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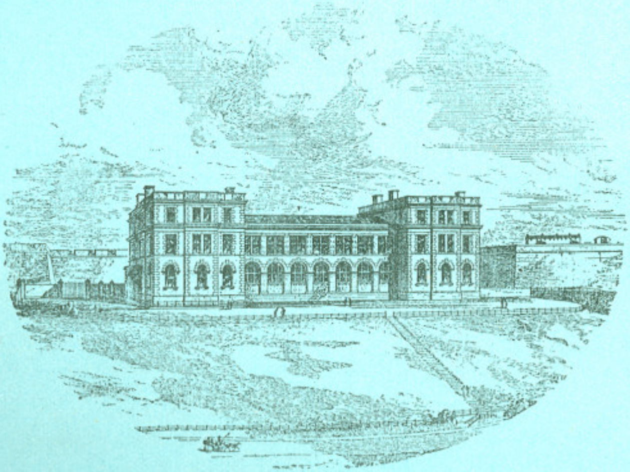

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On the Variation, Races and Migrations of the Mackerel (*Scomber scomber*).

By

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Pour bien savoir les choses il en faut savoir le détail.

De La Rochefoucauld.

Introduction.

The present investigation was undertaken at the invitation of H.M. Treasury, in consequence of an application to the government from H.M. Inspectors of Irish Fisheries for a scientific investigation into the life-history of the mackerel. The problem to the solution of which the inspectors attached particular importance was the relation to one another of the spring and autumn schools of mackerel which regularly visit the Irish coasts. In the spring a multitude of large fish approach the south and west coasts of Ireland to breed. In the autumn schools of immature, but usually well-grown, mackerel come around the island. According to one of the inspectors, the Rev. W. S. Green, there is a sharply defined interval between the two visitations of fish.

The first result of the Treasury's communication was the preparation by Mr. Allen of a report on the "Present State of Knowledge with regard to the Habits and Migrations of the Mackerel," which was published in this Journal in the autumn of last year. (vol. v., No. 1, August, 1897, pp. 1–40.) This report contains a compendious and suggestive summary of all the reliable information we possess up to the present concerning the geographical and seasonal distribution of the mackerel, its rate of growth and breeding habits, and the extent and causes of its migrations.

It will readily be understood that the investigation of the relations between the spring and autumn fish of the Irish coasts could not profitably be undertaken except as part of a general scheme which should embrace the study of the mutual relations of the mackerel of neighbouring seas as well; for hitherto it has not been ascertained whether the Irish fish as a whole are peculiar to Irish waters, or whether there is any intermingling with the mackerel of the English Channel and North Sea. The general impression appears to be that the mackerel round all the British coasts form a single race or family, which becomes dispersed during the summer in order to occupy the various seas and channels round our islands, but becomes largely reunited in the winter after the autumn migrations. Upon this theory the separation of the mackerel family is determined principally by size, the larger fish remaining near the shores of the ocean, from the Irish coast to the Lizard, the smaller fish pushing their way northwards and eastwards into the shallower waters of the Irish Sea, the English Channel, and the North Sea. This view is expressed, for example, by Day in his *British Fishes,* and by Mr. Matthias Dunn (*Report Royal Cornwall Polytechnic Soc.*, 1893). But the separation of the large Atlantic class from the small class found in the more enclosed waters is not regarded by these writers as in any way permanent. Every year, according to Mr. Dunn, the Atlantic (or Irish) class receives a reinforcement from the larger fish of the second (or shallow water) class; while the younger fish which have been bred off the Atlantic coast tend, in the spring of the year, to make common cause with the fish which frequent the English Channel. There is thus a complete mixture between the two classes, which cannot consequently be regarded as constituting local races in the sense in which we speak of Baltic and North Sea herring as forming separate races.

A still more decided view of the unity of the mackerel family has been entertained by Mr. W. S. Green, the energetic Inspector of Irish

Fisheries, who points to the similarity of the mackerel on both sides of the Atlantic as evidence of probable intercommunication between the American and European representatives of the species (Bull. U.S. Fish. Com., xiii., 1893, p. 357), and the same view appears to have been held, though reservedly, by Mr. Dunn (*loc. cit., p.* 3 *of reprint*).

Clearly the first thing to be settled at the outset of the investigation was the relationship between the mackerel of different seas. In addition, therefore, to consignments of fish from Irish and English ports, I have endeavoured at different times to secure representative samples of foreign fish. Of American fish I examined a number during my visit to Canada and the United States in the autumn of 1897, both at Toronto and in the Fulton Market at New York, and the Association is indebted to the United States Fish Commission for the transmission, in October, 1897, of an excellent sample of one hundred fish from Newport, Rhode Island. To Mr. W. de C. Ravenel, Acting Commissioner at that time, I desire to express my thanks, on behalf of the Association, for his kind and courteous assistance in the matter. To the Directors of the Hamburg-American Line we are also under a debt of gratitude for their gratuitous conveyance of this box of fish in a refrigerator of one of their express steamers direct from New York to Plymouth, an arrangement which contributed largely to the excellent condition of the fish on arrival after their long journey. From Brest I received a consignment of one hundred fish, for which, as for many other services, I have to thank Mr. W. S. Hoare, the British Consul at that port. Capt. W. Arthur, of the s.s. *Gipsy*, who had rendered me much assistance on an earlier occasion, by placing his boat at my disposal for securing some temperature and other observations, kindly conveyed the box of fish direct to Plymouth. I have also much pleasure in thanking Prof. Marion, of Marseilles, for a sample of Mediterranean fish, though they arrived too late to enable me to incorporate the results of their examination in the present report. Unfortunately, a consignment of fish which I expected from Norway has not arrived, and I must postpone until next spring any comparison between the British fish and those which annually visit the Scandinavian coast.

The sources of the English and Irish fish examined are given in the tables, and in the list of particulars concerning the consignments. It will suffice to say that I have received samples of several hundred fish from each of the following regions: the West and South coasts of Ireland, the English Channel, and the North Sea. Altogether I have examined in detail some 1800 fish, and the total number included in the tables of variation appended to this report amounts to 1649. The omission of about 150 fish from the tables is due to the fact that about 100 Plymouth fish were used in a preliminary enquiry before the general plan of investigation was decided upon, and that a number of fish caught at Plymouth during the summer of 1897 were so much smaller than any from other localities (from 4 to 9 inches in length), that I have thought it better to reserve most of the results of their examination until a sufficient number of young forms has been also obtained from other parts. These small fish are frequently taken in sprat seines, weirs, and in other ways on various parts of the British coast, and I should be much obliged to any who read these lines, and have the opportunity of assisting, if they would kindly forward to me any specimens of the common mackerel they may come across below 8 inches in length. They should be forwarded fresh (but damp) by post, if in small quantity; or in seaweed or ice by train, if in quantity; and the locality, date, and method of capture should be recorded. The cost of carriage, &c., will be willingly paid by the Association.

As regards the condition of the fish in the different consignments under examination, I should say that the Plymouth fish have been examined in a perfectly fresh condition, but that all other fish, except those in two Irish consignments, have been iced before examination, in order to enable them to withstand the effects of a more or less lengthy journey by rail or sea. The two Irish consignments referred to were those dated Kinsale, July 30th and September 3rd, 1897. These fish arrived during my absence in Canada, and after measurement were placed in tanks of formaline to await my return. With this exception, the condition of the different consignments at the time of examination may be regarded as practically uniform, so far as external characters are concerned. The viscera of the fish from Brest, and of some of the earlier Irish samples were, however, so rotten, owing to delays in transit, that no attempt was made to record the sexual condition of all the fish in these particular samples.

After this introduction I may proceed at once to describe the methods and results of the investigation up to the present time.

I. The Method of Investigation.

As all attempts to discover constant individual peculiarities in the mackerel of any one locality, as compared with those from any other, have completely failed, it is clear that, in order to determine whether local races exist or not, recourse must be had to the detailed study of the variation of certain chosen characters in the fish of different localities. The range of variation in these different local groups of fish can then be compared, and the frequency with which particular variations, or combinations of variations, occur in any one group can be compared with its frequency in all the others. Thus, if we suppose the number of finrays in the first dorsal fin to vary between 10 and 14, the value 12 will *probably* occur with greatest frequency. But other possibilities occur; and while 12 might be constantly the most frequent value in samples of one local group of fish, it is quite conceivable that 13 might be constantly the most frequent value in samples of another group; in which case, if the two groups were examined under similar conditions of sex, size, preservation, and so forth, we should be prepared to regard the two groups as racially distinct, the one indispensable condition being that the frequency of the particular variation shall have been determined in all instances upon a sufficient number of specimens.

It is, however, impossible to assign any one number beforehand as universally sufficient. The minimum sufficient number may be regarded as that which yields results approximately coinciding with those derived from an infinitely large number, *i.e.*, the percentages of frequency derived from it must bear some close degree of correspondence with the percentages derived from a much larger number. I have taken 100 as the minimum number of mackerel from which it is possible to derive a fairly reliable statement concerning the relative frequency of the variations exhibited by any one of the chosen characters. But the number of specimens requisite to yield a reliable statement of the frequency of variations of any organ bears a relation to the variability of the organ. If an organ varies slightly, the number of specimens must be increased. It is certain, for example, that 100 is an inadequate number for determining the normal frequency of the variations in the number of the dorsal finlets in the mackerel of British seas (see table H, p. 295); for, among 100 fish from Ramsgate, not a single specimen possessed less than 5 finlets, and 5 specimens possessed more than that number; whereas, of 300 fish from Lowestoft, 1 % possessed only 4 finlets, and only 3 % possessed 6; and of 300 Plymouth fish, the percentage (3) of specimens with the lower number was almost as great as the percentage (4) of those with the higher. On the other hand, the number (100) is quite sufficient to show a marked difference between the American and the British fish in regard to the same character, since nearly 20°/。 of the American fish possessed 6 finlets—a percentage almost four times as great as that observed in any other sample of 100 fish.

In order to check the adequacy of this number as a unit-sample for determining the frequency of the variations of more variable characters, we may turn to table B (p. 290), which deals with the variation in number of the black stripes or bars across the sides of the fish. We see there that in each sample of 100 fish from Lowestoft, Ramsgate, and Plymouth, the frequency of the values above 27 is constantly less than that of values below 27; whereas for each sample of about* 100 fish from Ireland, the values above 27 are, with only one exception, in excess of the values below that number. The constancy of this relation for each of the geographical areas mentioned appears to me to show that 100 is very nearly a sufficient sample, in the sense already defined, so far as this character is concerned.

As a matter of fact, the four important regions for mackerel fisheries round our coasts, viz., the North Sea, the Channel, the South and West coasts of Ireland, are each represented by a totality of fish of not less than 300; but I have entered at some length into this question, because I think that the division of the local groups into unit-samples provides a valuable means of checking the significance which may be attributed to the differences as determined for the local groups *en masse.*

II. The Characters Investigated.

After a preliminary study of the question, it seemed desirable to select numerical rather than dimensional characters for investigation, their variations being less dependent than those of the latter upon variable factors, such as disproportionate growth, food-supply, and enlargement of the reproductive organs. The characters eventually selected were the following:—

1. The Number of black Transverse Bars or Stripes across the sides of the fish, beginning at the point where the lateral line meets the posterior border of the scapular arch, and ending just behind the last dorsal finlet.
2. The Number of the same Transverse Bars which meet or cross the lateral line.
3. The Number of round black Dorso-lateral Intermediate Spots situated between the Transverse Bars.
4. The Number of Finrays in the First Dorsal Fin.
5. The Number of Finrays in the Second Dorsal Fin.
6. The Number of Dorsal Finlets.

The condition of each fish in regard to these six characters was recorded from the commencement of the investigation, in addition to the length of the fish, and, in the majority of cases, its sex. But I soon began to take note of other characters, in the hope of finding them useful in the end, and among these were the following:—

7. The general Shape and Regularity of Arrangement of the Trans-

* The irregularity in the number of fish in the samples from Ireland was due, I understand, to a curious system of depredation during transit which prevails in those parts, and is sanctioned by custom or, at least, endurance.

verse Bars, *i.e.*, whether straight, > shaped, or wavy; and whether regular, fairly regular, rather regular, or irregular.

8. The Continuity or Degree of Discontinuity of the black longitudinal Streak which is present in most mature fishes below the lateral line. I call this character the "Lateral Streak."

9. The extent and character of the Dusky Markings which are frequently found in mature fishes below the Lateral Streak, especially in the anterior half or third of the body length. These markings, when well developed, have the form of a fine zigzag tracery, but they are often diffuse and blurred. I call this character the "Sublateral Tracery."

