch).

The antennules appear to be three-jointed; the first joint is nearly twice as long as the second, while the third is equal to rather more than the entire length of the first and second (fig. 13).

The first maxillipeds are very small, and consist of a single stout joint armed with a moderately strong terminal claw (fig. 14).

The second maxillipeds are rather more slender and elongated than the other pair; the basal joint is twice as long as broad; the next two are small and narrow, and appear to be hinged to the basal joint; the terminal claw, which is moderately stout, is slightly curved (fig. 15).

Dr. Hansen states that he obtained female *Sphæronellas* in the marsupiums of three specimens of *Perioculodes longimanus* from Denmark, and that they appeared to be identical with *S. paradoxa*, the only appreciable difference being their smaller size. Dr. Hansen's extensive knowledge of this curious and difficult group of Crustacea precludes any doubt concerning the accuracy of the identification of these specimens. I am therefore inclined to regard the *Sphæronella* found on the *Perioculodes* from the Dornoch Firth as a somewhat different form from those he observed, and have described it provisionally under a distinct specific name.

This *Sphæronella* from the Dornoch Firth *Perioculodes* appears to differ not only in size and shape from *S. paradoxa*, but also in the size and proportional lengths of the joints of the antennules and in the size and structure of the second maxillipeds.

Sphæronella callisomæ, T. Scott, sp. n. Pl. xv., fig. 20–27.

The *Sphæronella* I record under this name was obtained on a specimen of *Callisoma crenata* (Spence Bate) collected at the mouth of the Firth of Clyde on February 7, 1899. The parasite is an adult female and measured ·86 mm. in length ($=\frac{1}{29}$ of an inch). The body seen from above is nearly globular, and the cephalon is seen projecting somewhat beyond the anterior aspect in the form of a moderately conspicuous tubercle (fig. 21). Seen from the side the body is broadly oblong, with both the anterior and posterior ends boldly convex. The anterior portion of the body appears to be thickly beset with minute hairs (fig. 20 and 21).

The antennules are three-jointed; the middle joint is very short, but the other two are moderately elongated (fig. 22).

The antennæ are very small and uniarticulate, and are each furnished with a single terminal seta about as long as the antennal joint (fig. 23).

The mandibles are slender, elongated, and sub-cylindrical (fig. 24).

The maxillæ are stout, and are each apparently composed of a single piece, and armed with two moderately stout terminal setæ, while a third seta springs from a minute lateral process, as shown in the drawing (fig. 25).

The first and second maxillipeds have each of them moderately stout basal joints, and they are each provided with strong terminal claws (fig. 26, 27).

The ventral filament, which is furnished with a terminal sucker-like disc, is long and slender, and twisted upon itself as shown in fig 20.

This *Sphæronella* does not agree with any described species known to me.

Sphæronella cluthæ, T. Scott, sp. n. Pl. xv., fig. 28–30.

A single adult female of this *Sphæronella* was obtained in the marsupium of a specimen of *Harpinia pectinata*, G. O. Sars,* found in a tow-net gathering collected in moderately deep water at the mouth of the Clyde estuary, and nearly midway between Ailsa Craig and Sanda Island; this tow-net gathering was collected on November 14, 1899.

* Some remarks on the distribution of this Harpinia will be found among the Notes on Amphipoda at page 256.

This parasite, which appears to differ from any other *Sphæronella* known to me, measures ·74 mm. in length (about $\frac{1}{34}$ of an inch). Its form is almost globular, especially the dorsal view, but seen from the side the height is rather less than the width (fig. 28, 29).

The only appendages that could be satisfactorily made out were the second maxillipeds, and these are moderately elongated and slender, and are each provided with a slender terminal claw (fig. 30).

There does not appear to be any previous record of a *Sphæronella* having been found on *Harpinia pectinata.*

Sphæronella pygmæa, T. Scott, sp. n. Pl. xv., fig. 31–34.

The adult female of this species represented by the drawings (fig. 31 and 32), whether viewed dorsally or from the side, is seen to be of a nearly oval form, the length being equal to about one and a half times the breadth. This parasite, which is very small, measures only ·49 mm. in length (about $\frac{1}{51}$ of an inch).

The antennules and antennæ appear to be rudimentary, while the only appendages of which a satisfactory examination was made were the first and second maxillipeds represented by the drawings (fig. 33, 34).

The first maxillipeds, which are very small and uniarticulate, are armed with a moderately stout terminal claw (fig. 33).

The second maxillipeds are elongated and three-jointed; the inner distal angle of the first joint is produced so as to form a small bifid projection; the first and second joints are sub-equal in length; the third is small and narrow, and bears a somewhat feeble terminal claw (fig. 34).

Habitat.—This small *Sphæronella* was obtained in the marsupium of a specimen of *Pseudocuma similis*, G. O. Sars. No males or post-larval females were observed.

There does not appear to be any previous record of a *Sphæronella* from this species of *Pseudocuma.*

Sphæronella amphilochi, H. J. Hansen. Pl. xv., fig. 35, 36.

1897. *Sphæronella amphilochi*, H. J. H., op. cit., p. 139, pl. vii., fig. 3 a and b.

The *Sphæronella* I record under this name was found in the marsupium of *Amphilochoides odontonyx* (Boeck) (= *Amphilochoides pusillus*, G. O. Sars).* The specimen represented by the drawing (fig. 35) is a young female, and as Dr. Hansen has only described the adult form of the species from a solitary example, a satisfactory comparison between our specimen and his description and figures could not be made. Dr. Hansen's specimen was, however, found on the same species of Amphipod, and this favours the identification of the two parasites as being the old and young females of the same species. The young female I am recording measured only ·14 mm. in length (about $\frac{1}{170}$ of an inch), but the size of the adult described by Dr. Hansen was ·54 mm.

A specimen which appeared to be an adult female was taken from the marsupium of the same Amphipod in which the young one now recorded was obtained, but it was somehow lost ere it could be thoroughly examined and figured.

The posterior part of the body of the young female is distinctly hispid, and the thoracic legs were furnished with long and slender terminal hairs, as shown in fig. 35. Near the middle of the dorsal aspect a number of slender bristles were observed.

* Crustacea of Norway, vol. i. (Amphipoda), p. 222. *See* also the supplement to the volume, p. 690, where the author restores Boeck's name, *A. odontonyx*, for the name used in the body of the work.

The second maxillipeds were moderately powerful, but the other appendages were smaller and weaker.

As this young female agrees with none of the other young forms described by Dr. Hansen, I prefer for the present to regard it as the post larval stage of his *Sphæronella amphilochi.*

As a list of the genera and species of the Choniostomatidæ described by Dr. H. J. Hansen in his interesting work on that curious group of parasitic Copepoda may be useful, I give it here. To this list I have added the few odd forms mentioned in the preceding notes, and one or two others recorded in previous Reports. The names of the hosts on which the parasites have been obtained are also given, and I have indicated by an asterisk (*) such of the species as up till now have been observed in Scottish waters. This will show how much room still remains for further research among these minute organisms.

The names of the parasites are arranged in alphabetical order on the left-hand side of the page, while the names of the hosts on which they have been found are placed immediately opposite.

Names of the Parasites.	Names of the Hosts.
Gen. *Aspidoecia.*	
**Aspidoecia normani*, Giard and Bonnier.	*Erythrops elegans*, G. O. Sars; *E. serrata*, G. O. Sars; *E. erythrophthalmus* (Goës.); *E. microphthalmus*, G. O. Sars; and *E. abyssorum*, G. O. Sars.
Gen. *Choniostoma.*	
Choniostoma hanseni, Giard and Bonnier.	*Hippolyte gaimardii*, M.-Edw. and *H. polaris* (Sabine).
Choniostoma mirabilis, H. J. Hansen.	„ *gaimardii*, M.-Edw.
Gen. *Homœoscelus.*	
Homœoscelus mediterranea, H. J. H.	*Iphinoë trispinosa* (Goodsir).
Homœoscelus minuta, H. J. H.	*Diastylis lucifera* (Kröyer).
Gen. *Mysidion.*	
Mysidion abyssorum, H. J. H.	*Erythrops abyssorum*, G. O. Sars.
„ *commune*, H. J. H.	*Erythrops serrata*, G. O. S.; *E. abyssorum*, G. O. S.; and *Parerythrops obesa*, G. O. S.
Gen. *Sphæronella*, H. J. H.	
(a) *Sphæronellas* parasitic on Amphipoda.	
Sphæronella abyssi, H. J. H.	*Astyra abyssi*, Boeck.
„ *acanthozonis*, H. J. H.	*Acanthozone cuspidata* (Lepech.).
* „ *amphilochi*, H. J. H.	*Amphilochoides odontonyx* (Boeck). (=*Amphilochoides pusillus*, G. O. Sars).
„ *antillensis*, H. J. H.	*Corophium bonelii*, M.-Edw.
„ *argissæ*, H. J. H.	*Argissa hamatipes*, Norman (=*A. typica*, Boeck).

Names of the Parasites.	Names of the Hosts.
Sphæronella atyli, H. J. H.	*Paratylus swammerdami* (M.-Edw.).
,, *bonnieri*, H. J. H.	*Protomedia fasciata*, Kröyer.
,, *caliopii*, H. J. H.	*Calliopius læviusculus* (Kröyer).
* ,, *callisomæ*, T. Scott.	*Callisoma crenata*, Spence Bate.
,, *capensis*, H. J. H.	*Lemboides afer*, Stebbing.
,, *chinensis*, H. J. H.	*Corophium bonellii*, M.-Edw.
* ,, *cluthæ*, T. Scott.	*Harpinia pectinata*, G. O. Sars.
,, *danica*, H. J. H.	*Corophium crassicorne* (Bruz.).
,, *dulichiæ*, H. J. H.	*Dulichia monocantha*, Metzger.
,, *elegantula*, H. J. H.	*Cheirocrates sundewalli* (Rathke).
,, *frontalis*, H. J. H.	*Ampelisca macrocephala*, Lillj.
,, *giardii*, H. J. H.	*Protomedia fasciata*, Kröyer.
,, *gitanopsidis*, H.J.H.	*Gitanopsis arctica*, G. O. Sars.
,, *holbolli*, H. J. H.	*Paramphithoë boeckii*, H. J. H.
,, *intermedia*, H. J. H.	*Bruzelia typica*, Boeck.
,, *irregularis*, H. J. H.	*Metopa rubrovittata*, G. O. Sars.
,, *leptocheira*, H. J. H.	*Leptocheirus guttatus*, Grube.
,, *longipes*, H. J. H.	*Ampelisca tenuicornis*, Lillj.
,, *messinensis*, H. J. H.	*Gammaropsis melanops*, G. O. Sars.
,, *metopæ*, H. J. H.	*Metopa bruzelii* (Goës.).
,, *microcephala*, Giard and Bonnier.	*Ampelisca typica*, Spence Bate.
* ,, *minuta*, T. Scott.	*Perioculodes longimanus* (Spence Bate).
* ,, *paradoxa*, H. J. H.	*Bathyporeia norvegica*, G. O. Sars; *B. pelagica* (Bate); and *B. robertsoni* (Bate).
,, *vestita*, H. J. H.	*Microprotopus maculatus*, Norman.
(b) *Sphæronellas* parasitic on Isopoda.	
Sphæronella affinis, H. J. H.	*Janira maculosa*, Leach.
,, *curtipes*, H. J. H.	,, *spinosa*, Harger.
,, *munnopsidis*, H. J. H.	*Munnopsis typica*, M. Sars.
(c) *Sphæronellas* parasitic on Sympoda.	
Sphæronella decorata, H. J. H.	*Diastylis rathkei*, Kröyer.
,, *dispar*, H. J. H.	*Eudorella truncatula* (Spence Bate).
,, *insignis*, H. J. H.	*Diastylis cornuta*, Boeck; and *D. rostratus*, Goodsir (=*D. lævis* Norman).
,, *marginata*, H. J. H.	*Iphinoë trispinosa* (Goodsir).
,, *modesta*, H. J. H.	*Eudorella emarginata* (Kröyer).
* ,, *pygmæa*, T. Scott.	*Pseudocuma similis*, G. O. Sars.
Gen. *Stenothocheres*, H. J. H.	
**Stenothocheres egregius*, H. J. H.	*Metopa bruzelli* (Goës), and *Metopa borealis*, G. O. Sars.
,, *sarsi*, H. J. H.	*Stenothoë marina*, Spence Bate.
Gen. *Salenskya*, Giard and Bonnier.	
**Salenskya tuberosa*, Giard and Bonnier.	*Ampelisca spinipes*, Boeck.

AMPHIPODA.

The following notes on some species belonging to the Amphipoda and one or two other groups of the Malocostraca obtained in plankton—samples collected during the investigations recently carried out by Dr. T. Wemyss Fulton in the North Sea and the Moray Firth—may be of interest.

Hyperia medusarum (O. F. Muller). This species, which appears to have a decidedly northern and Arctic distribution, and of which there is so far no authentic British record, was obtained in a surface plankton-sample collected about 180 to 185 miles east by north of Aberdeen on October 8th, 1903. One or two full-grown females and several young specimens were noticed. In the same gatherings there were observed *Clione borealis* and *Limacina retroversa*—two northern Pteropods—as well as *Tryphosa nanoides*, *Hoplonyx cicada*, and some other and commoner forms.

Tryphana malmi, Boeck. This curious and brightly coloured little Amphipod occurred in a surface gathering collected off the Ord of Caithness, Moray Firth, on November 21st, and in a bottom gathering collected off Lossiemouth on December 29th, 1903. This is the first time I have met with *Tryphana* so close to the Scottish north-east coast, but the Rev. Canon A. M. Norman records its occurrence at Banff, whence specimens were sent to him many years ago by Thomas Edward.* Professor G. O. Sars in his great work on the Crustacea of Norway records this species from three different places on the west coast of Norway, and only from deep water; he states further that Boeck also obtained it in deep water in Hardangerfjord.† The only other localities which Norman gives in his note on the distribution of the species are the Faroe Isles and North Atlantic, lat. 18° 8′, long. 30° 5′ W. (Stebbing). *Tryphana malmi* may, however, be less rare than the apparent dearth of information concerning its distribution would seem to imply. I have obtained it in at least two plankton-samples from the Shetland Islands, in addition to the two mentioned above.‡

Anonyx nugax (Phipps). This species, rarely met with in the British seas, was captured in Aberdeen Bay on December 23rd, 1903. The species was taken for the first time in Scottish waters in February, 1889; on that occasion it was obtained near May Island, at the mouth of the Forth estuary.§ It was again met with in January, 1901, in the Cromarty Firth, when specimens collected on the 10th of that month by Mr. F. G. Pearcey were forwarded to the Fishery Board's Laboratory at Bay of Nigg, near Aberdeen,‖ and the present record of its occurrence in Aberdeen Bay is the only other occasion on which it has been observed off the east coast of Scotland. None of the Scottish specimens of *Anonyx nugax* have attained to anything like the size of some Arctic examples.