10. The Abundance and Distribution of small irregular dusky Spots, frequently found on the posterior part of the abdominal region, and scattered over and among the Transverse Bars of the Dorsolateral Area. They are to be sharply distinguished from the round black Spots which I have termed "Dorsolateral Intermediate Spots." The pigment of these latter is a deep black, and it is situated at a lower level in the tissues than the pigment of the irregular "Dusky Spots." Moreover, the Dorsolateral Spots are invariably situated *between* two adjacent Transverse Bars, of which, in a morphological sense, they are undoubtedly discontinuous modifications. The Dorsolateral Spots are independent of the growth of the fish, being as frequent in small fish as in large, but the "Dusky Spots" appear to make their first appearance about the time of maturity.

11. The Extent of a black longitudinal Connecting Streak which connects the ventral ends of the Transverse Bars. The Connecting Streak is usually confined to the posterior quarter or third of the body-length, but occasionally extends further forwards, and in rare instances traverses the whole length of the body, intersecting the lateral line at an acute angle. In such cases the "Lateral Streak" is frequently ill-developed.

Of these accessory characters, only the first (No. 7—the Shape of the Transverse Bars) has been considered in the present report, owing to its suggested bearings on the question of secondary sexual peculiarities.

The data acquired in regard to the variation of the remaining accessory characters are not discussed in the present report, although I hope to make use of them on a future occasion. My reasons for omitting them are chiefly that some of the characters (Nos. 8, 9, and apparently 10) were found to arise rather late in life, about the time of maturity; and as the exact size at which they make their appearance is itself subject to variations, it was considered inadvisable to introduce such characters into a discussion of racial peculiarities until the causes which determine their appearance have been more definitely ascertained.

These three characters, in fact, depend upon a formation of pigment in the superficial layers of the skin, apparently different in kind from that which brings about the transverse bars and intermediate spots. Some further study of the pigmentation of the mackerel will be necessary before their value for racial determinations can be assured. This objection does not apply, it is true, to the last character enumerated (No. 11); but my records of the variation of this character were commenced much later than those of all the others, and are not yet sufficient to yield any general results.

The investigation in hand accordingly rests upon an examination of the variation of seven characters, of which six are numerical and one morphographical. Four of these characters deal with the characteristic markings of the fish, and three with the structure of the dorsal fins.

It will be noticed that the number of transverse bars has been recorded twice for each fish; firstly, as an entire series, and secondly, between certain arbitrary limits. This has been done with a view to expose any errors which might arise from the fact that the bars are not always distinct and parallel, but are frequently branched and anastomosed with one another, broken, or otherwise irregular, rendering the task of enumeration not always easy, and so introducing a certain subjective element into the records. Now the number of bars, or portions of bars, which cross or meet the lateral line admits of fairly exact enumeration, and seemed to me to offer an excellent method of checking the estimate formed of the number of bars in the entire series. In this expectation I have not been disappointed, as the discussion of tables B and C will reveal, although the fact that the course of the lateral line itself is also subject to slight variations has naturally prevented an absolute correspondence in all details between the two modes of enumeration.

It only remains to add that the number of transverse bars and of intermediate spots, together with the data concerning the shape of the bars, have all been determined upon the same side of the fish, viz., the left. I frequently took note of the condition of the right side of the fish also, but these notes are nowhere referred to in the present report, and are not incorporated in any of the tables.

III. Particulars Concerning the Consignments of Mackerel Investigated.

In this section are given the place, date, and method of capture, the name of the consignor, and such other information as may bear upon the authenticity and representative character of the samples. All the samples were forwarded to Plymouth in ice, except those which were caught in the neighbourhood of that port. The samples are enumerated in the order in which they appear in the tables at the end of this report. The order is geographical, except that the American sample, the characters of which are shown to be quite peculiar, is placed at the head of the list.

NEWPORT, U.S.A., October 18th, 1897. 100 fish. "The mackerel are just as they were taken from the water, without selecting as to sizes, but being a perfect sample of a catch of 400 fish taken in a trap or pound net in the waters near Newport, R.I."—Messrs. Blackford, of Fulton Market, New York. (See Introduction.)

LOWESTOFT (1.) October 7th, 1897. 100 fish. Caught in nets 4 miles S.E. from Lowestoft. "These are the finest sample of fish to-day for the season. They have been much smaller hitherto. They are not selected."—Mr. Alfred T. Turner, Trawl Market, Lowestoft.

(2.) October 12th, 1897. 50 fish. Caught in nets 14 miles S. by E. from Lowestoft—Mr. Turner. These are the half of an average 100 of fish taken direct from the boat; but they are *not representative* of the whole catch, as, owing to a misunderstanding, the 50 smaller fish out of the hundred were alone forwarded. "The difference in size between the two half-hundreds was, however, not great."—A. T. T.

(3.) June 28th, 1898. 50 fish. Nets. A representative sample from Mr. Turner.

(4.) July 12th, 1898. 100 fish. Caught in nets 10 or 12 miles E. of Lowestoft, "quite abreast of the town."—Mr. Turner. A representative sample, except that the four smallest fish (measuring $11\frac{1}{2}$ and $11\frac{3}{4}$ inches in length), out of a total of 104 examined, have been eliminated.

RAMSGATE, October 27th, 1897. 100 fish. Caught in nets off the Kentish Knock, about 20 to 24 miles from Ramsgate Harbour. A representative sample. Messrs. W. Ferridge & Co., Central Fish Market, Ramsgate.

PLYMOUTH (1.) July to October, 1897. 76 fish. Caught in a variety of ways. *Not representative.* The following are the dates, places, and methods of capture.

July 21st.	In the Sound near the Laboratory. Seine. 12 fish.
„ 22nd.	1 mile S. of Breakwater. Hook and line. 13 fish.
Sept. 21st.	*Probably* off Penlee Point. Hook. 10 fish.
„ „	River Tamar, 5 miles above Saltash. 1 fish.
Oct. 7th.	River Tamar, Saltash to Cargreen. Small-meshed drift net. 3 fish.
„ 20th.	Between Eddystone and Mewstone. Pilchard nets. 19.
„ 27th.	*Probably* off Eddystone. Pilchard nets. 18 fish.

(1*b*.) September to November, 1897. This modification of the preceding sample occurs in table D. It consists in the substitution of 25 small November fish, caught principally in herring nets, for the 25 fish caught in July. It was required owing to the fact that the character to which table D refers was not examined in any British fish before my visit to America in August.

(2.) Nov. 16th to 20th, 1897. 100 fish. Caught on the 16th, 17th, 18th, 19th, and 20th November, in drift nets worked a few miles S.E. from the Eddystone (14–18 miles S. of Plymouth Breakwater). Supplied by Mr. J. Turner, Plymouth. The sample is *not quite representative.* The total number examined was 109, but the nine smallest (from $10\frac{1}{4}$ to $11\frac{3}{4}$ inches in length) were eliminated.

At this time enormous numbers of drift mackerel were being taken in this locality, especially on the nights of the 16th and 17th November. Smaller fish, from $7\frac{3}{4}$ to 11 inches in length, were commonly taken at the same time in herring nets worked nearer shore.

(3.) July 6th, 1898. 100 fish. Caught in nets 30 miles south of the harbour. Supplied by Mr. Turner. *Not quite representative.* The total number examined was 118, but the 18 smallest (from 10 to 11 inches in length) have been eliminated.

(4.) July 11th, 1898. 24 fish. Caught at mid-day in the Sound, immediately below the Laboratory, in a seine. The sample is fairly representative of the total catch of 600 fish.

SCILLY (1.) May 8th, 1898. 12 fish. Caught off Bishop Lighthouse, May 7th and 8th. Landed at Plymouth, May 9th.

(2.) June 2nd, 1898. 12 fish. Caught "in light green water" 80 to 90 miles S.W. by W. (magnetic) from Newlyn, *i.e.*, about 65 miles S.S.W. (true) from St. Mary's, Scilly. Total catch, 600. Forwarded by Mr. B. J. Ridge of Newlyn, Penzance. ["Fish caught off the Bishop Lighthouse about this time were mostly shotten."—B. J. R.]

(3.) June 9th, 1898. 50 fish. Caught 20 miles S.W. from the Wolf Lighthouse. Forwarded by Mr. B. J. Ridge.

BREST, June 20th, 1898. 100 fish. Caught by hook and line off Camaret, south of Brest, France, and forwarded in ice by steamer direct from Brest to Plymouth. (See Introduction.) The length of one fish was not recorded, but is assumed to have been 14 inches, the most frequent size.

KINSALE (1.) July 30th, 1897. 119 fish. Caught with nets off the Old Head of Kinsale. Forwarded by Mr. James Carroll, Fish Merchant, Kinsale, per Cork steamer to Plymouth. *Note from sender:*—"They are a fair average specimen of the fish now being taken. All mackerel now captured are of small size and poor quality—

will much improve about September." *Placed in formaline* on arrival at the Laboratory, and examined Sept. 19th, 24th, and 25th.

(2.) Sept. 3rd, 1897. 99 fish. Caught with nets off the Old Head of Kinsale. "A fair average specimen of the fish now being taken." Forwarded by Mr. Carroll. *Placed in formaline* on arrival at the Laboratory, and examined Sept. 16th to 19th.

(3.) Sept. 17th, 1897. 92 fish. Caught with nets off the Old Head of Kinsale. "A fair average specimen of the fish now being taken." Mr. Carroll.

(4.) July 1st, 1898. 100 fish. Mr. Carroll.

SMERWICK, March 12th, 1898. 99 fish from Smerwick Harbour, County Kerry; forwarded by Mr. John McKenna, Butter Merchant, Dingle.

BRANDON (1), April 16th, 1898. 45 fish. Caught at Brandon Creek, County Kerry; forwarded by Mr. McKenna. 46 fish actually arrived, but the smallest (length, $12\frac{1}{4}$ inches) has been eliminated, owing to its marked divergence in size from the rest of the sample.

(2.) April 23rd, 1898. 101 fish. Caught at Brandon Creek; forwarded by Mr. McKenna.

IV. SIZE OF THE MACKEREL INVESTIGATED.

The length of the body has been taken as the basis for comparing the relative sizes of the fish investigated, and this has been measured in all cases from the tip of the closed jaws to the median extremity of the fork of the tail. The longer rays of the tail-fin are subject to accidents in capture and transit, and cannot therefore be included in an accurate comparative table of measurements; but it should be remembered that these rays are generally included in ordinary measurements of body-length, which would consequently be somewhat in excess of my determinations. The fish have always been measured in the same way, by placing them with their left sides uppermost upon a measuring-board, with the tip of the jaws touching a vertical plate immoveably fixed at the zero of the scale, which is accurately ruled to quarters of an inch. The length of the fish has been read off to the nearest quarter.

The observed number of specimens of the different sizes represented in each consignment of fish is recorded in table A. The general size of the fish representing each locality can, however, be more readily gathered from the more condensed statements given below, which are in percentages of the total number from each locality. In Table I. the size is indicated in inches, the fractional differences recorded in table A being neglected. In Table II., which is still further condensed, the range of size included in each vertical column is 2 inches.

TABLE I., *showing Distribution of Size in One-inch Groups.*
(Percentages.)

Place of Capture.	No. of Fish.	Length of Fish (inches). 10+	11+	12+	13+	14+	15+	16+	17+
Newport, U.S.A. .	100		2%	53%	33%	10%	1%	1%	
Lowestoft . .	300		3	28	48	20	1		
Ramsgate . .	100		4	23	40	25	5	3	
Plymouth . .	300	5	29	38	21	5	2		
Scilly . . .	74		5	33	27	22	8	4	1
Brest . . .	100		1	2	36	42	14	4	1
Kinsale . . .	410	½	23	55	15	5	1		
Kerry . . .	245			7	20	33	29	11	¼
Irish: Autumn .	310	⅓	30	63	7				
Irish: Spring .	345		1½	14	25	30	21	8	¼

TABLE II., *showing Distribution of Size in Two-inch Groups.*
(Percentages.)

Place of Capture.	No. of Fish.	Length of Fish (Inches). 10+11	12+13	14+15	16+17
Newport . .	100	2	86	11	1
Lowestoft . .	300	3	76	21	
Ramsgate . .	100	4	63	30	3
Plymouth . .	300	34	59	7	
Scilly . . .	74	5	60	30	5
Brest . . .	100	1	38	56	5
Kinsale . . .	410	24	70	6	
Kerry . . .	245		27	62	11
Irish: Autumn .	310	30	70		
Irish: Spring .	345	2	39	51	8

These tables show that the great majority of fish investigated were from 12 to 13¾ inches in length.

The Lowestoft and Ramsgate samples closely resemble one another in size, the latter having a slight preponderance of the larger fish.

The samples of smallest-sized fish were those from Plymouth and Kinsale, and these may be regarded as practically similar to one another in this respect. They show a considerable percentage (24°/. to 34°/.) of fish below 12 inches in length, a percentage much higher than that in any other of the local samples. The percentage of fish above 13¾ inches in length is also excessively small in these two samples, being only 6°/。 or 7°/。, whereas it is 21°/。 for Lowestoft, 30°/。 for Ramsgate, and about 60°/。 for Brest and County Kerry.

The samples of largest-sized fish are those from Brest and County Kerry, in which there are practically no fish below 13 inches in length.

The American fish are intermediate in character between the Lowestoft and Plymouth samples, but are unique in regard to their great uniformity in size, 86°/。 being between 12 and 13¾ inches in length.

The fish in the Scilly sample are a mixed lot, obtained over a wide area at the western entrance to the English Channel. As the total number of these fish does not amount to the number already assigned as the minimum for a unit sample, their variations are not much discussed on the present occasion; but it is interesting to notice the curious distribution of sizes among these 74 fish which were all captured within a single month. The sample shows three distinct maxima of frequency, one at 12 inches, another at 13 inches, and another at 14 inches (see table A). This phenomenon is not due solely to the mixture of samples from different localities, for it is shown also in the single consignment of 50 fish captured on June 9th.

From what has been said, it will be seen to be possible to divide the local samples into groups characterised by the preponderance of large, moderate, or small sized fish. This grouping takes the following form :—

Large:	Kerry.
	Brest.
Moderate:	Lowestoft.
	Ramsgate.
	Scilly.
	Newport, U.S.A.
Small:	Plymouth.
	Kinsale.

This grouping is by no means to be understood as implying that the mackerel found in these localities constantly bear the size relations assigned to them here. It is no doubt true that the largest fish are always most abundant on the Atlantic coast, but the correspondence between the samples and the natural distribution of the fish in this instance must be regarded as an exceptional coincidence. The samples are only representative of the fish caught at the dates mentioned in the tables (subject to certain reservations already given in the particulars concerning the consignments). To draw general conclusions upon the natural distribution of size among the fish all round our coasts, it would be necessary to secure the regular delivery of representative samples from fixed stations throughout the year, as was done, for example, by the Scottish Fishery Board in the case of the herring (4th Report S.F.B., 1886, pp. 65–72). Such an arrangement would be decisive, but expensive, and could not, I believe, be undertaken by the Association under present conditions. An attempt which I made in the Autumn of 1897 to secure the periodic consignment of a small sample from Kinsale fell through owing to the refusal of the fish merchant to undertake the supply of small quantities, the price of which would not repay him for his trouble.

Nevertheless, in spite of their incompleteness, the following general features of the samples may be advantageously summarised, if only as a means of inviting further attention to the subject:—

1. Large fish, measuring 14 inches and upwards, preponderate only on the Atlantic coasts of Ireland and Brittany. The sample from Brest is particularly valuable as an index of distribution, because the fish composing it were all caught with hook and line, the sizes in most of the other samples being partially determined by the mesh of the nets with which the fish were captured. The late date (June 20th) at which these large Brest fish were taken close to shore is also worthy of notice. The sample caught at Kinsale some ten days later (July 1st) consisted of distinctly smaller fish.

2. On the Irish coast the spring fish are much larger than the autumn fish; but in the Channel and North Sea no such difference is to be recognised. Indeed, in the latter areas the autumn fish appear on the whole to be slightly larger than the early breeding fish, and seem to be the same fish at a later stage of growth.

3. The sequence of events on the Irish coast, as indicated by table A, appears to be as follows: In March * moderately large fish (13 and 14 inches) arrive; in April the size of the fish attains its maximum (a preponderance of 14 and 15 inch fish); at the end of June (Kinsale, July 1st) the proportion of large fish is greatly reduced, and there is a considerable accession of small fish (11 and 12 inches), the total *range* of size being now at its maximum; by the end of July the large fish have all disappeared, and there is a preponderance of 11 inch fish; and from now onwards the size gradually but slightly increases, as though by growth rather than by new immigrations of larger fish. In this summary I have assumed that samples of fish caught off the South and West coasts of Ireland (*i.e.*, Kinsale and Kerry) are equally representative of the general size prevailing at the periods of capture, though I have no doubt that the examination of simultaneous samples from the two coasts will reveal slight differences, at any rate, in this respect. This point I hope to elucidate during the present autumn and the next spring seasons.

* Two large mackerel, one of each sex, were forwarded to me by Mr. Green in February. They measured 16 ins. in length, and were caught off Gariness, Co. Cork, on Feb. 23rd, 1898.

V. Sex.

§ 1. *Proportion of the Sexes.* Out of a total of 918 mackerel caught in British waters 423 were males and 495 females, forming a percentage of 46 males to 54 females, or a proportion of 117 females to every 100 males.

This excess of females over males is slight compared with the preponderance of this sex which Fulton has shown to exist in the case of most sea-fishes with pelagic eggs. (8th Report Scottish Fishery Board, 1890, p. 349; 9th Report, 1891, p. 247. Partially quoted in Cunningham's "Marketable Fishes," 1896, p. 76.) In this respect the mackerel comes nearest to the cod, in which the proportion of females to 100 males is 133.

The explanation which Fulton suggests of the general preponderance of females in species of sea-fishes is founded on the great difference in bulk between the ripe ovary and testis, which often leads to obvious differences in the degree of distension of the abdominal cavity in the two sexes during the breeding season. The necessity for the annual production of a certain minimum number of eggs, coupled with the difficulty experienced by the females of many species in carrying their proper quantity of ova, has accordingly led in some cases to a relative increase in the size of the females, in others to an increase in their relative number, or even, as indeed is generally the case, to an increase of the females under both these heads. The duration of the spawning season is also affected by the same factors.

As the general size of the female mackerel is shown in a subsequent section to be only slightly in excess of that of the male, we are probably correct in attributing the relatively slight preponderance of females in the mackerel to the relatively large body-cavity which this species possesses, as compared with the body-cavity of a gadoid or flatfish. The small size of the mackerel's egg also obviates the necessity for a large preponderance of females.

The large size of the body-cavity in the mackerel is probably, in its turn, connected with the active pelagic habits of this fish, as it would be a manifest impediment to vigorous movements if the abdominal region should become so distended in the spawning season as it is in the more lethargic cod and flatfish tribes. As the same feature is also found in the herring and pilchard, it would appear to be a general phenomenon among pelagic and so-called "migratory" species.

§ 2. *Segregation of the Sexes.* It has been maintained by Couch (*British Fishes*, vol. ii., p. 68) that the sexes of the mackerel become much divided during the early migration. Out of 20 specimens taken indiscriminately on one occasion during March he counted 16 males and only 4 females. During another season he counted 17 males to 3 females. It is true that on a third occasion Couch found the sexes to be equally represented in a sample of the earliest spring fish; but he explains this exception by adopting the opinion of the fishermen that the fish of this particular school belonged to a different class from the ordinary spring fish—that they were old fish of the preceding season which had not moved out into deep water, and that they did not represent the usual spring immigrants from the Atlantic.

The evidence of American observers on this point is conflicting (Commissioner's Report for 1881, U.S. Fish Com., 1884, p. 114).

My own observations on the proportion of the sexes in various samples of mackerel at different seasons are recorded in table E (p. 293). The only sample examined during March was one from Smerwick, County Kerry, and it certainly supports Couch's statements that in this particular sample the males were nearly twice as numerous as the females, 63 out of a total of 99 fish being of the former sex.

But it must be pointed out at the same time that an actual excess of males over females in particular samples is also found at other seasons of the year. Thus, out of 25 Lowestoft fish, captured October 12th, 1897, there were 15 males to 10 females; and out of 100 Ramsgate fish caught a fortnight later 55 were males. In the American sample, also caught during October, 55 °/ₒ were males. The preponderance of males in these cases is certainly not so great as in the Smerwick sample, but it is sufficient to show the necessity of caution in accepting conclusions of this kind based upon relatively small samples. Until observations on the subject shall have been considerably multiplied, I think it will be best to suspend judgment upon a matter which may be, biologically, of considerable importance.

In this connexion I would draw attention to the evidence submitted in the succeeding section, which shows that the numerical proportion of the sexes differs, as a whole, according to the size of fish under consideration, owing to a difference in the rate and limits of growth of the two sexes. Now it is an open question whether the so-called "schools" of mackerel are formed by the chance association of fish which happen to be near one another, independently of sex and size, or whether they are not due to the selective association of fish having some common characteristic. The evidence derived from samples of fish caught in drift-nets is of little value, owing to the selective action of the mesh of the nets. The evidence from samples caught in small-meshed seines would be fairly conclusive, but the existing data are too few to be of any use. Nevertheless, such evidence as we possess in the case of other fishes tends to show that selective association plays a considerable part in the formation of shoals, and that similarity of size is one of the points selected. Bateson, for example, speaking of the grey mullet, says, "Similarity in size seems to be usual in these shoals." (Journal M.B.A., I., p. 250.) If, therefore, we assume this principle in the case of mackerel shoals, it is clear, from the facts to be adduced shortly, that the normal preponderance of females will tend to be reduced in the case of shoals of fish below 14 inches in length, and increased in the case of shoals of fish measuring 15 inches or more, quite independently of any selective segregation of the sexes.

It is then possibly not without significance that, so far as my own samples go, a preponderance of males was only observed in samples of relatively small fish, more than half the fishes in each sample being below 14 inches in length, and a very small number (from 0 °/₀ to 11 °/₀) attaining a length of 15 inches.

§ 3. *Sex and Size.* The following table shows the observed frequency of male and female fish of the various sizes mentioned, in a total population of 918 mackerel, and also the same facts as percentages of this latter sum. This population consists of all the samples of British fish in which the sex has been determined, as shown in Table E. The American sample has been excluded, since the present investigation clearly shows the American fish to constitute a distinct race, much more remotely allied to the European fish than are the British races *inter se.* The last horizontal row of figures shows the relative number of females of each size compared with the number of males of the same size taken as 100.

TABLE III., *showing relation between Sex and Size.*

Length (Inches).		10+	11+	12+	13+	14+	15+	16+	17+	Total.
Frequency observed.	♂	1	37	114	140	86	36	8	1	423
	♀	2	37	141	133	100	56	23	3	495
Frequency in percentages of the total number =918.	♂	0·1	4	12	15	9	4	1	0·1	46 %
	♀	0·2	4	15	14	11	6	2·5	0·3	54 %
Number of ♀ compared with ♂ taken as 100.		—	100	124	95	116	156	288	300	117 (mean.)

The table shows that the females in my samples exceed the males in number at almost every size, the exceptions being at 11 inches where the frequency of males and females is the same, and at 13 inches where the males exceed the females by 1 °/₀ of the total number. It is to be noticed that the males are relatively more numerous among the small fish than among the large; or, in other words, that the numerical ratio of males to females becomes more and more reduced as the size of the fish under consideration increases. This fact is expressed by the figures on the last horizontal line, which gives the number of females of each size corresponding to a constant number of males, taken as 100. It will be seen that, except for a slight irregularity in the columns representing 12 and 13 inches, the relative number of females becomes considerably increased as the size enlarges.

As, however, the extreme sizes, both small and large, are represented by relatively small numbers of fish, whether male or female, a more reliable result will be obtained by dividing the fish into a smaller number of size-groups. Thus, in two-inch groups, the proportion of females to every 100 males becomes—

10–11 inches	103
12–13 „	108
14–15 „	128
16–17 „	289

thus revealing an increase in the preponderance of females at every successive grade. The increase is not quite regular, being slight from 10 to 13 inches, then rapid at 14 and 15 inches, and very highly marked above 15 inches.

Two explanations of this increasing preponderance of females with increasing size suggest themselves :—

1. The males may be subject to a more rapid death-rate than the females; or

2. The growth of the males may be arrested at an earlier stage than that of the females.

As the true proportion of the sexes of the mackerel at the time of hatching or *in ovo* cannot be ascertained with our present knowledge, it is difficult to test the former alternative, which is *a priori* improbable, owing to the absence of any known differences between male and female mackerel as regards habits of life or structure of the body. So far as the physiological wear and tear of reproduction goes, this probably affects the female more severely than the male.

The second alternative is the more probable one, since sexual dimorphism in regard to size is a very common phenomenon, and in fishes the female frequently exceeds the male in length. Still the cessation of growth in the males does not take place uniformly at any one stage, since the extreme limit (17 inches) attained by the females in my samples is also attained by the males. The exact stage of cessation is clearly subject to considerable variation, and is probably preceded by a retardation in the relative rate of growth, as compared with that of females of the same size. It is improbable that any considerable percentage of males actually stop growing at 11, 12, or 13 inches, so that, taking the normal number of females for every 100 males to be 117, as explained in the preceding section, we must explain the relative excess of males below 14 inches as due to retarded growth of the males in excess; but the increasing relative deficiency of males above 14 inches in length must be due to a large extent to actual arrest of growth, since the normal proportion of males to females is never realized in groups of fish measuring more than 14 inches in length.

The minute economy which prevails among species under natural conditions of existence is clearly revealed by the facts established in the preceding paragraphs; for it is obvious that, *ceteris paribus*, the equivalent growth of males and females would lead to an increasing superfluity of the male reproductive elements, owing to the great difference in size between an ovum and a spermatozoon.