Hoplonyx cicada (Fabricius). This species, which, like the last, is also a northern form, has already been referred to in the note on *Hyperia*

* British Amphipoda of the Tribe Hyperiidæ, &c., *Ann. and Mag. Nat. Hist.*, (7), vol. v., p. 133 (January 1900).

† Crustacea of Norway, vol. i., Amphipoda, p. 18.

‡ Conseil permanent International pour l'exploration de la Mer; Bull. des Results, Pt. D., for August, 1903, pp. 44–47.

§ *Eleventh Ann. Rept. of the Fishery Board for Scotland*, Part III., p. 212, pl. v., fig. 18–20 (1893).

‖ *Nineteenth Ann. Rept. of the Fishery Board for Scotland*, Pt. III., p. 258 (1901).

medusarum ; but the largest specimen observed in the collections under consideration was obtained in the same gathering with *Anonyx nugax*, from Aberdeen Bay. Though the species appears to be widely distributed along the west side of the British Islands, the records of its occurrence on the east coast of Scotland appear to be very few, and its presence in Aberdeen Bay is all the more interesting.

It may be stated that the gathering from Aberdeen Bay collected on December 23rd, 1903, contained a considerable number of other species of Amphipoda besides the two I have specially mentioned, and the names of the following may be given, *Acidostoma obesum*, *Tryphosa longipes*, *Ampelisca spinipes*, *Iphimedea minuta*, and one or two fine specimens of *Amathilla homari*. Specimens of *Diastylis rostrata* and *Siriella armata* were also observed.

Harpinia pectinata, G. O. Sars. The occurrence of the single specimen of *Harpinia pectinata* already mentioned in connection with *Sphæronella cluthæ*, whose host it was, is of sufficient interest to be specially referred to in these notes. The only stations that may be considered as within the British limits where this species has hitherto been observed "are all to the west of Ireland and between Ireland and Rockall."* Its capture at the mouth of the Clyde estuary may be an indication that it may be found in other places when carefully sought for. *H. pectinata*, which seems to be confined to moderately deep water, is a form that may easily be mistaken for a more common species, the characters by which it is distinguished being not easily made out without dissection. Professor G. O. Sars speaks of it as being "by no means rare" off the south and west coasts of Norway and occurring, as a rule, in company with *H. neglecta*. The Rev. T. R. R. Stebbing has seen the Clyde specimen and confirms my identification.

Metopa borealis, G. O. Sars. The occurrence of this species in Aberdeen Bay has already been referred to under the Choniostomatidæ as one of the hosts of *Stenothocheres egregius*. *Metopa borealis*, like *M. alderi* and one or two other members of the same genus, has an unarmed telson, but with the assistance of Professor G. O. Sars' excellent monograph, it need not be confounded with any of the other species referred to. *M. borealis* is a northern form, but appears to have a fairly wide distribution; it is one of the rarer forms recorded by Dr. Robertson from the Firth of Clyde.

Paratylus falcatus, Metzger. One or two specimens of *Paratylus falcatus* were obtained in a tow-net gathering collected in the Dornoch Firth on December 26th, 1903. Though this *Paratylus* bears a strong resemblance to *P. uncinatus*, G. O. Sars, the tooth-like posterior projections of the segments of the metasome on the dorsal aspect readily distinguish it. I have found both forms in Scottish waters, but neither of them very common.

Megaluropus agilis, Norman. This somewhat curious species, readily distinguished by the peculiar form of the eyes, was obtained in a bottom plankton-sample collected on December 29th about three miles off Lossiemouth, Moray Firth.

ISOPODA.

Idothea neglecta, G. O. Sars. Professor G. O. Sars in his great work on the Crustacea of Norway, now in course of publication, has in Volume II.

* British Amphipoda, by Rev. A. M. Norman; *Ann. and Mag. Nat. Hist.*, (7), vol. v., p. 337 (April, 1900).

(Isopoda) described as distinct species one or two forms which previously have apparently been included with the Isopod known as *Idotea tricuspidata*, which was in consequence considered to be a variable species. One of the forms referred to, which Professor Sars has raised to specific rank is named by him *Idothea neglecta*,* and he states concerning it that it "occurs along the whole Norwegian coast from Christiania Fjord to Vadsö, and is often found in great abundance among decaying algæ in depths ranging from six to twenty fathoms." This form is probably not uncommon round the coasts of Scotland, and is, I think, included among the varieties of '*Idotea tricuspidata*' described in Bate and Westwood's Sessile-eyed Crustacea.† *Idothea neglecta* appears to be moderately frequent in some parts of the Clyde estuary; my friend Mr. Alexander Patience of Glasgow, who first directed my attention to its occurrence in the Clyde, has obtained a considerable number of specimens, which he has been kind enough to let me examine, and there are several specimens in the collection in the Fishery Board's Laboratory, Bay of Nigg, which are also from the Clyde district. The average size of the male of this *Idothea* is stated by Sars to be 25 millimetres in length (=1 inch). One of the specimens in the Laboratory is, however, much larger than that, being 33 millimetres, while others in the same collection measure 28, 27, 25, and 20 millimetres. The female is much smaller than the male, its average size being, according to Sars, only 16 millimetres. All the specimens in the Laboratory have been collected in different parts of upper Loch Fyne during 1897 and 1899.

Idothea neglecta has not yet been recorded from the east coast of Scotland.

SYMPODA.

Eudorellopsis deformis (Kröyer). This curious little species was obtained in a plankton-sample collected by the s.s. "Glenogle" about fifty miles to the eastward of the May Island, Firth of Forth, on August 20th, 1903; the species has been observed in various other localities, but very sparingly and usually in moderately deep water.

Pseudocuma similis, G. O. Sars. This species has already been referred to as the host of *Sphæronella pygmæa* under the Choniostomatidæ; a few specimens occurred in a plankton-sample collected in moderately deep water about three miles off Lossiemouth, in the Moray Firth, on December 29th, 1903. *Pseudocuma similis* resembles the more common *P. cercaria* very closely, and this may be the reason it has only recently been recognised as a British species.

A considerable number of other microcrustaceans, more or less interesting, have been noticed in various plankton-samples collected during the recent fishery investigations carried out under the direction of Dr. Fulton in the North Sea and Moray Firth. These may be described in a subsequent paper dealing more generally with that group of marine organisms.

I take this opportunity to substitute other generic names in room of two that have recently been adopted for certain forms of Copepoda, but which I now find to be pre-occupied.

(*a*). Genus *Platypsyllus*, T. Scott, *Twentieth Report of the Fishery Board for Scotland* (1902), Pt. III., p. 455. I find that *Platypsyllus* was used in 1869 both by Dr. Ritsema and Professor Westwood for a

* Crustacea of Norway, vol. ii., p. 84., pl. xxxv, fig. 1.

† British Sessile-eyed Crustacea, vol. ii., p. 381, text figs.

genus of Coleoptera, its use by me for a genus of Copepoda must therefore apse, and the name I propose to substitute for it is *Jeanella*, the diminu-ive of the proper name Jean.

(*b*) Genus *Paranthessius*, T. Scott, *Twenty-first Report of the Fishery Board for Scotland* (1903), Pt. III., p. 120. This name has already been used by Professor Claus for a genus of Copepoda different from that described in the Report mentioned, and it must therefore be replaced by another, and the name I propose to substitute for it is *Heteranthessius*.

DESCRIPTION OF THE PLATES.

PLATE XIII.

Monstrilla longicornis, I. C. Thompson. — Diam.

Fig. 1.	Female, dorsal view	× 26·5.
Fig. 2.	Male, dorsal view	× 35.
Fig. 3.	Antennule, female	× 40.
Fig. 4.	Fifth pair of thoracic feet, female	× 53.
Fig. 5.	Abdomen and caudal furca, female	× 80.
Fig. 6.	Antennule, male	× 53.
Fig. 7.	Abdomen and caudal furca, male, ventral aspect	× 80.

Monstrilla gracilicauda, Giesbrecht.

Fig. 8.	Female, dorsal view	× 35.
Fig. 9.	Antennule, female	× 53.
Fig. 10.	Abdomen and caudal furca, female,	× 79.

Monstrilla grandis, Giesbrecht.

Fig. 11.	Female, dorsal view	× 26.
Fig. 12.	Male, dorsal view	× 35.

Monstrilla anglica, Lubbock.

Fig. 13.	Female, dorsal view	× 21.

Monstrilla dubia, T. Scott, sp. n.

Fig. 14.	Female, dorsal view	× 26.

Thaumaleus rigidus, I. C. Thompson.

Fig. 15.	Female, dorsal view	× 35.
Fig. 16.	Antennule, female	× 130.
Fig. 17.	Fifth pair of thoracic feet, female	× 130.

Thaumaleus zetlandicus, T. Scott, sp. n.

Fig. 18.	Female, dorsal view	× 21.
Fig. 19.	Male, dorsal view	× 21.

PLATE XIV.

Thaumaleus thompsoni, Giesbrecht.

Fig. 1.	Female, dorsal view	× 20·5.
Fig. 2.	Antennule, female	× 79.
Fig. 3.	Fifth pair of thoracic feet, female	× 79.
Fig. 4.	Abdomen and caudal furca, female	× 97.

Thaumaleus rostratus, T. Scott, sp. n.

		Diam.
Fig. 5.	Female, dorsal view	× 26·5.
Fig. 6.	Antennule, female	× 79.
Fig. 7.	Fifth pair of thoracic feet, female	× 79.
Fig. 8.	Abdomen and caudal furca, female	× 79.

Monstrilla grandis, Giesbrecht.

Fig. 9.	Antennule, female	× 53.
Fig. 10.	Fifth pair of thoracic feet, female	× 79.
Fig. 11.	Abdomen and caudal furca, female	× 72.

Monstrilla anglica, Lubbock.

Fig. 12.	Antennule, female	× 53.
Fig. 13.	Fifth pair of thoracic feet, female	× 79.
Fig. 14.	Abdomen and caudal furca, female	× 97.

Monstrilla gracilicauda, Giesbrecht.

Fig. 15.	Fifth pair of thoracic feet, female	× 79.

Monstrilla dubia, T. Scott, sp. n.

Fig. 16.	Antennule, female	× 64.
Fig. 17.	Fifth pair of thoracic feet, female	× 106.
Fig. 18.	Abdomen and caudal furca, female	× 79.

Thaumaleus rigidus, I. C. Thompson.

Fig. 19.	Abdomen and caudal furca, female	× 130.

Thaumaleus zetlandicus, T. Scott, sp. n.

Fig. 20.	Antennule, female	× 64.
Fig. 21.	Fifth pair of thoracic feet, female	× 79.
Fig. 22.	Abdomen and caudal furca, female	× 79.

PLATE XV.

Monstrilla grandis, Giesbrecht.

Fig. 1.	Antennule, male	× 53.
Fig. 2.	Abdomen and caudal furca, female	× 106.

Thaumaleus zetlandicus, T. Scott, sp. n.

Fig. 3.	Antennule, male	× 53.
Fig. 4.	Abdomen and caudal furca, male	× 79.

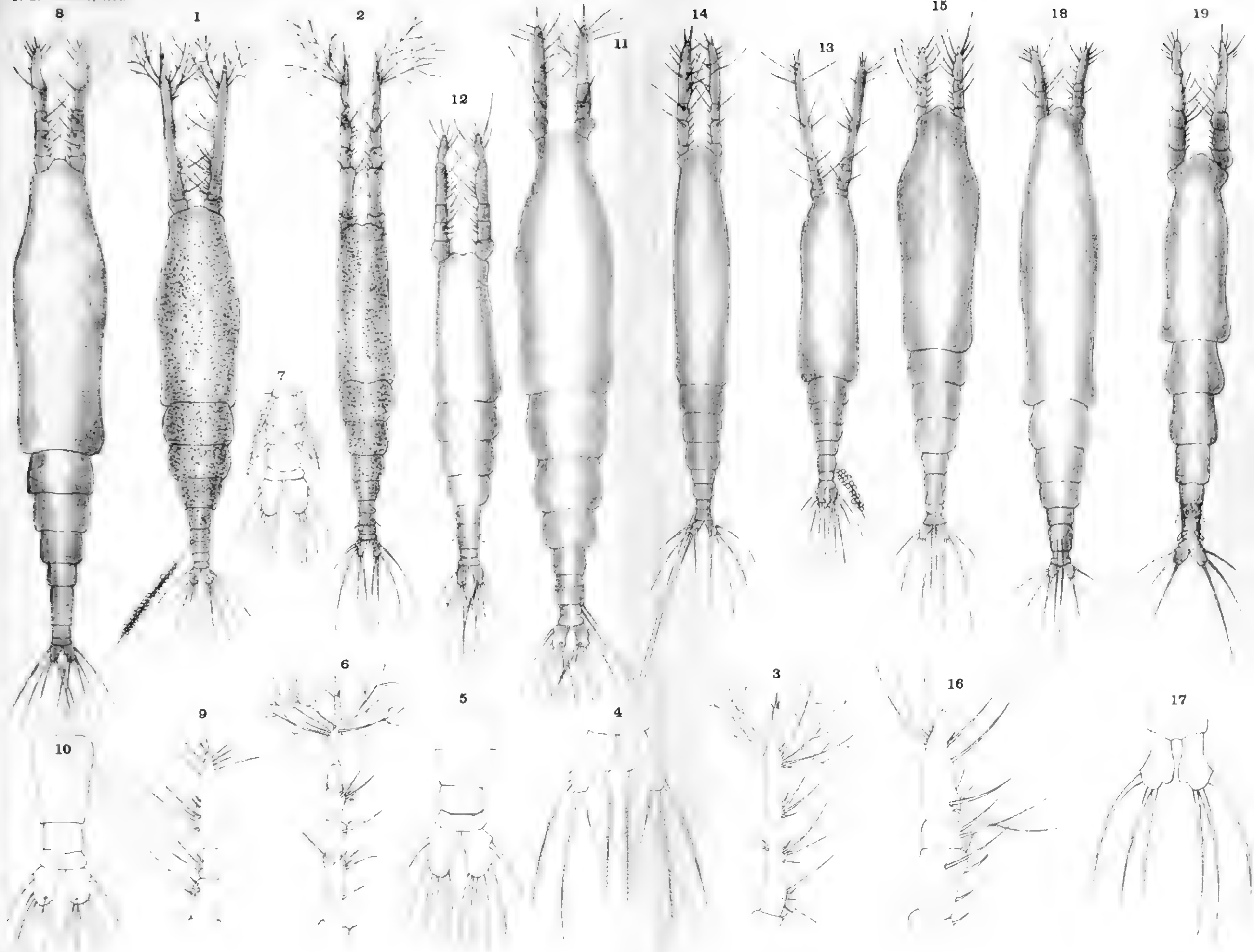
Stenothocheres egregius, Han.

Fig. 5.	Side view, female	× 53.
Fig. 6.	Dorsal view, female	× 53.
Fig. 7.	Antennule, female	× 521.
Fig. 8.	Antenna, female	× 781.
Fig. 9.	Foot of first pair	× 781.
Fig. 10.	Foot of second pair	× 781.