It remains to add that the average size of 423 males recorded in the tables is 12·988 inches; that of the 495 females, 13·145 inches. Consequently, if the average size of the males be taken as 100, that of the females becomes 101. The difference between the size of *mature* males and females is probably a little greater than this, but the subject of maturity in the mackerel is reserved for a later report.

§ 4. *Secondary Sexual Characters.* Apart from size, I have been unable to discover any evidence whatever of the existence of secondary sexual peculiarities in the mackerel. My investigations of this point will be found under the special sections dealing with the shape of the Transverse Bars (p. 261), the Dorso-lateral Intermediate Spots (p. 263), and the First Dorsal Fin (p. 267). With the exception already mentioned, I can therefore repeat the remark of Smitt that "all the statements as to an external difference of sex in the mackerel which have been made up to the present have proved untrustworthy on closer examination" (*Scandinavian Fishes*, I. 1892, p. 112).

VI. Number of Transverse Bars.

§ 1. *The Entire Series.* The frequency of the variations in the entire number of transverse bars in the various local samples and in certain chosen combinations of these is set out in Table B. (p. 290).

The extreme range of variation is from 23 to 33, *i.e.*, 11 bars.

The modal (*i.e.*, most frequent) number is almost invariably 27, there being only three exceptions to this rule among 21 samples, viz., Scilly, June 9th, (50 fish), Kinsale, July 1st (100 fish), and Brandon, April

16th, (45 fish). Two of these samples, it will be noticed, are small: in one the modal number is 26, in the other 28.

The first impression made upon a survey of the figures in the table is undoubtedly the slight nature of the differences in the range and frequencies of variation in the different samples. But the next impression is the remarkable constancy with which mean-values of less than 27 are associated with samples from localities in the North Sea and English Channel, while the means for the Irish and American samples exceed that figure with only one exception. This indicates, as can easily be seen by comparison, that in North Sea and Channel samples the values below 27 always occur more frequently than those above 27; while in the Irish and American samples, with only one exception, the reverse is the case.

For North Sea and Channel samples, the means vary from 26·50 to 26·94, and, for Irish samples, from 26·90 to 27·56. The American mean is 27·38.

If we exclude all samples of less than 90 fish, the means, taken in the same order, vary from 26·62 to 26·91, and from 26·90 to 27·32.

Analysing this contrast still further, by means of the table of percentages for the local groups (neglecting groups of less than 200 fish), we see that the frequency of the value 26 varies from 30 °/₀ to 31 °/₀ in the case of Lowestoft and Plymouth, but from 21 °/₀ to 23 °/₀ in the case of Kerry and Kinsale. Similarly the frequency of the value 28 varies from 14 °/₀ to 15 °/₀ for Plymouth and Lowestoft, but from 23 °/₀ to 25 °/₀ for Kinsale and Kerry. The frequency of the modal value 27 is constant at 38 °/₀ for the two Irish groups, but varies from 38 °/₀ to 42 °/₀ for Lowestoft and Plymouth.

The conclusion is irresistible that the Lowestoft and Plymouth fish resemble one another very closely, and that the Kerry and Kinsale fish do so likewise, but that there is a comparatively serious difference between the Irish fish and those from the North Sea or Channel.

Hitherto, however, we have not taken into consideration the actual frequencies of the extreme values (*i.e.,* those below 26 and above 28). These values occur very rarely, and their separate frequencies cannot consequently be compared with exactitude in samples of ordinary magnitude. To bring their frequencies into consideration, it will be necessary to merge all the extreme values into two groups, one of low, and the other of high value, and to compare the frequencies of the combined values. This has been done in the following condensed table, in which, also, the Ramsgate data have been combined with the Lowestoft records to form a single group representative of the North Sea, and Brest has been combined with Scilly. No one, I imagine, will be prepared, on the evidences provided in this report, or on any other grounds, to regard the Ramsgate autumn fish as anything but the southern extension of the Lowestoft shoals. The Scilly data closely resemble those from Brest in many respects, and the combined data may be regarded as representing the mackerel off the mouth of the Channel during June.

TABLE IV., *showing frequencies of values of Transverse Bars.*

(Percentages.)

	Number of Fish.	23 to 25	26	27	28	29 to 33
Newport, U.S.A.	100	6	13	37	28	16
North Sea	400	9	29	42	15	5
Plymouth	300	8	30	42	14	6
Brest and Scilly	174	5	32	41	17	5
Kinsale	410	5	23	38	23	11
Kerry	245	3	21	38	25	13

This table strikingly confirms the conclusions already drawn. The resemblance between the percentage frequency of the different values in the case of Plymouth and North Sea fish amounts practically to identity, and the resemblance between the same data for Kinsale and Kerry fish is almost equally exact. The combined Brest and Scilly data also closely resemble the North Sea and Plymouth records.

On the other hand, the American and the two Irish groups diverge considerably from the others in the low percentage of the low values and in the high percentage of the high values, and the American sample shows this contrast still more markedly than the Irish groups.

From the variation of this character, therefore, I conclude that the mackerel examined fall into three groups, characterised by differences in the frequency of high and low values of the transverse bars. These groups, arranged in order of frequency of the high values, are:—

1. American, in which 44 % of the fish have 28 or more bars each.
2. Irish, in which the number of fish having the same high number of bars varies between 34 % and 38 %.
3. English Channel and North Sea (including Brest and Scilly), in which the number of fish having the high number of bars varies between 20 % and 22 %.

I also conclude that these differences indicate a racial separation between the three groups. The American fish are shown in the sequel to be distinguishable from European fish in regard to every character, so that I do not anticipate that my conclusion as to the existence of a peculiar American race of mackerel will be disputed. But the differences between the Irish and the Channel fish are not so sharply defined in all respects as those between the American and European, so that the same degree of certainty cannot be attached to my conclusion as to the existence of a separate Irish race. Nevertheless, I would point out that, if the racial distinctness of the American fish be admitted, it is impossible to avoid a similar conclusion in regard to the Irish fish also, if we confine our attention to the evidence of the variation of the transverse bars, for the difference between the Irish and Channel samples is greater than the difference between the Irish and American, and is almost as great as the difference between the American and the European as a whole.

Moreover, the general difference between the Irish and English fish is not confined to the gross samples from these localities as a whole—in which case it might be attributed to errors of observation or calculation—but it has been shown to be also characteristic of the numerous individual samples of fish from these localities, almost without exception. This fact, in my opinion, is one of very great importance.

It must also be stated that the differences between the samples are not due to any increase in the number of bars with the growth of the fish. This can be inferred merely by comparing the sizes of the fish in the different samples. Thus the highest mean number of bars occurs in the American sample, which consisted almost entirely of relatively small fish, while the lowest mean number occurs in the Lowestoft sample, dated June 28th, in which the distribution of sizes was practically identical with that in the American. (See Table A.) Again the values are almost equally high for the Kinsale samples as for the Kerry samples, although the former consist exclusively of small fish, and the latter exclusively of large fish.

The following facts which I have ascertained point unequivocally to the same conclusion.

The transverse bars are formed at an early period, and the basis of their formation is a deposit of pigment along the free surface of the myotomes. It is this relation to the myotomes which gives the bars in the majority of cases a marked > shaped curvature. Now the number of myotomes corresponds to the number of vertebræ, which is almost invariable in most species of bony fishes, and particularly so in the mackerel. From the relation of the bars to the myotomes it may, accordingly, be assumed that no change in their number takes place after formation.

If the correspondence between transverse bars and myotomes were perfect, the number of the bars would be the same as the number of vertebræ, and equally invariable. This is obviously not the case. But it is important to notice that *the average, or rather modal, number of bars is exactly the same as the number of vertebræ.* The modal number of bars between shoulder girdle and last dorsal finlet is shown in my tables to be 27. The total number of vertebræ in the mackerel is 31. But the vertebral column extends a little in front and a little behind the limits mentioned, and by dissection I have found that this excess coincides with the extent of the two anterior and the two posterior vertebræ. Consequently the number of vertebræ in the region corresponding to the bars enumerated is four less than the total number, viz., 27, which is also the modal, or most frequent number of bars. This correspondence furnishes a conclusive confirmation of the general accuracy of my data in regard to the present character, as well as of my statement that the bars are formed in relation to the myotomes. The variation in the number of bars is due to the fact that the pigment is not deposited in a regular manner along the free surface of the myotomes, except in very rare cases. In most fishes the pigment streak can be seen to correspond with a particular myotome for part of its extent, and then to become broken or discontinuous, either remaining as an isolated fragment, or more frequently effecting an abrupt anastomosis with the pigment of a neighbouring myotome. These two facts, the discontinuous deposition of pigment along the myotomes, and the irregular anastomosis of the pigment streaks of neighbouring myotomes, account not only for the variable shape of the transverse bars, but also for their variable numbers. The variation in the number of the bars, in spite of the fundamental relation between the bars and the myotomes, does not involve any variation in the number of the myotomes or vertebræ. But, just as the number of myotomes is fixed for each fish, so the number of pigment-bars which are formed in connection with them is not subject to alteration after the period of formation. This period falls between the metamorphosis of the larva and the acquisition of a length of some 4 or 5 inches.*

To remove all doubt concerning this important point, I have calculated the mean number of bars in all the very small fish taken at Plymouth during the autumn of 1897. The total number of fish was 67, ranging in length from 5½ to 10 inches. The mean number

* It is curious to notice that the transverse bars of the adult mackerel occupy a position in relation to the myotomes which is quite different from that occupied by the vertical lines of chromatophores in young mackerel from 14 to 18 mm. in length, according to Holt's description and figures (this Journal, V., 1898, p. 116, figures 3 and 4). In preserved specimens at this early stage Holt states that, "on the sides of the trunk, the chromatophores are set more thickly at the lines of division of the myomeres than elsewhere," *i.e.*, along, instead of between, the septa which separate the myotomes.

of the bars was 26·66, a number well within the range of the means for North Sea and Channel samples, viz., from 26·50 to 26·94.

§ 2. *The Bars which cross or meet the Lateral Line.* The frequency of the variations in the number of these bars is given in Table C (p. 291).

It will be noticed that, in spite of the greater exactitude with which the number of these bars can be determined, the range of variation is distinctly greater. In the case of the entire series the range covered only 11 bars; in the present case the range is from 12 to 25, and covers consequently 14 bars. When it is remembered that in the former case the whole side, and in the present case only a part of the side of the fish, was under examination, the observed difference in the range of variation must be regarded as significant. I attribute the difference to the fact that the field occupied by the bars in the first case is invariable, being the whole side of the fish, while that which provides the material for variation in the present case is in itself variable. The anterior boundary is fixed by the shoulder-girdle, as in the entire series; but the posterior boundary of the field depends on the curvature of the lateral line in that part of the body. The place where the bars cease to meet the lateral line generally coincides with an abrupt downward bend in the course of the line; but, as the bend is sometimes absent, or takes place in front of, or behind, its usual position, the number of bars which meet the line is correspondingly increased or reduced.

The number of bars affected by this irregularity in the curvature of the lateral line is not great, and the error which is introduced by it into the records of the variability of the number of bars consequently tends to become smaller and smaller as the number of observations is increased. But, as the mean values in Table C show, it is sufficient to break down the high uniformity of results between the unit-samples of any one region which was exhibited in Table B.

Excluding the two small samples of 12 fish from Scilly, the modal number is seen to be usually 18; but the exceptions to this rule are more frequent in the present case than for the entire series, being 6 instead of 3.

The means for the samples from Lowestoft, Ramsgate, and Plymouth vary from 18·03 to 18·58; for Scilly and Brest from 18·64 to 18·65, and for the Irish samples from 18·15 to 18·62. The American mean is 18·88.

If we exclude all samples of less than 90 fish, the means for the North Sea and Channel vary from 18·04 to 18·43, those for the other localities being unaffected.

Thus the American mean, as before, is the highest, and the lowest means are found among the North Sea and Channel samples, as was also the case for the entire series of bars; but the contrast between the Irish and the Channel means is much less emphatic for the partial series than for the entire series of bars, owing to the more extended range of the mean values for both localities.

The explanation is, I believe, the same as for the greater range of variation of the partial series as compared with the entire series, viz., the irregularity introduced by the variability of the lateral line, which renders the number 100 insufficient as a unit-sample. If this is so, a closer approach to the former result ought to be revealed by comparing the means of the local groups of fish as a whole, neglecting groups of less than 200 fish. These means in fact for the Lowestoft and Plymouth groups vary from 18·21 to 18·23, and for the Kinsale and Kerry groups from 18·37 to 18·45, thus displaying a close agreement between the Lowestoft and Plymouth fish, and also between the Kinsale and Kerry fish, but a considerable difference between the Irish fish and those from the North Sea or Channel.