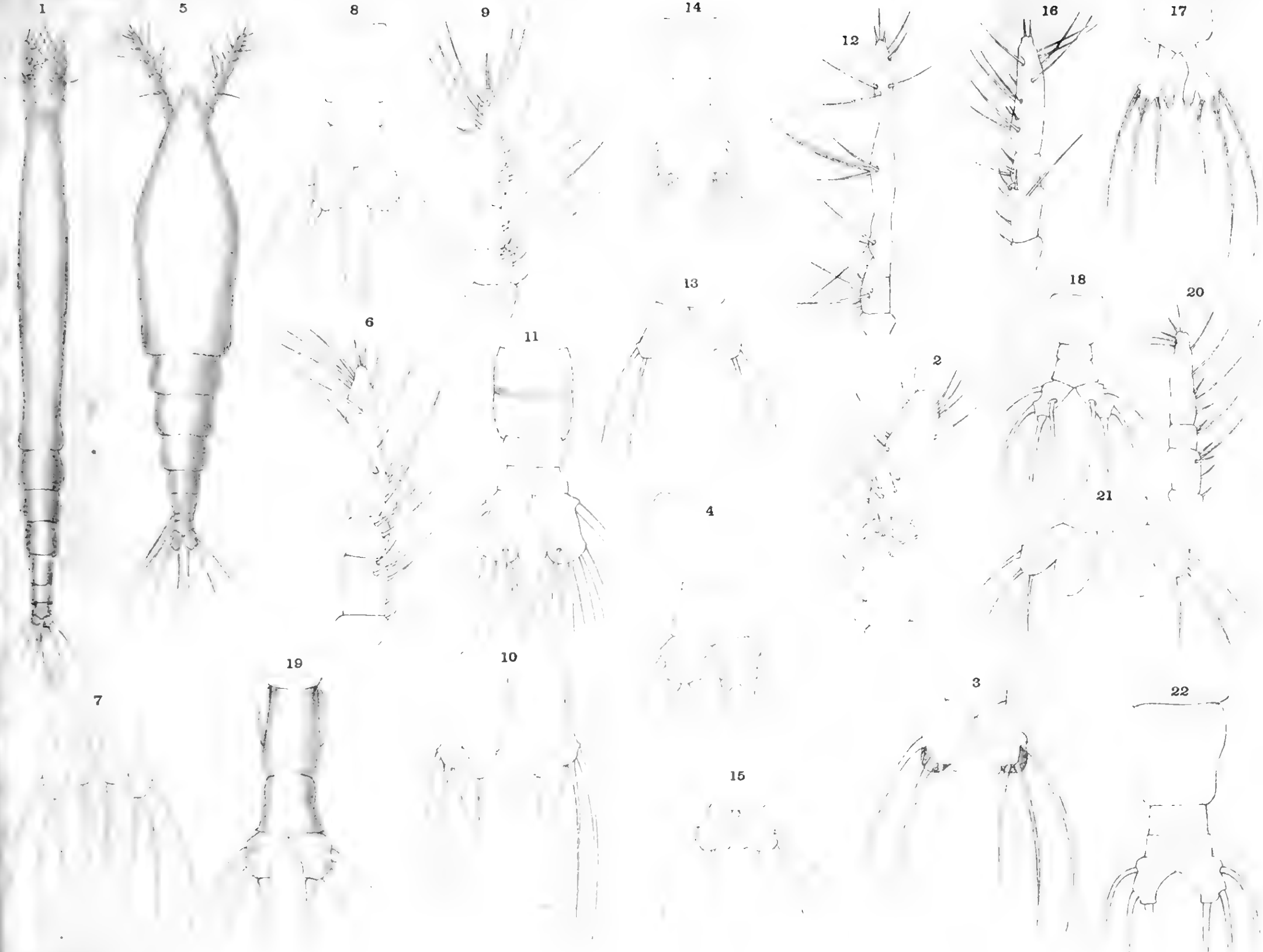
Sphæronella minuta, T. Scott, sp. n.

Fig. 11.	Female, side view	× 106.
Fig. 12.	Female, dorsal view	× 106.
Fig. 13.	Antennule	× 781.
Fig. 14.	First maxilliped	× 781.
Fig. 15.	Second maxilliped	× 781.

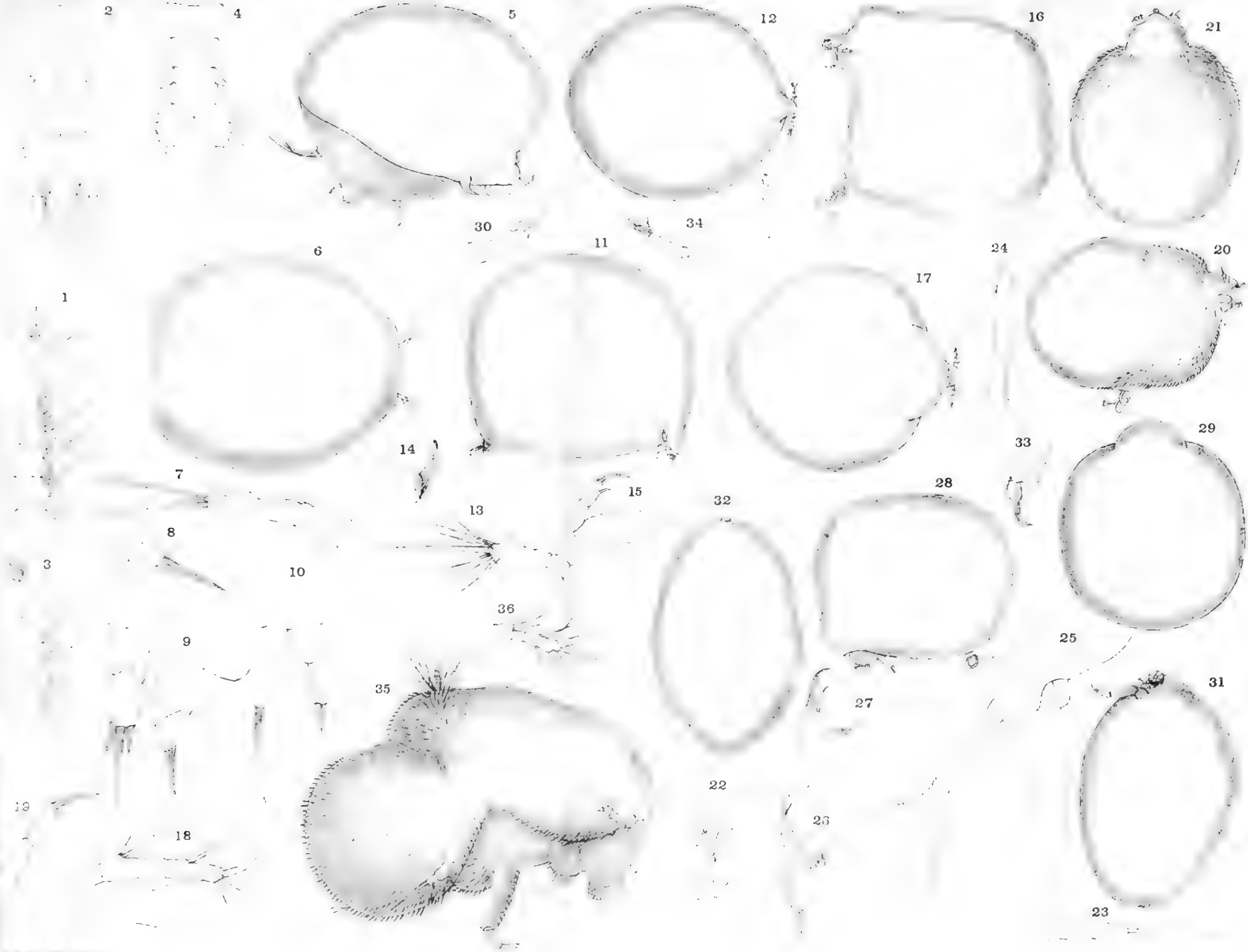
PLATE XIII.



A. SCOTT, del. ad nat.



. Scott, *del. ad nat.*


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

Sphæronella paradoxa, Han.

		Diam.
Fig. 16.	Female, side view	× 79.
Fig. 17.	Female, dorsal view	× 79.
Fig. 18.	Antennule	× 781.
Fig. 19.	Maxilliped	× 781.

Sphæronella callisomæ, T. Scott, sp. n.

Fig. 20.	Female, side view	× 53.
Fig. 21.	Female, dorsal view	× 53.
Fig. 22.	Antennule	× 390.
Fig. 23.	Antenna	× 781.
Fig. 24.	Mandible	× 781.
Fig. 25.	Maxilla	× 781.
Fig. 26.	First maxilliped	× 521.
Fig. 27.	Second maxilliped	× 521.

Sphæronella cluthæ, T. Scott, sp. n.

Fig. 28.	Female, side view	× 64.
Fig. 29.	Female, dorsal view	× 64.
Fig. 30.	Second maxilliped	× 79·5.

Sphæronella pygmæa, T. Scott, sp. n.

Fig. 31.	Female, side view	× 106.
Fig. 32.	Female, dorsal view	× 106.
Fig. 33.	First Maxilliped	× 781.
Fig. 34.	Second Maxilliped	× 390.

Sphæronella amphilochi, Han.

Fig. 35.	Female, side view	× 521.
Fig. 36.	Antennule of the same	× 781.

V.—REPORT ON THE OPERATIONS AT THE MARINE HATCHERY, BAY OF NIGG, ABERDEEN, By DR. T. WEMYSS FULTON, F.R.S.E., Superintendent of Scientific Investigations.

During the season of 1903 the operations on the hatching of plaice were continued on a considerable scale as in previous years, and under the same conditions as are described in preceding reports. It need only be stated that the supply of fertilised eggs is obtained, not by stripping the ripe fishes of their eggs and milt, as is done in some other marine fish hatcheries, but by retaining the fishes from season to season in a large tidal pond, feeding them, and at the spawning season simply collecting the eggs from the water by appropriate means, and transferring them to the hatching apparatus. For this method, a large retaining pond is necessary, and the one constructed at the Bay of Nigg has answered its purpose admirably, the fishes remaining in it throughout the year in good health and supplying their eggs at the proper period with a minimum of trouble to the attendants, and with good results in regard to the success of incubation.

One of the consequences of this system which contrasts with the condition at Dunbar, where the fishes were merely retained in the pond for some time before the spawning began, is that spawning goes on for a much longer time than used to be the case under the former system. It begins earlier and may continue longer, the dates varying with the temperature to some extent, but the extent of the season is always greater. Thus at Dunbar the collection of eggs did not as a rule commence till March, the principal reason being that the fishes had not had time to become accustomed to their restraint in confinement after being placed in the pond, and they retained their eggs instead of spawning in a natural way, very often with fatal results, as described in previous reports. In point of fact they did not spawn until they had become accustomed to the conditions in which they were placed. The respective dates for the beginning of the spawning at Dunbar and at the Bay of Nigg are as follows:—

9th March	to	8th May	=	60	days
23rd March	,,	23rd May	=	61	,,
8th March	,,	8th May	=	61	,,
22nd February	,,	11th May	=	78	,,
15th February	,,	7th May	=	81	,,
10th March	,,	29th April	=	50	,,
10th March	,,	5th May	=	56	,,
22nd January	,,	2nd May	=	100	,,
8th February	,,	25th April	=	76	,,
23rd January	,,	16th May	=	113	,,

It will be observed that the mean duration of the spawning process at Dunbar owing to this delay in its commencement was sixty-five days, while at the Bay of Nigg the mean duration has been eighty-six days, or twenty-one days longer. In the first season at the Bay of Nigg the hatchery was not ready in time, and in the third season the beginning of spawning was delayed by cold, though the termination, which was earlier than usual, was natural. The ordinary duration of the spawning season of the plaice appears to be about the longer periods, extending over three full months and part of other two—and the observation is of some importance in fishery investigations.

Eggs were observed in small numbers a few days before the regular collection began, and a few were found after the date when the collection ceased. The total number of eggs secured from the pond by means of tow-nets was about 65,940,000, the eggs being measured in a vessel of known capacity and the number thus estimated. Spawning took place for the most part in March, the numbers of eggs secured in the various months being as follows:—

January, - - -	240,000
February, - - -	11,840,000
March, - - - -	37,080,000
April, - - - -	15,900,000
May, - - - -	880,000

In some years the bulk of the spawning occurs in the early part of April. On some mornings in March last year as much as five gallons of eggs were taken from the pond. Of the number of eggs collected 81 per cent. were hatched, and the remainder succumbed at one stage or another in the apparatus; there is reason to suspect that some of the eggs which are lost in this way are not fertilised, a tendency having been shown to economise the space in the pond by having in it an unduly large proportion of females at the expense of the number of males.

The estimated number of fry which were hatched and kept for a period in the apparatus was 53,600,000, and they were afterwards placed in the sea, most of them being liberated a few miles off Aberdeen, by means of a fishing yawl. At the request of the line-fishermen further up the coast a number were set free on three occasions off Fraserburgh, the total distributed there being about 16,000,000.

The particulars as to the distribution of the fry and the details as to the numbers of eggs collected throughout the season are given in the tables appended, which also show the variations in the temperature and the specific gravity of the water in the spawning pond and on the beach.

The number of fishes kept in the pond to act as the breeding stock was as usual supplemented in autumn by others caught by means of trawlers and brought alive to the hatchery in large tubs; for there is always a certain amount of natural mortality among them, particularly during the summer. The plaice, as hitherto, were fed on mussels, which are usually removed from their shells, but are sometimes only crushed.

The ponds and apparatus, which have been described in preceding annual reports, continue to serve their purpose well, and the water supply, both in regard to temperature, density, and purity, is very suitable for the work. The only changes that have been made in the arrangements consist in the removal of the water tumbling-box from the inside of the hatchery, where it was served with the incoming water, to the outside, where it is now operated by the out-flowing water. The box is necessary to provide the motive power to the Dannevig hatching apparatus, and it was found to interfere to some extent with the pressure of the water to one side of the hatchery and thus to retard the supply. Also by the fitting up of the tank-house for scientific experiments it was found necessary to divert a portion of the water from the reservoir tank for this purpose, and the change necessitated a little more pumping early in the mornings.

The question of attempting to rear the fry on a fairly large scale has been considered. It not unfrequently happens that at the end of the hatching season young metamorphosed plaice are found in some part of the apparatus, which have succeeded in passing the post-larval stages, although it is not easy to get such forms when it is attempted to rear them. The difficulty is in providing a supply of suitable food, and it is proposed to utilise a tank to act as a receptacle for spawning invertebrates, so that the water, enriched with the embryos and larvæ may be used to supply the young fishes.

For a few years the placing of the fry in Loch Fyne has been intermitted, and they have been distributed, as described, along the coast of Aberdeenshire. The reason for doing so is in order to enable observations as to the abundance of young plaice on the beaches in Loch Fyne to be made under natural conditions, without artificially reared fry being placed there in the same season, and the push-net examination of these beaches is being continued each summer. The fry were originally taken to Loch Fyne without such observations having been made beforehand, and there were therefore no data for comparing the abundance of the young plaice in the years in which the fry were put into the Loch. From the natural fluctuations which take place with fish everywhere, it is obvious that it is desirable to have observations carried on long enough to be able to distinguish one cause of fluctuation from the other, just as in cases where the influence of a method of fishing, or of stopping it, requires to be tested in the same way.

During the hatching season the hatchery was visited by deputations of fishermen from the coast of Aberdeen, as in previous years, at the request of the Technical Education Committee of the County Council, and they received demonstrations as to the processes employed.

[TABLES.

TABLE I.—Showing the Daily Progress of the Hatching Operations, as well as the Temperature and the Specific Gravity of Water in the Pond, and on the Beach.

Date.	Number of Eggs Collected.	Number of Eggs found Dead in Boxes.	Number of Fry put out.	Total Stock in Boxes.	The Sea Water in the Pond at Noon.		The Sea Water on the Beach at Noon.	
					Temp.	Sp. gr.	Temp.	Sp. gr.
					Cent.		Cent.	
Jan. 20	...	...	...	...	3·1	27·2	4·2	27·2
,, 21	...	...	...	...	3·8	27·2	4·4	27·2
,, 22	...	...	...	...	4·0	27·3	5·0	27·3
,, 23	60,000	...	...	60,000	4·1	27·2	5·0	27·0
,, 24	...	...	...	...	4·2	27·4	5·1	27·0
,, 25	...	...	...	...	...	...	...	...
,, 26	40,000	...	...	100,000	4·6	27·3	5·3	27·1
,, 27	20,000	...	...	120,000	5·3	27·2	5·5	27·2
,, 28	...	...	...	...	5·4	27·2	5·4	27·0
,, 29	40,000	...	...	160,000	5·3	27·3	5·3	27·0
, 30	40,000	...	...	200,000	5·5	27·4	5·4	27·1
,, 31	40,000	...	...	240,000	5·6	27·3	5·2	27·0
Feb. 1	...	...	...	240,000	...	...	...	...
,, 2	120,000	...	...	360,000	4·2	27·2	5·0	27·0
,, 3	40,000	...	...	400,000	4·1	27·3	5·0	27·2
,, 4	120,000	...	...	520,000	4·2	27·1	4·9	26·9
,, 5	280,000	...	...	800,000	4·0	27·4	4·6	27·0
,, 6	40,000	60,000	...	780,000	4·0	27·3	5·1	27·1
,, 7	200,000	...	...	980,000	...	...	...	...
,, 8	...	...	...	980,000	...	...	...	...
,, 9	400,000	...	...	1,380,000	4·4	27·1	4·8	27·3
,, 10	200,000	...	...	1,580,000	4·6	27·2	5·0	27·0
,, 11	320,000	80,000	...	1,820,000	4·4	27·2	4·9	27·1
,, 12	160,000	...	...	1,980,000	...	...	...	...
,, 13	320,000	...	...	2,300,000	...	...	...	...
,, 14	200,000	...	...	2,500,000	...	...	...	...
,, 15	...	...	...	2,500,000	4·8	27·4	5·1	27·0
,, 16	480,000	120,000	...	2,860,000	5·2	27·3	5·3	27·1
,, 17	560,000	...	...	3,420,000	5·4	27·5	5·2	27·0
,, 18	480,000	...	...	3,900,000	5·7	27·3	5·6	27·2
,, 19	600,000	...	...	4,500,000	6·2	27·2	6·0	27·1
,, 20	800,000	...	...	5,300,000	6·0	27·3	6·0	26·8
,, 21	...	260,000	...	5,040,000	5·8	27·4	5·9	27·0

TABLE I.—*continued.*

Date.	Number of Eggs Collected.	Number of Eggs found Dead in Boxes.	Number of Fry put out.	Total Stock in Boxes.	The Sea Water in the Pond at Noon.		The Sea Water on the Beach at Noon.	
					Temp.	Sp. gr.	Temp.	Sp. gr.
					Cent.		Cent.	
Feb. 22	1,320,000	...	...	6,360,000	5·5	27·2	5·9	27·0
,, 23	880,000	...	...	7,240,000	4·8	27·3	5·7	27·0
,, 24	320,000	...	...	7,560,000	4·4	27·2	5·4	27·1
,, 25	1,240,000	100,000	...	8,700,000	4·6	27·3	5	27·0
,, 26	880,000	...	...	9,580,000	4·4	27·4	5·3	...
,, 27	1,160,000	140,000	...	10,600,000	4·5	27·2	5·0	27·2
,, 28	720,000	...	...	11,320,000	4·6	27·2	5·1	...
Mar. 1	...	...	...	11,320,000	4·8	27·3	5·0	27·0
,, 2	1,680,000	320,000	...	12,680,000	4·7	27·5	5·0	27·1
,, 3	1,200,000	...	...	13,880,000	4·4	27·2	5·0	27·0
,, 4	1,040,000	...	...	14,920,000	4·8	27·1	5·3	27·8
,, 5	1,160,000	...	...	16,080,000	4·6	27·2	5·2	27·0
,, 6	980,000	380,000	...	16,680,000	4·8	27·2	5·1	27·0
,, 7	960,000	220,000	...	17,420,000	4·9	27·0	5·0	27·1
,, 8	...	...	...	17,420,000	5·0	27·4	5·1	27·0
,, 9	1,720,000	...	...	19,140,000	4·8	27·3	5·1	27·9
,, 10	1,600,000	480,000	...	20,260,000	5·0	27·5	5·2	27·1
,, 11	1,280,000	...	...	21,540,000	4·7	27·2	5·0	27·2
,, 12	960,000	270,000	...	22,230,000	4·9	27·5	5·1	27·2
,, 13	1,320,000	...	...	23,550,000	5·1	27·4	5·3	27·0
,, 14	1,440,000	220,000	...	24,770,000	5·3	27·4	5·3	27·1
,, 15	...	...	...	24,770,000	5·2	27·3	5·2	27·2
,, 16	2,000,000	330,000	4,000,000	22,440,000	5·4	27·4	5·1	27·0
,, 17	...	...	...	22,440,000	5·0	27·2	5·4	27·0
,, 18	2,360,000	360,000	...	24,440,000	5·2	27·4	5·2	27·2
,, 19	1,160,000	260,000	...	25,340,000	5·6	27·5	5·1	27·0
,, 20	1,200,000	460,000	3,800,000	22,280,000	5·5	27·3	5·2	27·9
,, 21	2,060,000	...	...	24,340,000	5·4	27·5	5·4	27·1
,, 22	...	360,000	...	23,980,000	5·9	27·6	5·2	27·3
,, 23	3,500,000	400,000	...	27,080,000	6·2	27·4	5·4	27·4
,, 24	1,280,000	320,000	...	28,040,000	6·0	27·3	5·8	27·2
,, 25	1,520,000	220,000	...	29,340,000	5·8	27·3	5·8	27·1

TABLE I.—*continued.*

Date.	Number of Eggs Collected.	Number of Eggs found Dead in Boxes.	Number of Fry put out.	Total Stock in Boxes.	The Sea Water in the Pond at Noon.		The Sea Water on the Beach at Noon.	
					Temp.	Sp. gr.	Temp.	Sp. gr.
					Cent.		Cent.	
Mar. 26	1,220,000	260,000	4,300,000	26,000	...	...	...	...
,, 27	1,240,000	320,000	...	26,920	6·0	27·2	5·8	27·3
,, 28	...	280,000	...	26,640,000	6·2	27·3	5·8	27·1
,, 29	1,960,000	...	...	28,600,000	6·4	27·5	5·8	27·2
,, 30	...	450,000	...	28,150,000	6·3	27·4	5·9	27·5
,, 31	2,240,000	340,000	...	30,050,000	6·1	27·2	6·0	27·3
April 1	...	...	4,000,000	26,050,000	6·2	27·6	5·8	27·4
,, 2	2,040,000	420,000	...	27,670,000	6·4	27·3	5·9	27·3
,, 3	...	...	...	27,670,000	6·1	27·1	6·2	27·0
,, 4	1,560,000	520,000	...	28,710,000	6·6	27·4	6·2	27·2
,, 5	1,040,000	...	...	27,750,000	...	...	...	...
,, 6	...	280,000	6,000,000	23,470,000	6·4	27·5	6·3	27·1
,, 7	...	480,000	...	22,990,000	6·1	27·3	6·2	27·4
,, 8	1,960,000	300,000	...	24,650,000	6·4	27·6	6·2	27·3
,, 9	1,160,000	...	...	25,810,000	7·0	27·3	6·6	27·2
,, 10	560,000	470,000	...	25,900,000	7·2	27·4	6·8	27·0
,, 11	800,000	...	...	26,700,000	6·8	27·7	6·6	27·3
,, 12	720,000	...	...	27,420,000	7·0	27·8	6·4	27·0
,, 13	...	320,000	...	27,100,000	6·8	27·6	6·4	27·4
,, 14	1,220,000	...	...	28,320 000	6·5	27·4	6·1	27·8
,, 15	440,000	280,000	8,000,000	20,480,000	6·0	27·5	6·0	27·3
,, 16	400,000	...	...	20,880,000	5·9	27·8	6·1	27·4
,, 17	400,000	400,000	...	20,880,000	5·4	27·4	6·0	27·2
,, 18	...	...	...	20,880,000	5·1	27·6	5·8	27·7
,, 19	800,000	320,000	...	21,360,000	5·0	27·3	5·8	27·4
,, 20	440,000	...	4,400,000	17,400,000	4·8	27·2	5·1	27·2
,, 21	340,000	240,000	...	17,500,000	4·9	27·4	...	...
,, 22	400,000	260,000	...	17,640,000	5·0	27·3	...	...
,, 23	400,000	...	...	18,040,000	...	...	...	...
,, 24	...	...	...	18,040,000	5·8	27·4	5·8	27·2
,, 25	...	340,000	...	17,700,000	6·4	27·6	6·1	27·5
,, 26	820,000	...	...	18,520,000	6·6	27·5	6·4	27·3

TABLE I.—*continued.*

Date.	Number of Eggs Collected.	Number of Eggs found Dead in Boxes.	Number of Fry put out.	Total Stock in Boxes.	The Sea Water in the Pond at Noon.		The Sea Water on the Beach at Noon.	
					Temp.	Sp. gr.	Temp.	Sp. gr.
					Cent.		Cent.	
April 27	...	180,000	...	18,340,000	6·3	27·8	6·1	27·3
,, 28	...	...	...	18,340,000	6·0	27·5	6·2	27·5
,, 29	...	160,000	...	18,180,000	6·4	27·3	6·2	27·2
,, 30	400,000	...	7,300,000	11,281,000	...	...	...	...
May 1	...	...	...	11,281,000	...	...	...	...
,, 2	...	...	...	11,281,000	...	...	...	...
,, 3	400,000	...	...	11,680,000	...	...	...	...
,, 4	...	160,000	...	11,520,000	...	...	...	...
,, 5	300,000	...	...	11,820,000	...	...	...	...
,, 6	...	...	...	11,820,000	...	...	...	...
,, 7	...	...	5,500,000	6,320,000	7·0	27·2	7·3	...
,, 8	...	...	...	6,320,000	7·6	27·3	7·4	...
,, 9	...	...	...	6,320,000	8·0	27·5	7·2	...
,, 10	60,000	140,000	...	6,240,000	8·4	27·1	7·6	...
,, 11	...	...	...	6,240,000	8·3	27·2	7·7	...
,, 12	...	60,000	...	6,180,000	7·5	27·3	7·2	...
,, 13	60,000	...	...	6,240,000	8·1	27·5	7·4	...
,, 14	...	...	4,300,000	1,940,000	8·8	27·4	7·6	...
,, 15	40,000	...	...	1,980,000	8·6	27·2	7·3	...
,, 16	20,000	...	...	2,000,000	9 1	27·4	7·8	...
,, 17	...	..	...	...	...	..	...	...
,, 18	...	...	...	...	...	...	...	...
,, 19	..	...	...	...	...	...	...	...
,, 20	...	...	2,000,000	...	...	...	...	...
Totals,	65,940,000	12,340,000	53,600,000					

TABLE II.—Showing particulars in connection with the Distribution of Fry.

Date.	Locality.	Temp. of the Water.	Condition of Weather.	Number of Fry Planted.
March 16	About three miles off Aberdeen Bay.	5·4°	...	4,000,000
,, 20	Three miles off Girdleness.	...	Fair.	3,800,000
,, 26	Off Aberdeen Bay, between three and four miles.	5·3°	...	4,300,000
April 1	In Aberdeen Bay, three and a half miles off.	...	...	4,000,000
,, 6	Off Fraserburgh, two miles off Lighthouse.	5·6°	...	6,000,000
,, 15	Off Fraserburgh, outside the breakwater.	...	Sea rough.	8,000,000
,, 20	About two miles off Aberdeen.	5·9°	...	4,400,000
,, 30	About three miles off Aberdeen.	...	...	7,300,000
May 7	Three and a half miles off Girdleness.	6·2°	...	5,500,000
,, 14	About three and a half miles off Aberdeen Bay.	7.3°	...	4,300,000
,, 20	Fraserburgh, about two and a half miles off.	7·1°	Wind light.	2,000,000

VI.—ON THE POST-LARVAL AND EARLY YOUNG STAGES OF THE WITCH (*PLEURONECTES CYNOGLOSSUS*, LINN.). By H. CHAS. WILLIAMSON, M.A., D.Sc., Marine Laboratory, Aberdeen. (Plate XVI.)

A very complete series of post-larval and young witches has been collected by Dr. Fulton and these he has handed to me for description.

This form is especially interesting in that it has a very long post-larval period; it reaches a large size before it takes up a bottom habitat, *i.e.* before its transformation from a bilaterally symmetrical fish to a flat-fish.

Drawings of eight post-larval and two young stages are shown in Plate XVI. An extended and detailed description is not necessary, as these serve sufficiently to indicate the general form and the arrangement of the black pigmentation so far as the latter has survived preservation. All of the specimens had been preserved in a solution of formaline in seawater.

Cunningham* was the first to observe the larva of the witch, and his description may be here incorporated. He says—"The larva is not different from that of the other species of *Pleuronectes;* its length is 3·9mm.; there is no pigment in the eye; a number of very minute points are scattered down the sides." About 48 hours after hatching, "the length is now increased to 5·9mm. . . . . ; the median fin-fold is much wider; the eye is slightly pigmented, and pigment is largely developed in the skin of the body; the cutaneous chromatophores form five well-marked transverse stripes arranged in longitudinal series along the sides, three of them on the tail, are in the region of the rectum, and one about the pectoral fin."