This relation is precisely the same as that revealed by the variation of the entire series of bars, the means for the North Sea and Channel being lower than those for the Irish groups in each case.

It is interesting to notice also that the close approximation between the Brest and Scilly means in regard to the entire series of bars is again shown in regard to those which meet the lateral line; but whereas the combined mean for Brest and Scilly only slightly exceeded that for the North Sea and Plymouth in the former case, here it is actually higher than the Irish mean. The significance of this difference it is impossible to decide at present, as the total number of fish from Brest and Scilly only amounts to 174, a number which cannot be regarded as sufficient to neutralise the error due to the curvature of the lateral line. If the mean, however, be provisionally accepted as approximately correct, it points to the conclusion that in some respects the mackerel which are found off the mouth of the English Channel and the neighbourhood of Ushant in June may form a connecting link between the Irish fish and those of the North Sea and Channel. From the geographical relations of the areas under discussion such a result would certainly accord with *a priori* expectations.

The percentages of frequency of high and low values of the bars may best be understood from the following condensed table :—

TABLE V., *showing frequencies of values of partial Series of Bars.*
(Percentages.)

	Number of Fish.	12–16	17–18	19–20	21–25
Newport, U.S.A. .	100	7	35	42	16
{ North Sea . .	400	9	49	37	5
{ Plymouth . .	300	12	46	38	4
Brest and Scilly .	174	6	39	48	7
{ Kinsale . . .	410	8	43	41	8
{ Kerry . . .	245	10	45	37	8

We see from this table that the combined percentages in the two right-hand columns exceed those in the two left-hand columns in only two cases, viz., Newport, and Brest and Scilly. This preponderance of high values over low values corresponds to an excess of the mean values above 18·5.

In all other cases the figures in the two left-hand columns exceed those in the two right-hand columns. This preponderance of low values corresponds to mean-values less than 18·5.

The figures for the North Sea and Plymouth again correspond with remarkable exactitude, as also do those for Kinsale and Kerry. The difference between the Irish values and those for the groups from the North Sea and Channel is not great, but it is distinctly greater than the difference between the North Sea and Plymouth groups *inter se*, or between the groups from Kinsale and Kerry. The column which contains the highest percentages for each of these four localities is that recording the frequency of the numbers 17–18; and it will be seen that while the frequency of these values varies from 46 °/₀ to 49 °/₀ for the North Sea and Plymouth, it does not exceed 45 °/₀ for Kinsale and Kerry.

In this connexion it should be noticed that both the minimum and maximum frequencies of the lowest values (12–16) are lower for the Irish groups than for the North Sea and Plymouth. On the other hand, the highest values of all (21–25) occur twice as often among Kinsale and Kerry fish as among North Sea and Channel fish, viz., 8 °/₀, as compared with 4 °/₀ or 5 °/₀. This contrast in regard to the distribution of high and low values can be looked at in another way, viz., by comparing the relative frequency of the highest and lowest values in each group of fish. Thus in the American fish the frequency of the highest values is more than twice as great as that of the lowest values (16 : 7); for Brest and Scilly it is barely in excess (7 : 6); for Kinsale and Kerry the frequencies of the highest and lowest values are approximately the same (8 °/₀); while for the North Sea and Channel the lowest values are twice or thrice as frequent as the highest values (9:5 and 12:4).

So far, therefore, as concerns the main conclusions drawn from the variation of the entire series of bars, the variation of the partial series furnishes a fairly satisfactory confirmation. These conclusions were the existence of three main races of mackerel in American and British waters, viz. (1) an American, (2) an Irish, and (3) a race common to the North Sea and the Channel.

The only respect in which the results are at variance concerns the affinities of the fish from Brest and Scilly, which were clearly with the Channel and North Sea fish for the entire series of bars, and with the Irish fish for the partial series. Nothing but the examination of a larger number of fish from this region will solve the difficulty. Additional facts, however, are adduced in the sequel which tend to show that the Brest and Scilly fish are intimately related to those of the Channel and North Sea, but show, under each character examined, a slight approximation towards the Irish race.

VII. Shape of Transverse Bars.

The cause which determines the general shape of the transverse bars has already (p. 256) been discussed, and has been found to be the deposit of pigment along the external surface of the myotomes. As the myotomes in the dorsal half of the body have a marked > shaped, or geniculate, curvature, the bars consequently show a marked tendency to assume a corresponding shape. The breaks and anastomoses, to which the bars are subject at the time of their formation, show, however, such diversity and complexity of form that they defied all my earlier efforts to discover a suitable system of classification by which the vagaries in the shape of the bars might be recorded for subsequent comparison.

I began by noting whether the general arrangement of the bars was regular or irregular, adopting several grades of regularity and irregularity to cover the intermediate conditions; but, although I have a complete set of data in these terms, and have tabulated the results for comparison, the examination which I have made of them shows them to be practically worthless for exact conclusions. This is largely due, as I now know, to the fact that regularity in the bars, *i.e.*, parallelism, with an absence of breaks and bifurcations, may be of two very distinct kinds, which may be termed, for comparison, primary and secondary. Primary regularity is due to the bars having retained their fundamental relations to the myotomes; they are not only parallel and unbroken, but also geniculate in shape. Secondary regularity is caused by the anastomosis of portions of the pigment streaks of neighbouring myotomes in such a regularly repeated manner as to produce an equally marked parallelism of arrangement, coupled with a partial or complete loss of the typical geniculate curvature and relation to the myotomes. Thus a parallel series of vertical, or oblique, bars is frequently exhibited; and in such a case each bar upon dissection has been found to cross several adjacent myotomes, instead of following any individual myotome along its course. By grouping those two types of arrangement under the same head "regular," I was unwittingly uniting things which should have been poles asunder.

On discovering this error, I proceeded to record the general shape of the bars in addition to their degree of regularity; but it would be unprofitable on the present occasion to give a general account of these later observations, owing to the fact that the majority of the fish examined during the autumn of 1897, including the bulk of the fish from Kinsale, would have to be omitted from consideration.

It has, however, been asserted by Donovan (*fide* Day, *British Fishes*, Vol. I. p. 84) that the sexes can be distinguished by the shape of the bars, these being "straight" in the male and "undulated" in the female. As my observations are amply sufficient to test the accuracy of this statement, I give some figures bearing on the question. As the term "undulated" is somewhat ambiguous, and may be held to apply to the angular > shaped, or geniculate, bars, as well as to those of a more truly wavy, or convoluted type, I have determined the proportion of the sexes exhibiting each of these characters, in addition to the proportion exhibiting straight or vertical bars. To avoid all doubt, I have eliminated all cases except those in which the bulk of the bars could be definitely described as either geniculate, wavy, or straight.

The results are shown in the following table:—

TABLE VI., *showing Shape of Bars in relation to Sex.*

Shape of bars.	Number of Fish.	♂	♀
Geniculate . .	75	34	41
Wavy . . .	78	36	42
Straight . . .	72	26	46
Total .	225	96	129

The figures in the table completely disprove the accuracy of Donovan's statement, and show, once for all, that the shape of the bars is entirely independent of the sex of the fish.

The percentages of the total numbers of males and females examined are 43 ♂ and 57 ♀; and for the first two types of bar this proportion is almost exactly reproduced, being 45:55 for the geniculate bars, and 46:54 for the wavy bars. So far from the straight bars being distinctive of male fish, there is a slight preponderance of females showing this character, the proportion being 36 ♂ to 64 ♀. For a total of 72 fish, however, this proportion is sufficiently close to the total proportion of males to females to show the entire absence of sexual peculiarities in the matter.

VIII. Dorso-Lateral Intermediate Spots.

The general character of these spots has already been given in the description of the characters investigated (p. 241). They are, strictly speaking, discontinuous portions of the pigment streaks of the myotomes, but they assume so definite a shape, and possess such clearly-defined relations to the transverse bars, that it is possible to discuss the variations in their frequency independently of the bars of which, theoretically, they form a part.

No fragments of the bars are here considered as "intermediate spots" unless they possess a sharply-defined round or elliptical shape, and unless they are situated between two neighbouring transverse bars, or are entirely or partly enclosed in a ring-like modification of two neighbouring bars.

It sometimes happens that the extremities of the bars are separated off as small "end-pieces," which may even assume a rounded form. Such end-pieces are undoubtedly connecting links, from a theoretical point of view, between perfectly linear and continuous bars and the pigment-spots which I distinguish as "intermediate"; but if these end-pieces plainly continue the lines of the bars, and do not occupy an isolated intermediate position between two adjacent bars, they have been excluded from consideration.

The importance which I attach to the extreme type of "intermediate spots," as defined, rests on the following grounds. The shape and course of the bars is fundamentally determined, as already shown, by the shape and course of the myotomes or muscle-segments. Bars, therefore, which follow the course of the myotomes may be regarded as primitive in character. In such cases, since the surface of every myotome is occupied by a pigment-streak, it is clear that spots, having an intermediate position between two adjacent bars, can have no existence. Spots of this kind can only be found in fish whose transverse bars have departed from their primitive relation to the myotomes, and in which the primitive symmetry has been replaced by a new symmetry, due to the breaking up of the primary bars and the anastomosis of the fragments of one bar with those of its neighbours. Some of these fragments remain permanently isolated, and constitute the intermediate spots under discussion; while to right and left of them are seen the new or "secondary" bars which have resulted from the union of the other fragments of the primary bars.

Thus the presence of intermediate spots is in itself evidence of the transformation of the primary bars, and the frequency of these spots in races of fish may be expected to vary according as the process of transformation has proceeded to a greater or less extent.

A comparison of the markings of the different species of the genus *Scomber* shows, indeed, that they are subject to extraordinary modifications. Thus, according to Günther's catalogue (vol. ii., pp. 357–362), the stripes are transverse in *S. scomber*, *pneumatophorus*, *janesaba*, and *tapeinocephalus*, irregularly reticulated in *S. colias*, longitudinal in *S. chrysozonus*, replaced by longitudinal rows of spots in *S. moluccensis*, and of indistinct dots in *S. microlepidotus*. Why the transverse stripes should be retained in one species and replaced by longitudinal stripes in another, I am unable at present to say; but it is evident that the markings of the mackerel tribe are, so to speak, in a state of very unstable equilibrium, and susceptible of considerable modification, a fact which should render them of much service in the investigation of racial differences in the more primitive species. To this group the common mackerel belongs, owing to its retention of the transverse stripes, modified though these are in a variety of ways.

The variations in the frequency and numbers of the intermediate spots are given in Table D (p. 292).

The number of fish exhibiting one or more spots (which for brevity will be termed "spotty fish") is seen, as a rule, to be but a small proportion of the whole; but in this respect there is a striking contrast between the European and the American mackerel. In European samples the number of spotty fish is usually about 25 °/。 of the whole, varying from 7 °/。 to 29 °/。; but in the American sample the spotty fish predominate, and amount to 66 °/。 of the total number.

Similarly the total number of spots for every hundred fish is usually about 30 in European samples, varying from 8 to 57, but attains the extraordinary total of 215 in the American sample. The table giving the frequency of the different numbers of spots shows that the high American total is not due to the accidental inclusion of some one or two very spotty fish, but is due to a regular and extensive variation in regard to the number of spots, the numbers from 1 to 11 occurring with a frequency which decreases fairly regularly as the number of spots increases. In one fish actually 17 spots were enumerated.

It is not to be expected that a character which is altogether absent in 75 °/o of the fish would show any great uniformity of variation in samples of only 100 fish.

The range of variation in the samples, excluding those of less than 70 fish,* is, however, as follows:—

Locality.	Percentage of Spotty Fish.	No. of Spots per 100 fish.
Lowestoft and Ramsgate	17% to 28%	24 to 57
Plymouth	12% to 25%	25 to 57
Brest and Scilly	18% to 26%	32 (each)
Kinsale	16% to 23%	22 to 40
Kerry	7% to 12%	8 to 20

As we have already seen for previous characters, so here in regard to spottiness, the table brings out the close relationship between the North Sea and Plymouth fish with a fidelity which is really astonishing; and the close affinity of the Brest and Scilly fish with those of the former regions is also clearly shown. The novel feature of the table is the remarkable difference between Kinsale and Kerry fish in regard to this character, those of the West coast of Ireland having a very low degree of spottiness, while those of the South coast occupy an intermediate position between the Kerry fish and those of the Channel, approximating, however, more closely to the latter. The maximum percentage of spotty fish in the Kerry samples scarcely attains to the minimum percentage in the samples from every other region, and the maximum number of spots per hundred fish is actually less than the minimum number for other localities.

The reliability of the data as a test of racial peculiarities is established in my opinion by the close conformity of the results in regard to the North Sea and Plymouth fish, since these are groups the racial identity of which is rendered antecedently probable by the sequence of events in the fishing seasons, and by geographical and physical considerations. This antecedent probability has already been confirmed by the results described in the section on the number of transverse bars.