Holt† gives a more detailed account of the larva and early post-larva. The additional particulars which he furnishes are the following:—The larva, hatched from an egg captured in the sea, "had pigment of a pale chrome colour by reflected light, and of a dark yellow by transmitted light. This extended over the head, eye, and throughout the trunk and free caudal region, and over the yolk . . . . In the next stage black pigment is associated with the yellow, and also appears independently along the margin of the dorsal fin. In a specimen, two days old, hatched from artificially fertilized eggs the length is 5·5mm. We now find a change in the arrangement of the pigment, which is broken up into three distinct bars in the post-anal region. Moreover, the yellow pigment now exhibits a greenish colour by transmitted light."

A drawing of an early post-larval stage (derived from artificially fertilized eggs) ten days after hatching accompanies the following description:—"The eyes are black, with a bluish lustre; the lower jaw is very prominent, the pectorals very large, the otocysts large. The post-anal region is very slender, especially the part ventral to the notochord; the latter is very stout. The urocyst is larger than before. A ventral patch of black chromatophores has appeared midway between each post-anal pigment bar. The most anterior bar, that in the region of the pectoral fins, has lost its distinction. Pigment is absent from the dorsal fin in this region, whilst there has taken place a considerable development of pigment in the lower jaw and anterior ventral region; the coloured pigment

* *Trans. Roy. Soc. Edinburgh*, xxxiii., Pt. I., 1887.

† *Sc. Trans. Roy. Dublin Society* (2), iv., 1893.

is now orange by transmitted light, except in the median fin, where it is brown" (Holt .

Previous to the publication of the paper just referred to, Petersen* had described a post-larval pleuronectid measuring 32mm. in length. He considered it to be a Halibut (*Hippoglossus vulgaris*). Kyle† and Holt and Byrne‡ have recently described post-larval stages of the witch, and these agree closely with Petersen's form, which is apparently really a witch. It has, moreover, the spinous armature of the operculum to which Holt and Byrne draw special attention.§ The fin-ray formulæ for these specimens were as follows:—Petersen's—Dorsal, *ca*, 104; Anal, 88; Caudal, 82. Kyle's specimens (two in number)—Dorsal, 103 (105); Anal, 83, 85; Caudal, 18. Holt and Bryne—Dorsal, 108; Anal, 95.

The post-larval witch is a characteristic form which cannot be confounded with any other known species. Its main characters are its long and narrow post-anal body; the well-marked triple-bar arrangement of pigment on the same; the prominent head and snout, and its extended transformation period. Kyle in this connection says, in referring to the two examples, 12 and 14mm. long respectively, described by him, that their "most striking features, in addition to their length and relative thinness, are the long head, the projecting snout, with the deep depression over the eyes, and the early stage of metamorphosis." In Dr. Fulton's collection the largest post-larval (*i.e.* pelagic) witch measures 40mm., while the smallest young witch (*i.e.* transformed) measures 44mm. Holt describes one of the latter which measured 42mm.

The only other pleuronectid of our waters which approaches the witch in having a lengthy post-larval period is the Lemon Sole (*Pleuronectes microcephalus*). Post-larvæ of this form have been found measuring 27mm. (Holt), but the general shape of the pelagic stages of this species is very different from that of the witch; the outline of the former is oval, whereas that of the latter is elongated.

The witches from which the drawings were made exhibited black pigment only. The pigment other than black has disappeared since they were preserved; and in some cases the black pigment has faded considerably. This probably accounts for the fact that some variation on the pigmentation is found in the forms described, especially as regards the marginal fin. The outer edge of the marginal fin was, moreover, sometimes frayed, and in consequence the presence of pigment there was not in these cases determined.

It is hoped that the sketches here supplied will aid in the diagnosis of preserved examples. A number of the drawings are of natural size; the majority are enlarged. It is sufficient to note that the post-larval characters are constant; the general form, which is more readily indicated by the sketches than by a word-picture, is, when taken along with the bar arrangement, sufficient to indicate the species. A brief note will be given of each of the stages illustrated.

The first (Fig. 1a) is an early post-larval example, measuring in total length 5·2mm., in greatest breadth ·75mm. It has the typical pleuronectid form, viz. a short abdomen and a long post-anal region. The marginal fin shows no trace of fin-rays; the caudal fin is still diphycercal. The pigment is well marked. At the point of the mandible there are a few black pigment spots, and in the pectoral region there is a ventral group of spots. On the hind dorsal area of the abdomen a group of large chromatophores is visible, and along the keel of the abdomen there is a

* *Report of the Danish Biological Station*, iv., 1893.

† *Journal of the Marine Biological Association*, vol. vi., No. 4, Dec. 1903.

‡ *Report on the Sea and Inland Fisheries of Ireland*, 1901, Pt. II., Dublin, 1903.

§ Dr. Petersen has informed me that he is satisfied that the form is a witch.

row of similar pigment corpuscles. The eyes are black. The post-anal region is marked by three main transverse bars of chromatophores; they are equi-distant from one another. Each bar consists of a dorsal and a ventral moiety. The hindmost is in the region of the future caudal fin, and is large. Between the bars there are three pigment groups situated ventrally on the edge of the muscle-segments; they may be termed secondary groups, in contradistinction to the main broad bars. Of the post-anal pigment groups just mentioned, the hind main bar alone extends on to the marginal fin. Only one pigment spot was, in addition, found on the marginal fin; it was situated on the ventral fin. A ventral view of this post-larva is shown in Fig. 1b.

In Fig. 2 a specimen similar in size to one of those described by Kyle is reproduced. It measures 12·5mm. in length, and in greatest breadth reaches about 3mm. A greater amount of pigment is found in this individual than in the preceding. Along the ventral edge of the muscle-segments in the post-anal region a few more intermediate or secondary pigment spots are seen, and some pigment was made out on the ventral marginal fin in large and small spots. Anterior to the anus the condition of the preceding specimen holds. The caudal pigment is now diffuse; the caudal fin-rays are being laid down and the tail region is becoming heterocercal. The rudiments of the interspinous bones are indicated by a somewhat opaque part of the marginal fin, next the muscle-segments.

The interspinous bones, still very small, are to be made out in the next figure (3), a drawing of a post-larva measuring 14mm. in length and 5mm. in greatest breadth. In this specimen the large pigment corpuscles on the hind part of the optic lobes were prominent. A natural-size sketch of this post-larva is given in Fig. 9.

A witch 18mm. in length is reproduced in Fig. 4. The fin-rays are now almost completely formed, and the tail is nearly homocercal in character. A row of small pigment spots along the junction of the ventral interspinous bones and the fin-rays is made out.

In Fig. 5 all the interspinous bones and the fin-rays are formed. This example is of the same size as the specimen recorded by Holt and Byrne. In length it measures 25mm., in greatest breadth it reaches 7·5mm. The fin-ray formula is—Dorsal, about 110: Anal, about 95; Caudal, 22.

Fig. 7a is an enlarged drawing of a witch measuring 34mm. In it the pigment was not very prominent; it had probably faded.

A post-larval form, measuring 38mm., is shown in Fig. 12. Transformation is not yet completed. A drawing of the left side of the head of this example appears in Fig. 8.

A completely metamorphosed witch, measuring 44mm., is reproduced in Fig. 13. Holt described one which was a little smaller, viz. 42mm.

The migration of the left eye to the right side of the fish is a slow process. In the fish measuring 25mm. it has moved to a noticeable extent. It then appears a little above the ridge, when the fish is viewed from the right side (Fig. 5). In the large post-larva, 38mm. (Fig. 12), the eye is on the ridge; in another, measuring 40mm., the migration was not completed (Figs. 6a and 6b).

Dr. Fulton examined the last-mentioned specimen (40mm. long) shortly after it was killed in formaline. He found that the only pigment then visible was black. It was distributed as follows:—On the snout and jaw there was a collection of little specks; on the front of the lower jaw a like collection. A group of spots was present on the optic lobes, while a broad band of spots was conspicuous on the hind part of the abdomen. On the median line there were, on the post-anal body, six equi-distant pigment patches. The dorsal interspinous region showed eight fainter patches, while five or six similar patches were seen on the ventral interspinous region.

During the post-larval period the pigment on the two sides of the body remains practically identical. It is only in the larger specimens, *e.g.* 38mm., that it is possible to detect a lighter shade of pigment on the left side than on the right.

With the transformation, however, a very marked difference is noted (Fig. 13). The fish itself becomes more opaque, and its upper surface (the previous right side), shows a large quantity of pigment. Posterior to the anus there are on the upper surface seven broad patches across the median line of the body; on the dorsal fin there are five broad patches with intermediate smaller patches, and on the ventral fin three broad patches with smaller intermediate groups. The under or blind side, however, retains the post-larval pigmentation; in this case it resembled that found in the post-larva measuring 38mm. (Fig. 2).

Holt and Byrne draw attention to the presence of spines on the operculum of the post-larvæ. I have found this spinous armature in the example measuring 12·5mm. (Fig. 2). In the preceding specimen, 5·2mm. (Fig. 1), it was not made out. It was found in all the succeeding post-larval witches, and the spines were equally developed on both sides of the body. The sketches indicate with approximate accuracy the number and arrangement of them.

In the metamorphosed example, 44mm. long (Fig. 13), teeth were found on the operculum. Two large teeth projected from the posterior part of the operculum, and dorsal to these three were two (or three) other similar teeth. They were equally developed on both sides of the fish.

No spines were made out on the operculum of either side in the young witch measuring 59mm. in length.

Small teeth (in the jaws) were made out in the smallest member of the series, and they were present in all the other post-larval stages. They are not numerous. Teeth were not seen in the smaller bottom form.

LITERATURE.

Cunningham.—"The Eggs and Larvæ of Teleosteans," *Trans. Roy. Soc., Edinburgh*, vol. xxxiii., Pt. I., p. 97 (Plates I. to VII.). 1887.

Cunningham.—"Marketable Marine Fishes." London, 1896.

Holt.—"On the Eggs, Larval and Post-larval Stages of Teleosteans," *Sc. Trans. Roy. Dublin Society*, ser. 2, iv., p. 455, Plates I. to XV. 1893.

Holt and Byrne.—"On a Young Stage of the White Sole (*Pleuronectes cynoglossus*)," *Report on the Sea and Inland Fisheries of Ireland* for 1901, Pt. II., p. 67, Plate III. Dublin, 1903.

Kyle.—"Halibut (*Hippoglossus vulgaris*, Flem.) or Pole-Dab (*Pleuronectes cynoglossus*," *Journal of the Marine Biological Association*, vol. vi., No. 4., Dec. 1903, p. 618, 1 plate.

M'Intosh and Prince.—"On the Development and Life-Histories of the Teleostean Food and other Fishes," *Trans. Roy. Socy., Edinburgh*, Vol. xxxv., Part III. (No. 19), Plates I. to XXVIII.

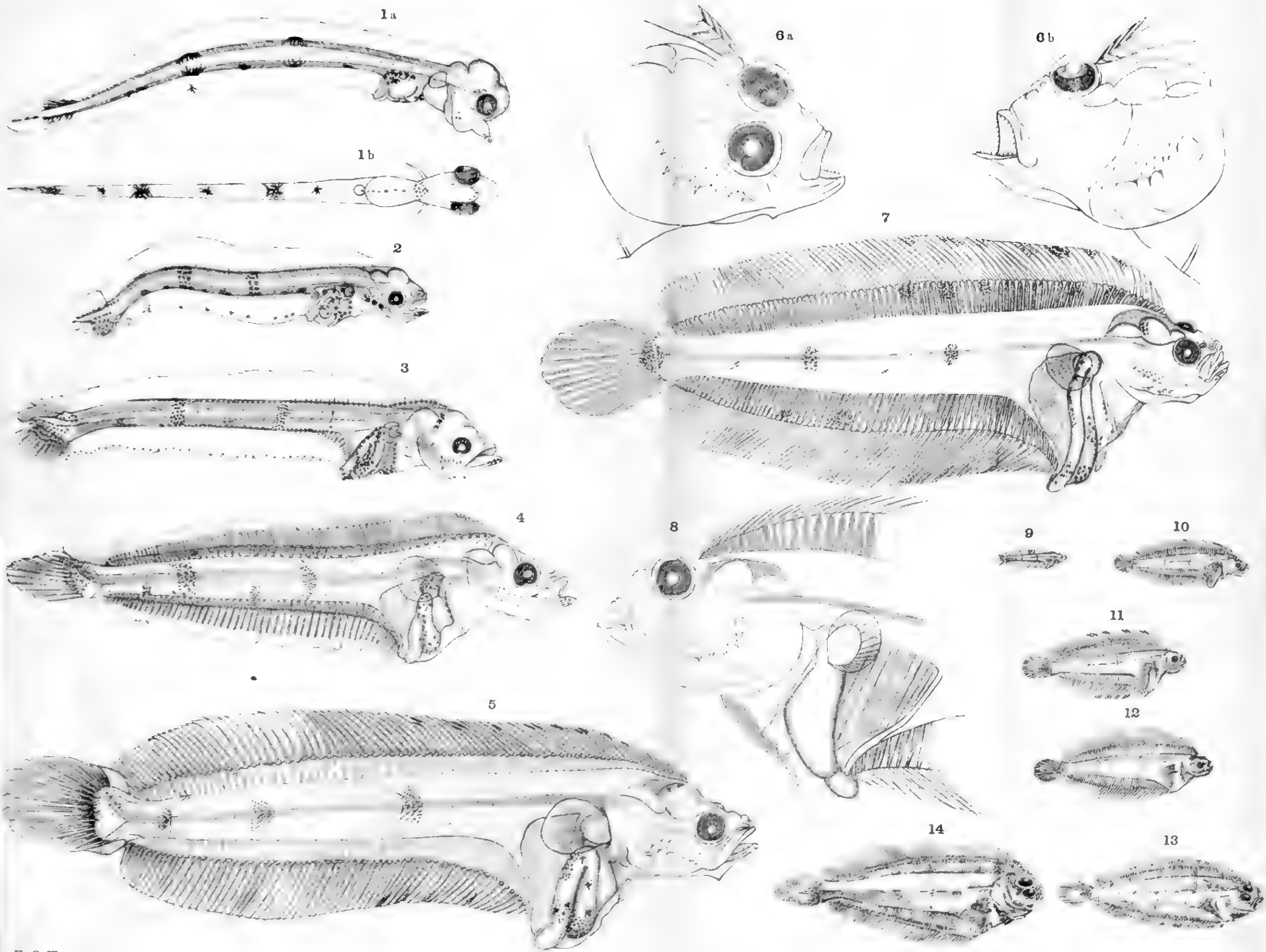
M'Intosh and Masterman.—"British Marine Food-fishes." London, 1897.

Petersen.—"On some Zoological Characters of Young (Post-larval) Flat-fishes," *Report of the Danish Biological Station*, iv., Appendix II., 2 plates, p. 126. Copenhagen, 1893.

Explanation of Plate XVI.

N.B.—No attempt has been made in the drawings to insert the proper number of interspinous bones and fin rays.

Fig. 1a.	Post-larval,	*Pleuronectes cynoglossus,*	5·2mm. long; ·75mm. greatest breadth, . .	× *ca* 19
Fig. 1b.	Do.,	do.,	do., ventral view.	
Fig. 2.	Do.,	do.,	12·5mm. long; 3mm. greatest breadth, . . .	× *ca* 6
Fig. 3.	Do.,	do.,	14mm. long; 3mm. greatest breadth, . . .	× *ca* 6
Fig. 4.	Do.,	do.,	18mm. long; 5mm. greatest breadth, . . .	× *ca* 6
Fig. 5.	Do.,	do.,	25mm. long; 7·5mm. greatest breadth, . . .	× *ca* 6
Fig. 6a.	Head of post-larval,	do.,	40mm. long; right side, .	× *ca* 6
Fig. 6b.	Do.,	do.,	40mm. long; left side, .	× *ca* 6
Fig. 7.	Post-larval,	do.,	34mm. long; 13mm. greatest breadth, . . .	× *ca*
Fig. 8.	Do.,	do.,	38mm. long: left side, .	× *ca* 6
Fig. 9.	Do.,	do.,	14mm. long, natural size.	
Fig. 10.	Do.,	do.,	28mm. long, do.	
Fig. 11.	Do.,	do.,	34mm. long, do.	
Fig. 12.	Do.,	do.,	38mm. long, do.	
Fig. 13.	Young,	do.,	44mm. long, do.	
Fig. 14.	Do.,	do.,	59mm. long, do.	



H. C. W.
Figs. 9–14. A. H. WALKER.

THE WITCH—*Pleuronectes cynoglossus.*

VII.—ON SOME PARASITES OF FISHES NEW TO THE SCOTTISH MARINE FAUNA.

By Thomas Scott, LL.D., F.L.S.

Plate XVII.

CONTENTS.

Preliminary Note.

Some time ago Dr Fulton, Scientific Superintendent to the Fishery Board, kindly handed to me for examination a specimen of *Trygon pastinaca*, Lin., which had been captured in the Dornoch Firth on October 22, 1903. This specimen measured about $14\frac{1}{2}$ inches across the pectoral fins and about $24\frac{1}{2}$ inches from the nose to the extremity of the very slender tail; it was thus not more than about the average size of this kind of fish, yet it yielded on examination no fewer than four different species of ectozoa. Two of these species belong to the Copepoda and two to the Trematoda, and only one of them, viz., *Brachiella pastinacæ*, van Beneden, appears to have been previously described. Descriptions and drawings of these apparently new forms are given here.

Moreover, while examining some organisms set aside from former collections, I found a specimen of *Lernæa lusci*, Bassett-Smith, obtained off Aberdeen in January, 1902; as this parasite has not before been recorded from Scottish waters, I have had a short description, with drawings of it, prepared for this paper.

I have further to state that at the end of this paper will be found a description and drawing of a very curious Natural History group consisting of a larval fish, somewhat emaciated, and two small Crustaceans, which appear to be attacking the fish; for this interesting specimen I am indebted to my friend and colleague, Dr Henry Charles Williamson.

The drawings have been prepared by my son, Mr A. Scott, A.L.S.

I propose to describe the various organisms mentioned in the order in which they are referred to above.

PART I.—COPEPODA PARASITA.

Fam. Dichelestidæ.

Genus *Eudactylina*, van Beneden (1853).

Eudactylina minuta, T. Scott. Pl. xvii., figs. 111.

Description of the Female.—The length of the specimen represented by the drawing (fig.1), measuring from the forehead to the end of the furcal joints, is about 1·1mm.(about $\frac{1}{23}$ of an inch), but that represented by figure 2 is slightly larger, and measures about 1·4 mm. The segments, especially along their dorsal aspect, are rough with minute scattered spines. The body is slender, as in the species previously described, but the fourth and fifth segments are rather more dilated than the others. The cephalosome is about equal in length to that of the first two segments of the metasome combined. The first segment of the metasome is a small one, while the next two are each rather longer and stouter than the one immediately preceding; the last segment of the metasome is considerably smaller than the third one. The segmentation of the urosome (abdomen) somewhat resembles that of *Eudactylina similis*, A. Scott.

The antennules, which are short and stout, are apparently five-jointed, as in those of the species referred to, and their armature is also similar to that of *Eudactylina similis*, but, on the other hand, there is a distinct difference in the proportional lengths of the joints,—the third being longer than the second joint and the fourth scarcely twice as long as the ultimate one (fig. 3).

The antennæ, which are moderately elongated, have a general resemblance in their form and structure to those of the other described species; but the second joint, which is about as long as the third, is produced on the inner aspect and near the distal end so as to form a single stout and prominent spine, and a single powerful hook-like spine with a thickened base carrying a few small setæ is articulated to the extremity of the third joint (fig. 4).

The mandibles and maxillæ do not present any marked difference from those of *Eudactylina acuta*, van Beneden.

The first maxillipeds, which resemble the same appendages in *Eudactylina similis*, are armed with a moderately stout terminal claw, and the end joint is furnished with a row of minute course denticles along the inner edge (fig. 5).

The second maxillipeds are large and strong and form powerful chelæ; they are somewhat similar in structure to those of *Eudactylina similis*, but the extremity of the claw which impinges against the lower spoon-like process has the stout apical tooth with a rounded hood-like covering (fig. 6).

In the first pair of thoracic feet both branches are two-jointed, and both are moderately stout; the inner branches are sparingly fringed with minute setæ, and armed with two apical spines of unequal length; the outer branches, which are rather shorter than the inner, are each furnished with a fringe of minute setæ on the outer margin of the first joint, while the end joint bears several spines round its outer margin and apex; the inner spine is of moderate length, but the others are small (fig. 7).

The structure of the second pair has a general resemblance to that of the same pair in *Eudactylina similis* and *E. acuta*. The inner branches, which are distinctly three-jointed, are considerably smaller than the outer ones, the first joint bears a longitudinal row of small spines on its inner aspsct, while the end joint carries two apical spines of moderate but unequal length. The outer branches are stout and elongated, and, like the inner ones, appear to consist of three joints, but the articulation between the first and second joints is apparently nearly obsolete; two short spines which have their bases dilated spring from the outer margin and near the distal end of the elongated first joint; the third joint, which is short and rounded at the extremity, is provided with a single and moderately stout subterminal spine, as shown in the drawing (fig. 8).

The third and fourth pairs are nearly alike, and resemble the same two pairs in *Eudactylina similis*, except that the inner branches are furnished with a number of scattered spinules on their outer aspect; the outer branches are each of them rounded at the extremity, and provided with a single elongated terminal seta, there are a few spines on the outer margins of the second and third joints, while the first joint bears a fringe of minute spines along its outer edge (fig. 9).

The fifth pair, which are broadly foliaceous and resemble in their general outline the same appendages in *Eudactylina acuta*, van Beneden, are furnished with several transverse rows of minute spines and three apical setæ (fig. 10).

The furcal joints, which are rather longer than the last abdominal segment, are each of them armed with two terminal spines—a stout one at the apex and a somewhat smaller one on the outer edge, as shown in the figure; a small seta springs also from near the middle of the outer margin (fig. 11).

Habitat.—On the gills of a specimen of the "Sting Ray," *Trygon pastinaca*, Linn., captured in the Dornoch Firth on October 22, 1903. No males of the *Eudactylina* were observed. The fish, as already stated, measured about 14½ inches across the pectoral fins, while its length from the snout to the extremity of the tail is about 24½ inches.

Remarks.—This *Eudactylina* appears to differ from previously described species by its smaller size—being little more than half the length of the smallest hitherto recorded, and from its being found on a different host. But there are also structural differences which separate it from other forms. I will recapitulate one or two of these: it differs in the proportional lengths of the joints of the antennules, in the armature of the antennæ, in the armature of the first maxillipeds, in the structure of the second pair of thoracic feet, and in the proportional lengths of the segments of the thorax.

Though a number of specimens were obtained, only a small proportion of them were in good condition for dissection.

Eudactylina acuta, Van Beneden.

1853. *Eudactylina acuta*, Van Beneden, Bull. Acad. Roy. Belg., vol. xx., pt. 1, p. 235; Mem. Acad. Roy. Belg. (1861), p. 150, Pl. xxv.

In my notes on the parasites of fishes in Part III. of the Twentieth Annual Report of the Fishery Board for Scotland (published October 2nd, 1902), I describe the occurrence of *Eudactylina acuta* on the gills of an Angel-fish, *Rhina squatina* (Lin.), captured in January 1902 about eight or nine miles south-east from Buchan Ness, and the description of the parasite is illustrated by a series of drawings. My son had already obtained the same *Eudactyline* on the gills of Angel-fishes captured in the Irish Sea, but there did not appear to have been any previous record of it from Scotland.

Through the kindness of Mr. Robert Duthie, Fishery Officer—presently stationed at Girvan, Ayrshire—I am enabled to record this interesting parasite for the second time from Scottish waters, which, like the specimens previously referred to, was found on the gills of an Angel-fish. This fish, which was captured by turbot-net fishermen in the seaward part of the Clyde estuary and landed at Girvan on May 25th (1904), was secured by Mr. Duthie, who kindly forwarded it to me for examination. The fish was an immature female, and measured two feet nine and a-half inches (nearly 83 centimetres) from the front of the head to the extremity of the caudal fin. This *Eudactyline* is an addition to the parasitic Copepod-fauna of the Clyde.

Lernæa lusci, Bassett-Smith. Pl. xvii., figs. 12 and 13.

1896. *Lernæa lusci*, Bassett-Smith, Ann. and Mag. Nat. Hist. (6), vol. xviii., p. 13, pl. iv., fig. 6.

The form described under this name is considerably smaller than the more common *Lernæa branchialis*, and hitherto it appears only to have been observed on the gills of the Brassie or Whiting Pout (*Gadus luscus*, Linn.). The specimen I have to record was obtained on the gills of a Brassie captured about ten miles off Aberdeen on January 16, 1901. This parasite measures a little over half an inch from the head to the end of the genital segment. The neck is slender and short, and the appendages of the cephalon are moderately developed. Dr. Bassett-Smith describes the posterior appendage as being sometimes as long as the neck, which is also characteristic of the specimen now recorded (fig. 13). The genital segment is considerably dilated and strongly sigmoid, except at the posterior end where, in marked contrast to *Lernæa branchialis*, it is only slightly curved; the twisted egg sacs are proportionally not so slender as in that species.

Lernæa lusci does not appear to have hitherto been recorded from Scottish waters, having been probably regarded as a form of *L. branchialis*. Figure 12 shows the specimen attached to the gill-arch of the fish.

Brachiella pastinacæ, Van Beneden.

1851. *Brachiella pastinacæ*, Van Beneden, Ann. des. Sci. Nat., 3rd ser., t. xvi., p. 118, pl. iv., figs. 8, 9.

Two specimens of this *Brachiella* were obtained in the nasal fossæ of the *Trygon* in which the *Eudactylina* just described was found. One specimen occurred in each of the two fossæ. These two specimens which were posted to the artist along with a few other things in order to have drawings of them prepared, failed to reach their destination, and I am therefore unable to furnish figures of this species.

PART II.—TREMATODA.

Fam. Tristomatidæ.

Thaumatocotyle concinna, gen. et. sp. nov. Pl. xvii., fig. 15.

A large sucker-disc, so characteristic of several of the Trematoda, is attached to the distal end of the body by a very short stalk which is apparently flexible. The sucker is nearly circular in outline, and its ventral surface is divided into thirteen marginal compartments which are separated from each other by narrow muscular bands; the compartment at the lower end of the sucker is larger than any of the other twelve and is of the form of an equilateral triangle, the blunted apex of which is directed inwards and reaches fully half way toward the centre of the sucker; the other twelve marginal compartments are of nearly equal size and are subquadrate in form, as shown in the drawing (fig. 15). Two moderately slender rods spring from two adjacent muscular bands near the centre of the disc, and extending to the circumference of the sucker terminate in little hook-like processes—one on each side of the lower triangular compartment.

The anterior end, which terminates somewhat abruptly and has a broadly triangular outline, is bifurcated in the middle. On the ventral aspect, close to the margin on each side of the fork and extending from it to the outer angle, there are arranged three small discs which may probably function as suckers.

The length of the specimen represented by the figure is about 3 millimetres (nearly $\frac{1}{8}$ of an inch), while the breadth at the widest part is equal to about one fifth of the length; the body is flattened and in some specimens nearly transparent, so that the internal structure may to some extent be discovered.

This Trematode does not agree with any genus or species known to me.

Habitat.—In the nasal fossæ of *Trygon pastinaca*, captured in Dornoch Firth, October 1903.

Heterocotyle pastinacæ, gen. et sp. nov. Pl. xvii., fig. 14.

Several specimens of the Trematode described under this name were obtained on the same *Trygon pastinaca* with the form just recorded, but they were found not in the nasal fossæ but on the gills along with *Eudactylina minuta* described in the first part of this paper.

In this Trematode the posterior sucker is slightly oval in outline—the transverse diameter being greater than that which is longitudinal in the proportion of about 13 to 11. The edge of the sucker is indistinctly crenate, and its ventral surface is divided into eight compartments, which extend from the circumference to near the middle, where they are interrupted by a small diamond-shaped space representing the point of attachment of the sucker to the body. The two lowest compartments are of a slightly larger size than the four upper ones, but the compartment on each side is about double the size of the one immediately above. Moreover, these side compartments, together with the two lower ones situated between them, are each sub-divided into two portions by a circular line, as shown in the drawing (fig. 14). About the middle of the band which divides each large lateral compartment from the lower one, there is attached a short rod that terminates in a strong hook.

The body is of a narrow ovate form and is considerably depressed; the greatest width is equal to nearly three and a half times the length; the total length of the specimen represented by the drawing is only 1·44 mm. (about $\frac{2}{35}$ of an inch). The anterior end is narrowly truncate, and is without any lateral appendages, as in *Phyllonella* or *Placunella*, which it otherwise resembles.

Besides the occurrence of the four different kinds of parasites from the Sting Ray mentioned here, Prof. van Beneden has obtained on specimens of the same species of fish taken on the coasts of Belgium, not only the *Brachiella pastinacæ*—which he found both in the nasal fossæ and on the gills—but also *Lerneopoda galei* and *Ergasilina robusta*; the first he obtained in the nasal fossæ and the other on the gills. The same writer also records finding five different kinds of Cestoids in the intestines of *Trygon.**

PART III.

Note on a Post-larval Fish Attacked by Podon leuckarti.

Plate XVII.—Fig. 16.

It is fairly well known to students of the Entomostraca that these organisms live to some extent on animal as well as on vegetable matter, and also that they do not always confine themselves to decaying substances, but that living specimens, if small enough and in a weak or sickly condition, are not exempted from being attacked by them. When examining a gathering of living Entomostraca in which Ostracoda are frequent, we may occasionally observe a number of these minute Crustaceans crowding round some object of general interest, and, when the reason for the crowding is investigated, find that they are busy feeding on a dead or dying companion.