The sensitiveness of the character as a test of racial differences is also confirmed by the great contrast which has been shown to exist between American and European fish in regard to this character, a contrast which is borne out by the variation of almost every other character, but which is more striking for this character than for the remainder.

* The small Brandon sample, dated April 16th, has been combined with that dated April 22nd, in order to obtain a representative percentage for this locality.

The conclusion, therefore, seems to me to be inevitable that the mackerel which frequent the south and west coasts of Ireland are not a single stock of fish which visit both coasts indifferently, but are separable into two stocks, one of which inhabits the waters off the west coast, the other those off the south coast.

I find some support for this conclusion in Mr. Green's statement that he has met with no evidence to show that mackerel in approaching the Irish coast "travel along it, either to north or south. From Cork to Donegal, which are the extreme limits of the fishery on the Irish coast, they appear at the same time." (Bull. U.S. Fish Com., xiii. 1893, p. 358.)

There is, of course, no impassable barrier between the two stocks of fish. Mixture must undoubtedly take place at the imaginary borderline between the southern and western areas, and in the spawning season a variable number of the floating eggs from one stock must be carried by currents into the area of the other; but it must be remembered that my samples are derived from localities relatively far apart, viz., Kinsale and off the mouth of the Shannon, and that while the west coast fish are only subject to mixture with the closely related south coast fish, those which are found in the eastern waters of the south coast are also liable to mixture with the mackerel of the English Channel. It is probably significant, therefore, that the differences between the Kinsale and Kerry fish consist in an approximation of the former fish, and not of the latter, towards those of the Channel in regard to the present character.

I may draw attention to the fact that this intermediate condition of the Kinsale fish is not confined to the present character. If reference is made again to Table B, it will be seen that the mean number of transverse bars is distinctly lower for Kinsale (27·15) than for Kerry (27·27), and consequently approximates towards the mean value for the Channel, which is the lowest of all (26·79). In this character, however, the Kinsale fish maintain a closer resemblance to the Kerry fish than to those of the Channel. Similar results have also been yielded by the first dorsal fin, as will be described later on (p. 275).

From a comparison of all three tables (B, C, and D) it would appear to be probable that the mixture which actually accounts for the intermediate condition of the Kinsale fish is rather with the Brest and Scilly fish than with those of the Channel in its narrower sense. Such a conclusion would harmonise well with the known range in the position of the fishing quarters during the spring season.

To conclude this chapter, I give a more condensed statement of the results for the four principal regions.

TABLE VII., *showing variation in Spottiness.*

Locality.	Number of Fish.	Percentage of Spotty Fish.			Total number of spots per 100 Fish.
		Total.	Fish with 1 spot.	Fish with 2 or more spots.	
America	100	66	23	43	215
North Sea and English Channel .	700	21	13	8	37
Brest and Scilly	174	22	15	7	32
Ireland, W. and S. . . .	556	15	11	4	23

This table brings out clearly (1) the decisive racial distinctness of the American fish, (2) the affinity between the fish from Brest and Scilly with those of the Channel and North Sea, and (3) the racial difference between the Irish fish and those of the preceding area.

In general terms it may be said that the American fish are very spotty, and the Irish fish, particularly off the west coast, are very free from spots, while the fish which frequent the English Channel, from its mouth to the coast of Norfolk, have a somewhat higher percentage, both of spots and spotty fish, than those of the Irish coast.

That spottiness has no connexion with the size of fish examined is clear from a comparison of the results with the table of sizes.

The following figures prove the absence of any sexual peculiarities in the matter. They are based on the entire set of samples in which the sex of the fish was recorded, *i.e.*, 100 American and 918 British fish.

American fish.—Proportion of males to females . . . 55:45
,, ,, male to female spotty fish . . 59:41
Deviation = 4 %

British fish.—Proportion of males to females . . . 46:54
,, ,, male to female spotty fish . . 44:56
Deviation = 2 %

IX. NUMBER OF FINRAYS IN FIRST DORSAL FIN.

According to Günther's *Catalogue of Fishes* (vol. ii., p. 357), the number of finrays in the first dorsal fin of the common mackerel is higher than in any other species of the genus *Scomber*, and varies from 11 to 14. The lowest number is presented by the Spanish mackerel (*S. colias*), which is stated both by Günther and Day (*British Fishes*, i., p. 91) to possess only 7 rays. An intermediate condition is shown by *S. pneumatophorus*, which possesses 10 rays, according to the same authorities. Steindachner, on the other hand, regards the two latter forms as varieties of one and the same species, in which the number of finrays would vary accordingly from 7 to 10. From an examination of several specimens from the Mediterranean, which I owe to Professor

Marion's kindness, I am inclined to agree with Steindachner in the matter. In any case, there is a marked difference in the number of finrays characteristic of the common and the Spanish mackerel, the two best known species of the genus *Scomber*. If there are any separate races of the common mackerel, there exists, accordingly, an *a priori* probability that the distinction between these races will include differences in regard to the number of rays in the first dorsal fin, especially as the variability of this character in *S. scomber* is already known to be considerable.

Before proceeding to an examination of my results, I should state that the determination of the exact number of rays present in the first dorsal fin of any mackerel is a matter requiring considerable care, owing to the minuteness of the posterior rays. The second or third ray is usually the longest, and the length of the remaining rays decreases gradually to zero. If one wished to omit the minute hinder rays from consideration, it would be as difficult to determine a just arbitrary limit as to endeavour to count the entire series. I have therefore adopted the latter course, and my figures represent the maximum number of finrays recognisable in each fish without actual maceration.

Upon a first inspection of the figures representing the average number of rays in the fish from each locality, I feared, from their apparent irregularity, that the difficulties of exact determination had proved too great for the acquisition of definite results, and this remark was made in the preliminary account of my researches communicated to the British Association at Bristol. From the more complete analysis of the figures, however, which I now provide, it will be seen that my fears were groundless, for the data have proved to be of sufficient exactitude to establish an unexpected but convincing relation between number of finrays and size of fish.

§ 1. *General variation.* The distribution of finray values among the various consignments of mackerel examined is given in Table E.

The range of variation is shown to be from a minimum of 9 rays to a maximum of 16 rays, but in a total number of more than 1600 fish the former value was only found twice and the latter value only once. The most frequent value was 12, which was found in about half the fish examined; 13 rays were found in about one quarter of the fish, and the remaining quarter consisted principally of fish possessing 11 and 14 rays, the former value being much more frequent than the latter. The fish with 9, 10, 15, and 16 rays formed a very small percentage of the whole (about 3 °/₀ altogether).

§ 2. *Local differences.* In a sample of 100 fish from the French coast near Brest, the variation of finray values was absolutely symmetrical (see Table E, p. 293), and exactly 50 °/ₒ of the fish exhibited the modal or most frequent value.

In all other samples the distribution of values was asymmetrical. The percentages for the various localities show that the modal value is 12 for all localities except Scilly, for which it is 13. This exception is no doubt partially due to the smallness of the consignments from that locality (only 74 fish in all), and is paralleled by a similar phenomenon in the case of a small consignment from Brandon, April 16th, in which the most frequent value was 11, although 12 in a subsequent and larger sample.

For most localities the number of fish having 13 rays preponderates over the number having 11. This is true for Lowestoft, Ramsgate, Plymouth, Scilly, and County Kerry. But the American fish show a slight preponderance of the lower value, and the preponderance of this value is considerable in the case of the fish from Kinsale. In this respect the Kinsale fish differ from those from all other British localities, and the matter requires special consideration.

On examining the data for the various samples received from Kinsale (Table E), it is seen that the preponderance of low values was not exhibited by all the consignments, those taken on September 17th, 1897, and July 1st, 1898, being normal in this respect. The preponderance of low values was entirely due to the samples dated July 30th and September 3rd, 1897. Now these were the only samples in the whole series of fish which were not examined in a fresh condition. They arrived during my absence in Canada, and after measurement were placed in tanks of formaline to await my return. The excess of low values is so unique in these two cases that I consider myself justified in attributing the difference to the effects of this re-agent, the tendency of which to develop free formic acid is well known. The amount of calcareous matter in the minute posterior rays is so small, that its solution by the acid would be merely a matter of time. As the fish remained six weeks in the formaline before examination, there can be little doubt that the calcareous matter in the smallest rays was dissolved in a certain number of cases to an extent sufficient, at any rate, to invalidate the records. The omission of the posterior ray from 20 °/ₒ of the fishes in these samples would be more than sufficient to account for the observed differences between the fresh and preserved samples of Kinsale fish.

If this correction be permitted, the variation of the first dorsal fin becomes very uniform for all British localities, with the exception of Scilly, an exception which is readily explicable by the inadequacy of the sample from that region. The numbers of finrays vary round 12 as a mode, and the percentage of values above the mode tends everywhere to exceed the percentage of values below it; but neither by a comparison of the percentages themselves, nor by the study of the average values for each locality, is it possible to trace any marked evidences of racial distinction among the British fish. The American fish alone seem to possess any distinguishing peculiarity as regards the variation of this organ.

The question, however, is complicated by the factors of growth and sex. Matthews has shown that in the herring there is a slight increase in the number of dorsal finrays with the growth of the fish, an increase which is not so much due to the appearance of new rays as to the enlargement of the minute anterior ray, which renders it less liable to escape notice in large fish than in small (4th Report Scottish Fishery Board, 1886, p. 92). It is therefore necessary to enquire whether there exists any similar relation in the mackerel between size of fish and number of recognisable rays.

Moreover, the first dorsal fin is frequently modified as a secondary sexual character in bony fishes, and although no such modification has ever been recognised in the mackerel, it is important to ascertain whether or not the number of rays is correlated with sexual distinctions. The proportion of the sexes in the various consignments of fish examined was not always uniform, and, if any correlation exists, the preponderance of opposite sexes in two different samples would occasion a difference in the results which might be readily mistaken for evidence of racial peculiarities.

§ 3. *Number of Finrays according to Sex and Size.* The sex of the fishes examined during the autumn of 1897 was not always determined, so that in the present enquiry we shall be restricted to the following samples of fish:—

Ireland.

(1) Kinsale, July 1st, 1898 . .	44	males	and	56	females
(2) Smerwick, March 12th, 1898 .	63	„	„	36	„
(3) Brandon, April 16th, 1898 . .	20	„	„	25	„
(4) „ „ 23rd „ . .	43	„	„	58	„
Total . .	170	„	„	175	„

English Channel and North Sea.

(1) Plymouth, Nov. 16th to 20th, 1897	41	males	and	59	females
(2) „ July 6th, 1898 . .	42	„	„	58	„
(3) „ „ 11th „ . .	10	„	„	14	„
(4) Ramsgate, Oct. 27th, 1897 . .	55	„	„	45	„
(5) Lowestoft, Oct. 12th „ . .	15	„	„	10	„
(6) „ June 28th, 1898 .	21	„	„	29	„
(7) „ July 12th „ .	39	„	„	61	„
Total . .	223	„	„	276	„

The size of the fish in these samples, irrespective of sex, is given in inches and quarters in Table A. In the enquiry before us, however, it is inadvisable to have too many size-groups, as that would reduce the number of fish in each group to a very small number. I have therefore subdivided the Irish males and females into groups according to the integral number which expresses the length of each fish in inches, the fractional differences being neglected. The fishes in each group have then been sorted according to the number of the rays in their dorsal fins. The same has been done with the males and females of the Channel and North Sea fish, and the resulting distribution of values is shown in Table F (p. 294). The upper half of the table represents the observed frequency of the various finray values, the lower half embodies the same facts reduced to percentages. The mean number of finrays for each inch-group of fishes has also been calculated, and is to be found in the column to the right hand of the frequency data for males and females alike.

The results contained in this table are particularly interesting. If we neglect the values ascribed to the extreme inch-groups, viz., those containing 11- and 17-inch fish, which are naturally erratic on account of the small number of observations, we see that on the whole there is a distinct tendency for the percentage of high values to diminish with increased size of fish. The Irish results are clearer than those for the Channel in this respect, owing to the greater number of large Irish fish. I will, therefore, direct attention to them in the first place. We see, for example, that for Irish fish of 12 and 13 inches length, whether males or females, at least 40 °/₀ possess more than 12 finrays; whereas for fishes above that size the percentage of high values (*i.e.*, above 12 rays) never exceeds 33 °/₀ and in most cases does not exceed 30 °/₀. On the other hand, the percentage of low values (*i.e.*, below 12 rays) does not exceed 22 °/₀ for fishes of 12 and 13 inches, but is increased to 30 °/₀ or more in the case of fishes of 15 and 16 inches in length. This general tendency is expressed fairly accurately by the mean values, which vary between 12·24 and 12·35 for the smaller fish (12 and 13 inches), and between 11·90 and 12·05 for the larger fish (15 and 16 inches).