* Les Poissons des côtes de Belgique leurs Parasites et leurs Commenceaux, pp. 14, 15 (1870).

But although such incidents are not of rare occurrence among the Entomostraca, the example to which I would direct attention, where a post-larval fish is apparently being attacked by two members of the family Polyphemedæ, is somewhat unusual. Larval and post-larval fishes have no doubt many enemies, among which may be included other fishes as well, and it has also been shown that even the harmless-looking *Sagittae* feed upon such larvæ,† but this is the first time I have observed Entomostraca presumably attacking a post-larval fish in the manner shown by the drawing.

As stated in the preliminary note, I am indebted to Dr. Williamson for this interesting specimen. The fish, he tells me, is a Pleuronectid—probably *Pleuronectes platessa*—but its emaciated condition made its correct identification somewhat doubtful. That these Crustaceans have become accidentally attached to the specimen is hardly likely, for the position they occupy and the firm hold they have of the fish, evidenced by their adhering while extraneous matter was being brushed off, and by their continuing to adhere firmly though subjected to a good deal of tossing about, does not favour such an explanation, but tends rather to support the opinion that they have intentionally seized hold of the young Pleuronectid, but whether for the purpose of attacking or merely for resting I am not prepared to say. The specimen is, however, sufficiently interesting to be recorded here. The fish was observed in a tow-net gathering collected last year and supposed to be from the North Sea. The two Crustaceans belong to the same species, viz., *Podon leuckarti*.

*Annals of Scottish Natural History, April, 1892, p. 142.

DESCRIPTION OF THE PLATES.

PLATE XVII..

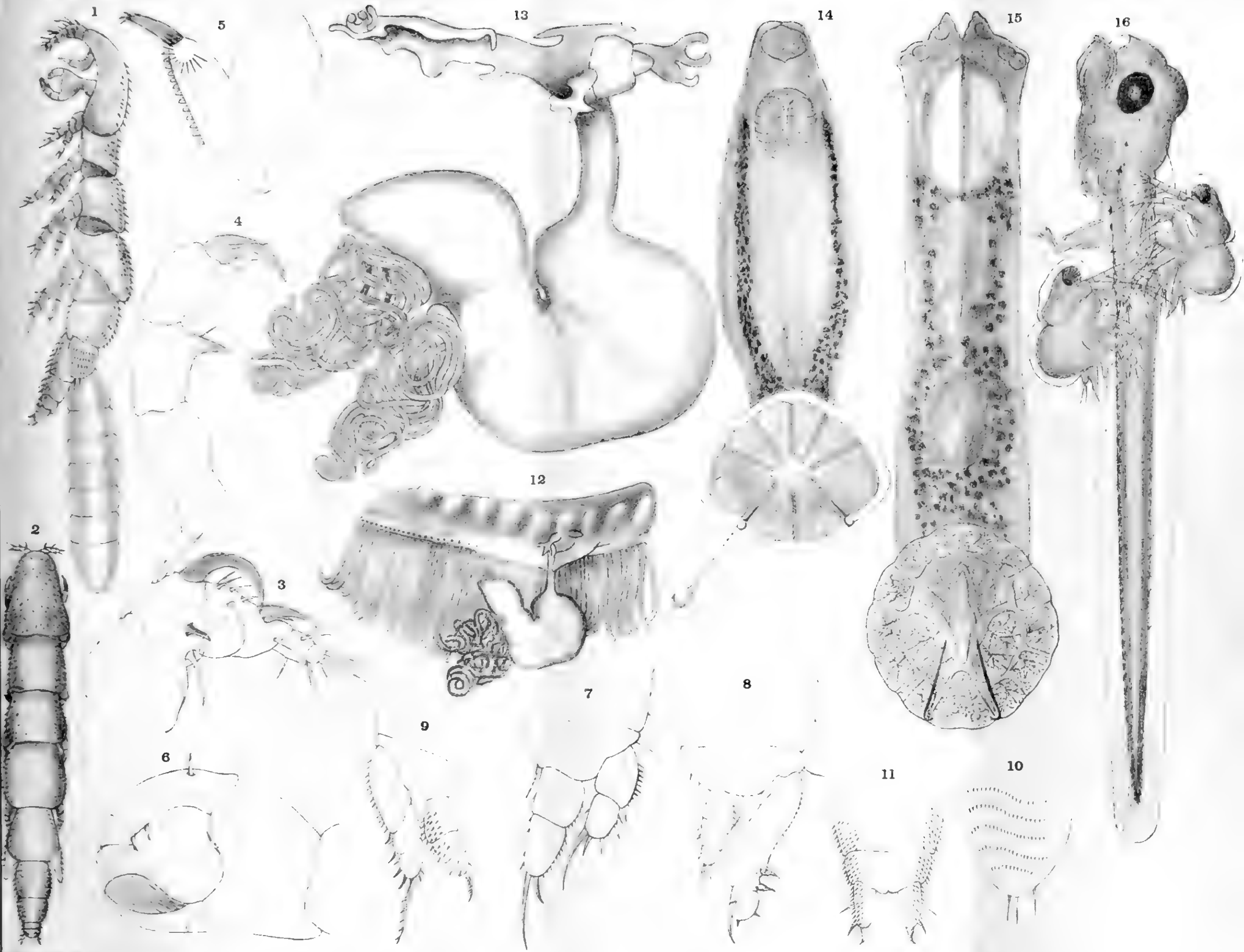
	Eudactylina minuta.	Diam.
Fig. 1.	Female, side view,	× 79·5
Fig. 2.	Female, dorsal view,	× 61
Fig. 3.	Antennule,	× 521
Fig. 4-	Antenna,	× 521
Fig. 5.	First maxilliped,	× 521
Fig. 6.	Second maxilliped,	× 390
Fig. 7.	Foot of first pair,	× 521
Fig. 8.	Foot of second pair,	× 260
Fig. 9.	Foot of fourth pair,	× 260
Fig. 10.	Foot of fifth pair,	× 260
Fig. 11.	Furcal joints and last two segments of abdomen,	× 260

Lernœ lusci.

Fig. 12.	Female, side view,	× 9
Fig. 13.	Parasite on gill of *Gedus luscus*,	× 3

Trematodes.

Fig. 14.	*Thaumutocotyle concinna*,	× 95·5
Fig. 15.	*Heterocotyle pastinacœ*,	× 53
Fig. 16.	Larval fish with two specimens of *Podon leuckarti* attached to it,	× 39·75



A. SCOTT, del. ad nat.

E
pc
fa
ha
as
Sa
E
sh

fo
pr
co
be
po
by
the
tos
sup
Ple
res
int
gat
Th

Fig.
Fig.
Fig.
Fig.
Fig.
Fig.
Fig.
Fig.
Fig.
Fig.
Fig.

Fig.
Fig.

Fig.
Fig.
Fig.

VIII.—ICHTHYOLOGICAL NOTES.

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

[Plate XVIII.]

CONTENTS.

The Young of the Conger (*Leptocephalus*).

Two specimens of the young of the conger eel were caught in the Moray Frth by means of the small-meshed net around the otter trawl, which has been so productive of rare forms, and as such specimens are very rarely obtained in British seas, and they differ from one another in age and characters, I have thought it desirable to give a description and figures of them here.

The first specimen (Fig. 1) was obtained on 27th December on Smith Bank, a well-known fishing ground off the coast of Caithness, in 28 fathoms of water. It was not recognised at the time among the other fishes caught and the lot were preserved in formaldehyde and taken to the marine laboratory at the Bay of Nigg. It was only later, when the material was being worked up, that the specimen was discovered. With the exception of a slight abrasion on the posterior half it was in good condition; the imperfection was probably due to the fish having been caught by doubling as it passed through the mesh of the net. On examination some weeks after it was caught it was found to be translucent, with a whitish opacity, the perfect transparency of the living form having been affected by the preservative. It was quite soft and flexible, resembling a tapeworm in these respects, as well as in its extremely flattened form. In extreme length it measured 145mm., ($5\frac{3}{4}$ inches), and it is therefore among the largest of the specimens recorded. Its weight, after the superfluous water had been removed, was only 0·61 grammes, and its volume was 1·1 cubic centimetres as nearly as could be determined. Its bulk in proportion to its length, as will be seen below, was thus very much under that of the other older but shorter specimen.

The extreme dorso-ventral height of the body was 13·5mm., and it was broadest from about 70 to 95mm. from the head; the height just behind the head was 7mm., or about half of the other. The thickness of the body was difficult to determine; it was much thicker behind the head, where it measured about 2mm., and from this point to the posterior extremity it gradually diminished, the greater part of it being rather under than over 1mm. in thickness. The length of the head from the tip of the snout to the gill-cleft measured 10mm., and its height at the eyes was 5mm., the breadth being 3mm. just behind the eyes. The eyes were relatively large, measuring 2·5mm. in diameter (they are represented as rather too large in the enlarged figure, and as a little too small in the other figure); the anterior edge is situated about 3mm. from the tip of the snout. The snout is blunt and obtuse and rounded, and longer than the lower jaw, which is more pointed. The cleft of the mouth ends rather behind the middle of the eye, and each jaw is armed with a series of somewhat long, fine, slender teeth, those in front being the longest; of these, 34 were made out in the lower jaw and 30 in the upper.

The pectoral fins, placed immediately behind the gill-opening, were small and delicate, measuring about 3·5mm. in length.

With regard to the pigment, there were two minute specks of black on the lower part of the gill-cover on the left side and four similar specks on the corresponding position on the other side. A linear series of black specks runs along each side of the ventral margin, beginning about 11mm. behind the pectoral fin; they are most distinct in the anterior portion but are continuous to the tail, and in the posterior part they are much more minute, numerous, and crowded, giving the appearance of a very fine black line. Along the lateral line there is a single linear series of corresponding chromatophores, of which 35 were counted, and beginning about 35mm. behind the head; they are usually situated at the junction of myotomes, and are most numerous towards the tail. No other pigment specks were observed.

Of the myotomes—which are very distinct except at the tail—I counted 142, but, as stated, those at the posterior extremity are indistinct.

The second specimen (Fig. 2) was of a different kind in several respects. It was taken in 24 fathoms, also in the Moray Firth but south of Smith Bank, on 12th February. In shape it is vermiform rather than tænioid, and appears to correspond to the *L. punctatus* of Kaup, and which has been shown by Grassi and Calandruccio to be the stage from which the perfect conger is directly developed. It measures 123mm. ($4\frac{7}{8}$ inches) in extreme length, and weighed, after the superfluous water was removed by blotting paper, 1·675 grammes, its volume being 1·8cm. It will be seen by comparing these figures with those referring to the other specimen that the reduction in length is accompanied by a considerable increase in bulk, since the shorter specimen weighed over 1 gramme more than the other, its weight being nearly three times greater. The volume, as stated, did not increase in the same proportion; the discrepancy is perhaps due to the tissues of the younger being less solid, perhaps to defect in the determination of the volume.

The extreme breadth of this specimen is 10·5mm. and its thickness 3mm. Its thickness is maintained in a fairly uniform way for the first two thirds of the length of the body, after which it diminishes rapidly. The distance from the tip of the snout to the commencement of the dorsal fin is 44mm. and from the same point to the anus 55mm. The head is 9mm. in length, 4·5mm. high, and 3·5mm. broad, and the top is more rounded than in the younger specimen. The eye is somewhat smaller, measuring 2mm. in diameter and placed 2·5mm. from the end of the snout. The lower jaw is shorter than the snout, but not to the extent represented in fig. 2b. Teeth, so conspicuous a feature in the younger specimen, could not be made out. The pectorals were more developed, being longer and, especially, broader. Of the myotomes, not so distinct as in the other form, 141 were counted. The black chromatophores were arranged as in the younger specimen, but none were observed on the head. Those along the lateral line are more conspicuous than those placed along the ventral margin, of which there are 26 in front of the anus, and they are much more numerous behind, being crowded together, as in the first specimen, towards the tail.

The literature dealing with these young forms need not be given here, as Cunningham has given a very full account of it in some of his papers,* and he has described a specimen of *Leptocephalus Morrisii* which he obtained at Plymouth in June, 1895.† Besides the classical papers of Grassi and Calandruccio, reference may be made to two papers, one by Eigenmann on "The Egg and Development of the Conger Eel," and the other by the same author and C. H. Kennedy, on the "Leptocephalus of the American Eel and other American Leptocephali," both published in 1901.‡

A Larval *Fierasfer*.

On 8th October last year a larval Fierasfer was taken in a tow-net used on board a fishing boat at a distance of about 185 miles E. by N. of Aberdeen; the net was used between the surface and twenty fathoms, the depth at the place being between fifty and sixty fathoms. (Pl. XVIII., fig. 3, 3a).

The specimen measured 64mm. ($2\frac{1}{2}$ inches) in length and exhibits the slender form characteristic of the genus; the yolk, as indicated in the figure, forms a considerable mass. The remarkably elongated first dorsal ray was apparently damaged, but enough of it is left to show the presence of the skinny lobes with which it is provided.

Fierasfer is remarkable for its habit in the adult condition of living within Holothurians in a condition of commensalism, but it would appear that its larval pelagic life is one of considerable duration. It is an extremely rare fish, and even Emery, who has written the classical monograph on it,§ was able to obtain only a few specimens.

Outside the Mediterranean, specimens have rarely been obtained. According to Couch, Edwards found six specimens, between 6 and 7cm. long, in March, 1863, on a sandy bottom off the coast of Banff, but the record stands in need of confirmation and is passed over by Day. The latter author mentions only two examples of *F. dentatus*, both got on the south coast of Ireland, one in 1836 and the other in 1852, and there does not appear to be any other good British record of its occurrence.

Only other three specimens appear to be recorded for the north of Europe. One was taken by a fisherman in from 100-200 fathoms on the Jutland Reef, to the west of the Scaw—and therefore not a great distance from the locality where the specimen here recorded was obtained—and it is now in the Royal Museum at Stockholm. The second specimen was got near Stavanger in 1881, and was described by Collet; it is in the Bergen Museum.|| The third was a specimen of *F. acus*, obtained by H.M.S. *Triton* in the Faröe Channel, on 9th August, 1882, close to the surface. It measured 104mm. in length, and has been described by Günther.¶

The Sting-Ray (*Trygon pastinaca*).

On the 22nd October a specimen of the sting-ray was taken in the trawl by one of the trawlers engaged in scientific work in the Dornoch Firth in from 8 - 13 fathoms. It was a female, measuring in extreme length 63·0cm., and in extreme breadth 37·5cm. It is noteworthy that

Journ. Marine Biol. Assoc., vol. iii, p. 281; vol. ii, p. 36.
†*Ibid.*, iv, p. 74.
‡*Bull. U. S. Fish Comm. for 1901*, pp. 37-81.
§"Fierasfer. Studi intorno alla sistematica, l'anatomia e la biologia delle specie mediterranee di questo genere." *Atti R. Accad. d. Lincei*, vii., 1879-80.
|| *Christian. Vidensk. Forhandl.* 1882, No. 19.
¶ "Report on the Pelagic Fishes collected by H.M.S. 'Challenger' during the years 1873-1876," page 27, 1899.

the torpedo described in the *Nineteenth Annual Report** was caught near the same place. On this specimen Dr. Scott found some new and interesting parasites (*see* p. 275.)