We reach, accordingly, this general result, *that, among Irish fish, whether males or females, the average number of finrays decreases as the length of the fish increases.*

Of course, this generalisation only applies to fish within the size-limits of the present investigation, *i.e.*, to mackerel of marketable size, between 11 and 17 inches in length. I have not hitherto received any small first-year fish from Irish waters, and cannot, therefore, say at what stage the maximum number of finrays is present. Some remarks on this point in connection with yearling Plymouth fish will be found below.

A second conclusion is also forced upon us by a comparison of the figures on the left and right sides of the same Table (F), which deal with the frequency of the various values for males and females respectively. Subject to the same reservation in regard to the extreme size-groups, we may say that, *for each size of fish, the table shows a perfect agreement between males and females in regard to the relative frequency of high and low values.* When high values predominate among the males, they predominate also among the females of the same size; when the percentage of low values rises in one sex, it rises also in the other. There is accordingly a close agreement between the mean number of finrays in males and females of the same size.

In the series of size-groups of Irish fish, whether male or female, the first distinct fall in the mean number of finrays occurs in the group of 14-inch fish, in which there is a decrease of 0·25 for the males, and 0·29 for the females, as compared with the mean values for the corresponding groups of 13-inch fish.

Unfortunately the group of 12-inch Irish fish is inadequately represented, and when we pass to the Channel and North Sea fish, we see that the group of 14-inch fish is there represented in the case of the males by only 26 fish, which is also insufficient to yield a reliable result. This is seen, for example, in the lack of correspondence between the means for the Channel males and females of this size, a feature which is still more noticeable for the 15-inch fish, which are represented by only 6 specimens of each sex.

In order, therefore, to compare the Irish with the Channel results, it is necessary to enlarge the size-groups, and this I have done by dividing the whole set of fish into three, instead of eight, compartments according to the size of the fish.

These compartments are as follows :—

(1) 10, 11, and 12-inch fish.
(2) 13 and 14-inch fish.
(3) 15, 16, and 17-inch fish.

As we have already seen that the mean values indicate pretty closely the changes which take place in the percentage distribution of high and low values, it will be unnecessary to recombine the percentage values in a separate table, although anyone desirous of checking these results can readily do so from the data given in Table F. I will give here merely the mean values for the three compartments already defined.

TABLE VIII., *showing mean number of first dorsal finrays for males and females of different sizes.*

Size of Fish (inches).	Ireland.				Channel and North Sea.			
	No.	♂	No.	♀	No.	♂	No.	♀
10, 11, and 12 .	27	12·33	26	12·31	111	12·21	140	12·31
13 and 14 .	107	12·16	83	12·14	105	12·13	128	12·02
15, 16, and 17 .	36	11·92	66	11·94	7	12·00	8	12·00

This table shows two things:—

1. That a reduction in the number of recognisable finrays with increasing size is a general phenomenon, common to mackerel from Irish and English seas alike: and

2. That there are no sexual peculiarities at any size in regard to the number of finrays in the first dorsal fin.

The first of these conclusions is obvious enough. The second conclusion is founded on the practical identity of the mean values for Irish males and females at corresponding sizes, and on the inconsistency in kind of the differences which exist between the males and females of the Channel and North Sea. The mean for the females in the first compartment exceeds that for the males by 0·10, while in the second compartment the mean for the males exceeds that for the females by 0·11. Whatever may be the explanation of these deviations between the male and female values, it is clearly not due to the existence of any secondary sexual peculiarities in the number of finrays.

The questions naturally arise, at what period in the life of a mackerel does the process of reduction begin, and what is the cause of the reduction?

The first question can only be answered after the examination of large numbers of young mackerel. The material at my disposal is at present too limited for me to go minutely into the matter, but is sufficient to show that the reduction in the number of rays begins before the attainment of a length of 10 inches. The mean number of finrays in 127 Plymouth mackerel above $12\frac{1}{2}$ inches in length is 12·02; the mean in 129 small mackerel from the same locality, all of which were below $10\frac{1}{2}$ inches in length, is 12·49. The frequency of the different values is shown in the following table:—

TABLE IX., *showing frequency of finray numbers in small and large Plymouth fish, irrespective of sex.*

Small fish = below $10\frac{1}{2}$ inches; minimum size $5\frac{1}{2}$ inches.
Large fish = above $12\frac{1}{2}$ inches; maximum size $15\frac{3}{4}$ inches.

Size.	Number of Fish.	Number of Finrays. 10	11	12	13	14	15	Mean.
Small.	129		21	48	41	14	5	12·49
Large.	127	8	24	62	25	7	1	12·02
Small.	%		16	37	32	11	4	12·49
Large.	%	6	19	49	20	5	1	12·02

As regards the cause of the reduction in the number of recognisable finrays, there are two possibilities, (1) the gradual absorption, and (2) the gradual concealment of the minute posterior rays.

I have been unable as yet to determine the extent to which actual absorption of the rays takes place, but I believe that some part of the reduction, if not the whole of it, is due to changes in the relation of the fin to the neighbouring tissues during growth of the fish. In an adult mackerel the first dorsal fin is lodged in a deep groove, within which it can be entirely depressed—an adaptation, without doubt, to habits of rapid locomotion, as this fin is never used for swimming, and would only be a hindrance if incapable of being bent back and tucked away within its socket; but in young fish up to 7 or 8 inches in length the groove is not yet formed. Consequently, in old mackerel the basal part of the fin is sunk beneath the general surface of the skin, while in young mackerel every part of the fin is freely exposed. The minute posterior rays do not protrude outside the groove in old fish, but are clearly visible in young fish. In these they require no preparation or dissection to be displayed; but in old fish the groove has to be carefully explored with a seeker, and often the lateral flaps of skin have to be cut away for the purpose, before the number of projecting rays can be accurately ascertained. This, of course, is a mere matter of care, which it is needless to say was invariably bestowed in the course of the investigation, the number of rays in this fin having been counted in each fish at least twice, and often four or five times, before being recorded. But a real difference between the two conditions consists in the fact that the posterior rays in large fish generally project less above the floor of the groove than do the corresponding rays of small fish, thus indicating in large fish a process of encroachment upon the lower part of the fin by the surrounding tissues. I fancy, therefore, that as the fish grows, this encroachment leads to the gradual covering up of the smallest rays altogether, which would sufficiently account for the observed reduction in the number of finrays as growth of the fish increases. As already remarked, I cannot yet say whether the spines are ever actually absorbed. From the nature of the case such a conclusion could only be derived from an extensive study of macerated specimens of different sizes, since mackerel will not live more than a few days in captivity, and it has not been possible to devote the necessary time to such an enquiry.

§ 4. *Racial differences.* Owing to the reduction of the number of finrays with growth of the fish, it is clearly impossible to use the data given in Table E as a basis for conclusions as to racial peculiarities, since no account has been taken in that table of growth-changes. If any racial peculiarities exist, they can only be determined by comparing fish of the same size from the different localities. Accordingly, as the various localities are most uniformly represented by 13-inch fish (see Table I, p. 246), I have compared the mean numbers of finrays in local groups of fish of this size.

The results are as follows:—

American . . .	33 fish. . .	Mean number	=	11·88
North Sea . . .	166 „ . . .	„	„	12·14
Plymouth . . .	64 „ . . .	„	„	12·00
Brest and Scilly . .	56 „ . . .	„	„	12·16
Kinsale	49 „ . . .	„	„	12·14
Kerry	49 „ . . .	„	„	12·33

The number of fish representing most of the localities is unfortunately too small to yield very accurate results, but the general trend of the differences is probably reliable. The American sample, as in other cases, yields one of the extreme values, in this case the lowest; and among European samples the Kerry and Channel values are widest apart, as was also the case in regard to the transverse bars (Table B) and intermediate spots (p. 266). The difference between the values for Plymouth and the North Sea is certainly rather large, as also is that between Kinsale and Kerry; but, in view of the small available numbers of fish of the proper size, I doubt whether any importance can be attached to these differences. A more reliable conclusion can probably be derived from the fact that the maximum value for the Channel and North Sea is no higher than the minimum value for the Irish coasts, and that Brest and Scilly yield a value which is intermediate between the two.

This result is in complete agreement with the results already obtained in regard to the number of bars and the degree of spottiness.

That this result is not accidental, but is founded on real differences in the degree of evolution of the different races of fish will be made clear in the next section.

X. Correlation between Spottiness and Number of Finrays.

We have already seen that the presence of intermediate spots among the transverse bars indicates a departure from the primitive arrangement of the bars, which coincided with the lines of the myotomes or muscle-segments. Increased spottiness accordingly indicates an increased departure from the primitive condition. We have also seen that the common mackerel belongs to the most primitive group of species of the genus *Scomber* so far as its markings are concerned. I have, moreover, briefly referred to the fact that the number of finrays in the first dorsal fin is higher in the common mackerel than in any other species of the genus *Scomber*. As the number of finrays has also been shown to be higher in young than in old mackerel, it is certain that, for the race as for the individual, a high number of finrays is the primitive condition for Scombroid fishes.

Accordingly, as increase in spottiness and reduction of finrays are equally departures from the primitive condition, we might expect to find a correlation between these two characters in well-defined races of mackerel; and if this correlation occurs in representative samples of fishes from different localities, it furnishes the strongest possible argument for their racial distinctness.

Such a correlation undoubtedly exists, as is shown in the following table, which gives for each group of fishes the indices of spottiness already ascertained (p. 267) side by side with the mean number of finrays in the first dorsal fin, as determined in fish of 13 inches length. Although an extensive examination of the variation of the Spanish mackerel, *Scomber colias*, has not yet been made, its spottiness is so marked, and the number of its finrays is so decidedly reduced, that I have no hesitation in placing it here as a type of extreme departure from the primitive Scombroid condition.

Race of Mackerel.	Percentage of Spotty Fish.	No. of Spots per 100 Fish.	Mean No. of Finrays (13 inches).
Scomber colias	100 °/₀(?)	500(?)	7–10
Sc. scomber			
American	66 °/₀	215	11·88
{ North Sea and English Channel	21 °/₀	37	12·10
{ Brest and Scilly	22 °/₀	32	12·16
Ireland, S. and W.	15 °/₀	23	12·23

It would be difficult to find a more convincing demonstration than this table affords as to the existence of local races of the common mackerel; and when it is remembered that the variation in the number of transverse bars led to a precisely similar grouping of the local consignments (p. 255), there can remain, I think, no doubt as to the general accuracy of the conclusions which are drawn in this report concerning the races of the mackerel.

The contrast between the Irish and English races of mackerel is sufficiently clear from the figures in the table, but it becomes still more distinct if we contrast the English race with the West coast stock of the Irish race, since the Kinsale fish occupy an intermediate position between the Kerry fish and the English race in respect of both characters. The following are the distinctive characters of the two stocks of the Irish race:—

	Spotty Fish %	Spots %	Mean No. Finrays.
Kinsale	19 %	29	12·14
Kerry	10 %	15	12·33

In respect both of spottiness and number of finrays, the Kinsale stock approaches the Channel race more closely than it does the Kerry stock, although intermediate between the two. In respect of the number of transverse bars it also holds an intermediate position, as already shown, but comes nearer the Kerry stock than the Channel race. The facts, therefore, demand the subdivision of the Irish race into West coast and South coast stocks.

On the other hand, it can be seen from the data already provided that no similar differences separate the North Sea from the Plymouth fish, the racial identity of which must accordingly be regarded as absolute.

The combined Brest and Scilly data approximate throughout to those for the North Sea and Channel, although they show a slight approach under each character towards the Irish, and particularly the Kinsale, values. In regard to the number of transverse bars, the high average of the Brest and Scilly fish shown in Table C would also appear to indicate an incipient racial divergence between the fish of the Channel proper and those which in summer haunt the mouth of the Channel west of a line from Mounts Bay to Brittany.

If this is so, it is a matter of the greatest importance, since it would necessitate the conclusion that the winter quarters of the North Sea and Channel fish are to be found in the Channel itself, and not to the west of it. This conclusion is by no means improbable, and would harmonize well with the peculiarities of the Plymouth winter fishery; but I cannot regard the evidence of the relatively small samples of

Brest and Scilly fish, or that of the partial series of transverse bars (Table C), as by any means decisive. I hope to re-examine these details by means of larger samples during the coming year.

XI. Second Dorsal Fin.

The variation in the number of finrays in the second dorsal fin is much slighter than in the case of the first dorsal. The extreme range of variation is from 9 to 15, *i.e.*, 7 rays; but the two extreme values on each side of the mode (*i.e.*, 9, 10, 14, and 15) occur very rarely, so that the range of variation scarcely covers more than 3 rays, viz., from 11 to 13.

Owing to the limited variability of the organ, no useful purpose would be served by publishing the separate data for the various consignments of fish, and I have therefore confined myself to a statement of the observed results for each locality as a whole. These are set out in Table G (p. 295).