This fish is said by Day to be not uncommon off the mouth of the Thames and along the south coast, and Dr. Murie states that on the coast of Kent and at Burnham specimens from $1\frac{1}{2}$ to 2 feet are not uncommon, while in the estuary of the Thames it is not abundant and only small specimens are found.† Holt refers to two small specimens trawled off Plymouth, and several taken on the trawling grounds off Salcombe; and he says the fish is well known to the local fishermen and hardly deserves special mention as a rare fish in that district.‡

It is, however, a very rare fish in Scottish waters. Parnell met with only one example, which was caught in a salmon-net in the Firth of Forth,§ and Mr Eagle Clarke, who has brought together all the descriptions of rare species of the Firth of Forth since the time of Parnell, met with only one specimen which he examined in 1897, and which was caught off the Isle of May, and it is the only instance he knows of since Parnell's record.‖ It does not appear, either, that the indefatigable Edwards of Banff ever came across a specimen.

It is noteworthy that this species, like the torpedo, usually has the skin smooth and soft; though Day mentions that there are occasionally some tubercles along the middle line of the back in the scapular region. The one is protected by its electric organ and the other by the formidable serrated spine with which its tail is provided, and which is capable of causing dangerous wounds; they thus differ from the ordinary rays in this respect.

The Pilchard (*Clupea pilchardus*).

On the 20th June last year a pilchard was taken in a drift-net employed in catching herrings, about 15 miles off Buckie, in the Moray Firth, where it was landed. I am indebted to Mr. Alexander Sutherland, the Fishery Officer of the district, for the record. It measured $8\frac{1}{4}$ inches in length.

In Scottish waters the pilchard is a very rare fish. Parnell, writing in 1837, says that it was then very rare, although some thirty years before it was common, and in certain localities found in equal abundance with the herring; as no authority is quoted the statement may be based on Parnell's own observations. He says that a few were occasionally taken in the summer months on the Berwick and Dunbar coasts, but that since 1816 no pilchard had been observed in the Firth of Forth. Day also states that pilchards were more than usually abundant at Yarmouth in 1780, 1790, and 1799, but he does not mention his authority.

They are, however, occasionally taken at long intervals. Thus Eagle Clarke states that Mr. Logan records in the "Proceedings of the Royal Physical Society of Edinburgh" (vol. ii., p. 289) that in March, 1861, considerable numbers of young pilchards were brought to the Edinburgh market along with herrings and sprats; they were only caught in large quantities for a few days in March, but they had occurred sparingly with herring during the previous winter months. Dr. Murie¶ says that

* *Part III.*, p. 290.

† "Report on the Sea Fisheries and Fishing Industries of the Thames Estuary," p. 169, Kent and Essex Sea Fisheries Committee, London, 1903.

‡ *Journ. Marine Biol. Assoc.* v., p. 198, 1898.

§ "Fishes of the Firth of Forth," p. 440, 1838.

‖ *Annals of Scottish Natural History*, Oct. 1900, p. 215.

¶ *Op. cit.*, p. 104.

a considerable number were taken off Harwich in September, 1868; and a few stragglers are still brought in with the herrings at Yarmouth, according to Patterson in the Zoologist for 1897.

The Fecundity of the Sprat.

Observations on the fecundity of the sprat have been apparently rarely made, no doubt from the rarity of ripe sprats among those caught by fishermen, the only statement on the point, as far as I am aware, being in my paper on the Fecundity of Fishes in the Ninth Annual Report of the Fishery Board.* In their work on British Marine Food Fishes, Professor M'Intosh and Mr. Masterman say that "the mature female appears to carry about 5000 or 5400 eggs, more or less," which agrees generally with what is stated in the paper referred to, but it is not mentioned whether their remark is based on my observations or on others of their own confirming it.

Ripe sprats having been caught in the Moray Firth in the small-meshed net used on board trawlers the opportunity was taken to investigate the point again, the previous observation having been founded on only one specimen, and that not very well preserved. As mentioned elsewhere, it is a striking feature in the ripe sprat that it is impossible to tell from the external appearance that it is ripe. There is no swelling caused by the ovaries or testes as in most other fishes, and on opening the fish the ovaries were found to be very small, although the eggs were mature and nearly mature. The contrast with the ripe herring, for example, is marked, and yet the eggs in the latter are demersal, while most fishes with pelagic eggs have greatly enlarged ovaries and exhibit abdominal tumefaction at the spawning time. It appears, however, that all this is in conformity with the number of eggs spawned by the sprat. The fish which I examined in 1890, referred to above, measured 4½ inches in length, and was found to contain about 1404 large eggs, and about 4000 smaller ones; the ovaries weighing 6·5 grains.

The following are the particulars of five females examined.

	Length.	Weight.	Weight of Ovaries.	Piece Examined.	No. of Eggs.	Total Eggs.
	Mm.	Grammes.	Grammes.	Grammes.		
1	122	12·8	0·38	·032	228	2713
2	120	12·0	0·492	·041	274	3488
3	124	12·8	0·441	·037	158	1880
4	122	10·5	0·458	·058	297	2346
5	120	11·8	0·541	—	147	2484

The eggs enumerated were those which were large and yolked, but there were many smaller, and in point of fact it would be difficult to draw a line anywhere between the large and the small, and to say that so many belong to this spawning season and so many to the next. The average number of eggs in these specimens was 2582, the small unyolked being excluded, which is rather greater than the number given for them in the early paper referred to. On the whole, however, on the assumption that the small eggs develop and become mature during the

* *Part III.*, p. 268.

course of the spawning season, the number stated in the paper may be about right, viz., 5000. The duration of the spawning season is not well known. The floating eggs were procured by the *Garland* from 23rd March to 19th August,* and it so happened that the extreme dates were in the same year, so that the period mentioned, comprising 149 days or very nearly five months, may be taken to represent the extent of the spawning season. How long the individual sprat goes on spawning is not known, but considering that the period embraces the warmest part of the year, and that growth is greater then, it is probable that at least the 5000 eggs are shed. But even in that case, it is evident that the sprat is one of the least fecund of fishes and, so far as known, the least of all among the fishes whose eggs are pelagic. Amid the varied complexities in the life of marine fishes the explanation is not easy to discover. That the comparatively early age at which the sprat may reach maturity is not the sole explanation—though doubtless an important factor—is shown by the fact that the whiting, which reaches maturity in its second year, produces a very much larger number of eggs.

An Albino Plaice.

Last year a few post-larval plaice were discovered in the hatching apparatus, and among them was a small albino specimen, or one in which the pigment was almost entirely absent. The only pigment present was a few scattered chromatophores along the rays of the dorsal, ventral, and caudal fins, on the anterior part of the head between the eyes, the edge of the lower jaw, and between the jaw and the pectorals, and about a couple of dozen of minute specks scattered over the posterior half of the body, mostly near the tail. The eyes were fully pigmented. The pigment was a dark umber. The body of the little fish was transparent, the bottom of the hatching-box being visible through it. It lived for about a year, and it differed in habit from the other small plaice living with it in that, while they were nearly always on the bottom, it preferred the side of the box, to which it clung, close to the surface of the water. The peritoneal lining of the abdominal cavity shone through the tissues with a metallic bronze appearance.

The Thickback (*Solea variegata*).

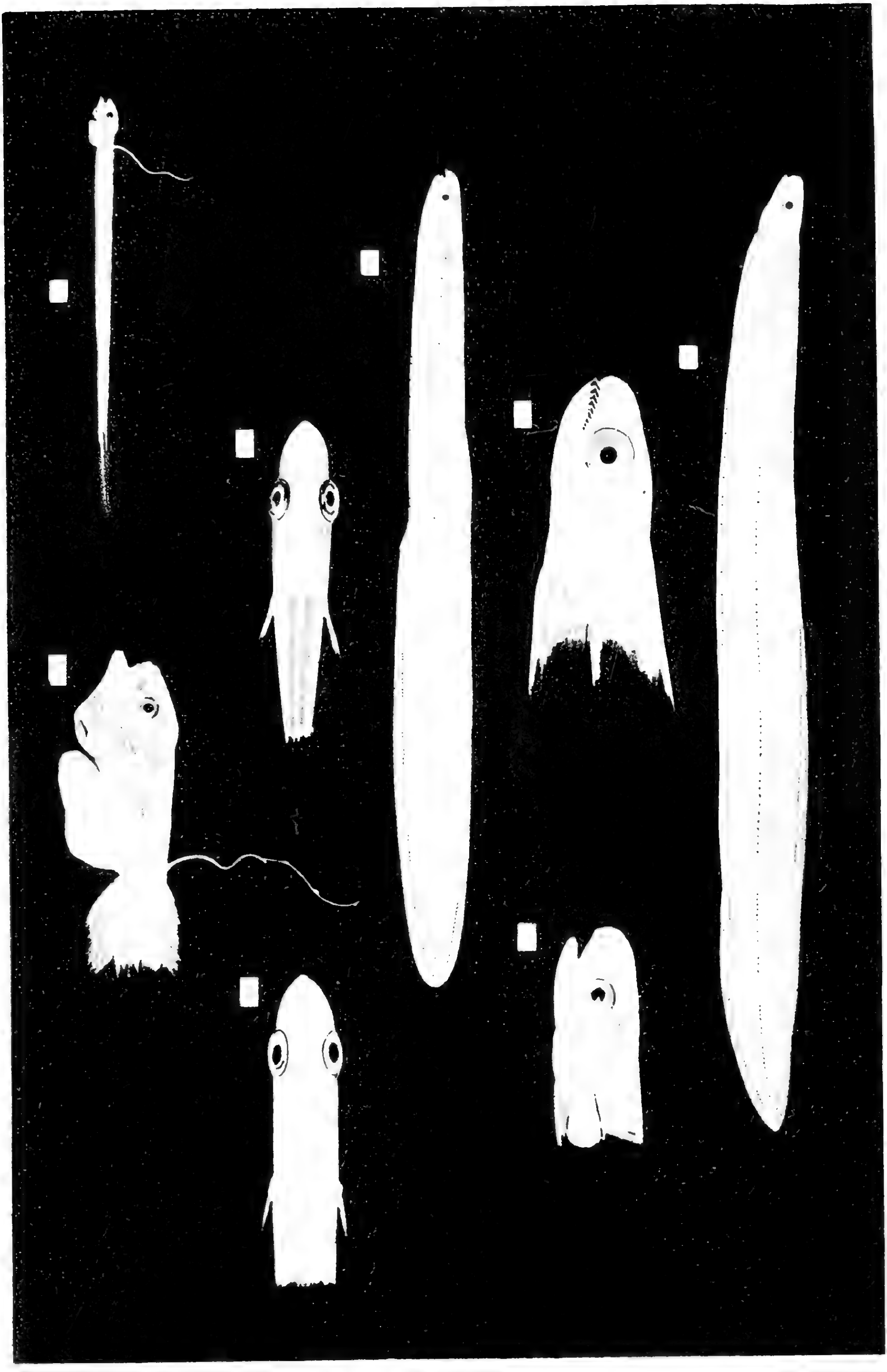
Two specimens of this species of sole were taken in the small-meshed net in the Moray Firth—the first on 27th December in 28 fathoms at Smith Bank, and the other on the following day in 30 fathoms off Burghead. They were both females—the first measuring 14·8cm. with the roe well developed, and the second 16·3cm. The latter weighed 38 grammes, the ovaries weighing 1·1 grammes, and the eggs were well advanced, the larger measuring ·84mm. in diameter. It is evident, therefore, that this fish spawns in the Moray Firth, but it is rare.

It is common on the south coast of England, especially (according to Cunningham)† south of the Eddystone, in from 30 to 40 fathoms. Two specimens were taken by Holt during the Irish Survey. It has also been occasionally captured on the west coast of Scotland, Gunther describing two immature specimens caught off Cantyre in 65 fathoms in March 1888,‡ and a few small specimens have been taken by the *Garland* in the Firth of Clyde. Day says that it was met with occasionally off Banff by Edwards, but I have not traced the record.

* Masterman—"A Review of the Work of the 'Garland' in connection with the Pelagic Eggs of the Food Fishes," *Ibid.*, Part III., Fifteenth Report, p. 234.

† "Marketable Marine Fishes" p. 259.

‡ *Proc. Roy. Soc., Edin.* xv., p. 220.



The Growth of the Halibut.

A specimen of the halibut, which was obtained for me by Mr. Ingram, the Fishery Officer at Aberdeen, may possibly throw some light on the growth of this fish. It was caught at Iceland by hook in the spring, and landed at Aberdeen. It measured 64·0cm. (25 inches) in length, and weighed 2·350 kilogrammes. On the under surface, extending the whole length and breadth of the fish, were certain markings, part of which was plain and part obscure. The following was very clear:—"T. M. 1901," and it was succeeded by what appeared to read "AGLI," but may have been meant to represent "AUGT," or August. The marks were obviously made with a knife, and the curves were angular; the cicatrix was very narrow and linear and attached to the subcutaneous tissue, and I suppose it occupied the same relative position in the surface of the fish at first, the skin growing equally all over.

I am informed by Mr. Ingram that the mate of the vessel which brought in the fish (the *Caspania*) states that in his time it was a common custom for the fishing apprentices at Grimsby to "engrave" their names in this way on small halibut, and then throw them overboard. If the date is authentic, it would show that the growth of the halibut in proportion to the size it attains is not rapid, because it implies that about two years and eight months elapsed after the marking was made, and the fish must at the time have been of a certain size. But a plaice of about the length given would be probably more than six or seven years old at least.

Reversed Action of the Gill-cover in Plaice.

It may be worth recording that the plaice in the large pond at the Bay of Nigg Laboratory frequently exhibit a reversal of the usual action of the gill-cover under certain conditions. In the process of respiration fishes take in water by the mouth, and by a process like that of swallowing expel it by the gill-openings. But when the tame plaice in the pond cling to the side at feeding-time, they very commonly push their snout and head for some distance out of the water, and it may then be observed that the water is spouted upwards from their mouth as a little fountain, an inch or so in height. In this case it is evident that the water is drawn in through the gill-openings behind, passes over the gills, and is then expelled by the mouth. The observation has some interest in connection with the known habits of some other fishes.

EXPLANATION OF PLATE.

Fig. 1. *Leptocephalus Morrisii*, natural size.
(1*a*.) Head enlarged, side view.
(1*b*.) ,, ,, dorsal view.
Fig. 2. *Leptocephalus punctatus*, natural size.
(2*a*.) Head enlarged, side view.
(2*b*.) ,, ,, dorsal view.
Fig. 3. *Fierasfer dentatus*, larva, natural size.
(3*a*.) Anterior part enlarged.

INDEX.

Glasgow: Printed by JAS. HEDDERWICK & SONS,
For His Majesty's Stationery Office.