There is a marked difference in the variability of this organ in the American fish as compared with the samples of European fish; for, whereas 12 rays occur in from 82 to 85 °/₀ of the European fish, they are found in only 63 °/₀ of the American, and the frequency of each of the remaining values is from twice to three times as great for the American fish as for the European. The mean value for the American sample is also considerably lower than for any European sample examined. The highest mean is that for the North Sea (11·950), and the lowest that for Kinsale (11·927), the difference between the two being 0·023. But the difference between the American mean and the nearest European mean is much greater than this, being 0·077.

The differences between the European samples are exceedingly slight, but attention may be drawn to the fact that the localities which provide the highest and lowest mean-values are geographically remote, viz., the North Sea and Kinsale.

The only satisfactory way of comparing values which present such slight local differences in the frequency of their occurrence, will be to combine the values above and below the mode (12) into two compartments of high and low value respectively, as below.

TABLE X., *showing frequency of High and Low Values of the Second Dorsal Fin.*

(Percentages.)

Locality.	Finrays. 9–11	12	13–15
Newport, U.S.A.	23 %	63 %	14 %
North Sea	10	84·3	5·7
Plymouth	12·3	81·3	6·3
Brest and Scilly	10·3	82·2	7·5
{ Kinsale	10·7	85·4	3·9
{ Kerry	9·8	85·3	4·9
{ North Sea and Plymouth	11	83	6
{ Brest and Scilly	10·3	82·2	7·5
Ireland, S. and W.	10·4	85·3	4·3

Undoubtedly the two groups which agree most closely according to the above table are those from Kinsale and Kerry. For these groups the frequency of the mode is the highest recorded, and is practically identical in the two cases (85·3 and 85·4 %). The two lowest frequencies of the high values (3·9 and 4·9 %) are also found in the same groups.

The figures do not appear to justify any further amalgamation of the groups; but it is worth noticing that the North Sea group approximates closer in its values to the Irish samples than does either of the others—a feature which is again exhibited with respect to the dorsal finlets.

We have already seen that, in respect to spottiness and the number of finrays in the first dorsal fin, the Irish fish approach most nearly to the theoretically primitive condition. Now the primitive number of rays in the second dorsal fin would appear almost certainly to have been 12, partly on account of the high frequency of this number throughout the samples, and partly on account of the fact, which is established below, that when this number is exceeded, the number of finlets tends to be reduced, and when the number of rays is reduced below 12, the number of finlets tends to be increased. This correlation implies a primitive constancy in the number of rays in the posterior dorsal fin of the ancestral mackerel prior to its subdivision into second dorsal and finlets. The total number of rays in the ancestral continuous fin was probably 17, which became subdivided into 12 rays for the primitive second dorsal fin and 5 rays for the finlets. If this view is correct, it is to be remarked that in the high frequency of the modal number of rays in the second dorsal fin, the Irish fish again display their primitive character. On this account, in spite of the slender basis for drawing racial distinctions from the variation of the present character, I think it will be conceded that, so far as any conclusions at all are permissible, they confirm the inferences which have already been drawn from the evidence of the more variable characters. It will if be noticed, moreover, that the North Sea and Plymouth data are amalgamated, the percentages for Brest and Scilly approximate to the percentages for the combined groups in a remarkably close manner,—much more nearly than they do to the combined Irish percentages. This result is in complete agreement with the results already described for the characters previously discussed.

XII. The Number of Dorsal Finlets.

The number of dorsal finlets in my samples was never less than 4 nor more than 6; but there is a certain difficulty in enumerating them, owing to the fact that the last ray of the second dorsal fin is sometimes imperfectly separated off as an accessory, or incipient, finlet. As the finlets and second dorsal fin are both modifications of a primitively continuous fin (such as that which exists in *Caranx trachurus*, the horse-mackerel, and its allies), it is desirable to include these incipient finlets in an account of the variability of the number of finlets. They have been included in the account of the second dorsal fin as a matter of course, each incipient finlet counting as one dorsal ray; but in the present case, in order to reduce their value as compared with the fully constituted and independent finlets, I have regarded them as half-finlets. Thus, a fish which has 4 true finlets and one incipient finlet has been recorded as having 4½ finlets.

The observed frequency of the different possibilities is recorded in Table H (p. 295).

The normal or modal number is, of course, 5. In the European samples this number occurs in from 92 to 94 °/ₒ of the fish, but the American race of mackerel is again distinguished from the European samples by its greater variability in regard to this character, the modal number being found in only 79 °/ₒ of the observed cases. In only 2 °/ₒ of the cases was the number reduced below 5, viz., 4½, but no specimen was seen with only 4 finlets. On the other hand, 19 °/ₒ had more than 5 finlets, viz., 12 °/ₒ with 5½ finlets, and 7 °/ₒ with 6.

The slight variability of the European fish in regard to this character renders necessary the same treatment as was applied in the case of the second dorsal fin, and I have therefore merged into a single compartment the cases showing less than 5 typical finlets, and into another compartment the cases with more than 5 typical finlets.

TABLE XI., *showing frequency of High and Low Numbers of Dorsal Finlets.*

(Percentages.)

Locality.	Dorsal Finlets. 4–4½	5	5½–6
Newport, U.S.A.	2 %	79 %	19 %
North Sea	2	94·5	3·5
{ Plymouth	3·3	92·3	4·3
{ Brest and Scilly	4	93	3
{ Kinsale	2·4	94·4	3·2
{ Kerry	2	94·3	3·7
North Sea and Plymouth	2·6	93·6	3·8
Brest and Scilly	4	93	3
Ireland, S. and W.	2·3	94·4	3·3

This table is, on the whole, similar in its general features to Table X., showing the variation of the second dorsal finrays. A very close affinity is revealed between Kinsale and Kerry, and again between Plymouth and the combined samples from Brest and Scilly, but the North Sea values, which merely approximated to the Irish values in the case of the dorsal fin, now entirely agree with them.

We again see that the Irish group is characterised by the high frequency of the normal number of finlets, or, as we may say, by its high normality.

In revealing the close affinity between the Kinsale and Kerry groups, and between the Plymouth group and the combined Brest and Scilly samples, this table furnishes a confirmation of what has previously been urged with regard to these points. The difference between the North Sea and Channel groups, although foreshadowed in the case of the second dorsal fin, is novel, and possibly significant; but in the next section it is shown that the variability of these organs is too slight to admit of any inferences being safely drawn as to the affinity between the various local groups of fish. The maximum number representing any one locality is only 410, while the deviations from the normal condition do not exceed 8 % for any of the British localities in the case of the dorsal finlets.

XIII. CORRELATION BETWEEN VARIATIONS OF SECOND DORSAL FIN AND NUMBER OF DORSAL FINLETS.

During the examination of the mackerel received, I frequently had occasion to notice that a marked degree of correlation exists between the number of finrays in the second dorsal fin and the number of finlets. I am not qualified at present to discuss the facts from a mathematical standpoint, but the existence of the correlation can readily be demonstrated.

As the variation of both characters is most marked in the American sample, I have analysed the data provided by it in the following manner:—

In 2 fish having 9 rays	. . .	*both* had 6 finlets.
Of 3 " " 10 "	. . .	1 had 6 "
		2 " 5 "
" 18 " " 11 "	. . .	4 " 6 "
		14 " 5 "
" 63 " " 12 "	. . .	*all* " 5 "
" 13 " " 13 "	. . .	11 " 5 "
		2 " 4 "
In 1 " " 14 "	. . .	1 " 5 "

These figures show (1st) that the normal or modal number of finrays (12) is constantly associated with the normal or modal number of finlets (5); (2nd) that when the number of finrays is below 12, the variation in the number of finlets is confined to deviations above the mode; and (3rd) that when the number of finrays is above 12, the deviations from the modal number of finlets are exclusively below the mode.

This relation can be shown still more clearly as follows:—

Of 7 fish with 6 finlets	2 had 9 rays.
	1 " 10 "
	4 " 11 "
" 91 " " 5 "	2 " 10 "
	14 " 11 "
	63 " 12 "
	11 " 13 "
	1 " 14 "
" 2 " " 4 "	2 " 13 "

These figures show (1st) that the normal number of finlets (5) is associated with a wide range of variation in regard to the number of rays in the second dorsal fin (from 10 to 14), (2nd) that when the number of finlets is above 5, the number of rays is constantly below 12; and (3rd) that when the number of finlets is below 5, the number of rays is constantly above 12.

This correlation is also exhibited by the mean values of each character for the American sample, the mean number of finrays (11·850) being the lowest observed, and the mean number of finlets (5·120) being the highest observed.

If the mean values for the various British localities are correct, they ought to exhibit a similar correlation in regard to these characters; but, as will be seen from the following table, such a correlation between the local means does not exist. The localities are grouped in order of magnitude of the mean numbers of dorsal finlets; the inverse order of magnitude for the second dorsal values is given in brackets.

	Finlets.		2nd Dorsal.
1. Newport, U.S.A. . .	5·120	...	11·850 (1)
2. Kerry	5·016	...	11.947 (4)
3. North Sea . .	5·014	...	11·950 (6)
4. Kinsale . . .	5·009	...	11·927 (2)
5. Plymouth . . .	5·003	...	11·940 (3)
6. Scilly and Brest . .	4·994	...	11·948 (5)

It will be seen that there is a conspicuous lack of correlation between the mean values for the various local groups of European fish. Kerry and the North Sea, which have the highest average number of finlets, ought to have the lowest number of dorsal rays, instead of which these values are among the highest observed. On the other hand, the combined Brest and Scilly values occupy approximately their correct positions in the sequence.

It is clear, therefore, that the means cannot be regarded as correctly representative of the local groups of fish, and that no racial affinities or differences can be based on the figures as they stand. In view of the indubitable correlation between the two characters under discussion, I am inclined to attribute the inaccuracy of the means to the slight amount of variation in these characters among European fish, which renders necessary a much larger number of data than those at my disposal. A sufficient increase in the number of observations for each region would render the means more truly representative, and ought to reveal the correlation that must be exhibited before the values can be regarded as reliable.

Indirectly this explanation indeed can be shown to be correct by amalgamating those groups which we have already seen upon other grounds to be closely related. The order is the same as in the preceding list.

	Finlets.		2nd Dorsal.
1. Newport, U.S.A. . .	5·120	...	11·850 (1)
2. Ireland, S. and W. . .	5·011	...	11·934 (2)
3. North Sea and Plymouth .	5·009	...	11·946 (3)
4. Brest and Scilly . .	4·994	...	11·948 (4)

This table shows that when the local groups of fish are amalgamated in the manner described, the means for finlets and second dorsal fin are distributed in the order demanded by the correlation of the two characters.

This result is not obtainable by any other mode of amalgamation. Thus, if the Kerry and North Sea groups are merged together, on the ground of the close resemblance they exhibit in regard to the high mean number of finlets, the resulting mean for the finlets becomes 5·015, and that for the finrays 11·948. *Each of these values would be the highest in its series, and therefore hopelessly wrong from the point of view of correlation.*

Similarly, if the Plymouth and Kinsale groups are amalgamated, the resulting means would both be among the lowest in their respective series, instead of displaying the inverse relation of high and low values which is demanded for accuracy.

I conclude from these facts that the grouping which fulfils the correlation test is the correct one; and, as this grouping is identical with that demanded by the variation of all the other characters examined, it would appear to rest upon the firm basis of real genetic affinity and racial differences.

XIV. Summary of Evidence concerning the Races of the Mackerel.

§ 1. *American Mackerel.*

The American mackerel have been shown in this report to differ very considerably from all samples of European mackerel examined.

The difference is exhibited in regard to every character the variation of which has been determined, and in every respect the American fish hold an extreme position among my samples. Thus the highest average is yielded by the American sample in regard to the following characters: (1) the number of transverse bars, (2) the number of spotty fish, (3) the number of spots per hundred fish, and (4) the number of dorsal finlets; whilst the lowest average is yielded by it in regard to the number of finrays in (1) the first dorsal, and (2) the second dorsal fin.

There can be no doubt as to the significance of these facts. The American mackerel constitute a distinct variety or race, whose most obvious characteristic is its high degree of spottiness.

It must remain for American or Canadian naturalists to determine the question as to the existence of minor local differences among the American fish. During the meeting of the British Association at Toronto last year, I examined a dozen mackerel which had been caught in the Gulf of St. Lawrence; and, although this number is insufficient to determine the existence of minute racial differences, I may state that it was the examination of these fish which first revealed to me the marked spottiness of the mackerel of the western shores of the Atlantic. In this respect, therefore, I have no doubt of the close agreement between the mackerel of Canadian and American waters.

§ 2. *European Mackerel.*

A subdivision of the mackerel which frequent the British coasts into two principal races, an Irish race and a race frequenting the English Channel and North Sea, appears to be demanded by the following facts which have been elucidated by my researches :—

(1) The identity of the Plymouth and North Sea fish, and the close agreement between the Kinsale and Kerry fish in regard to the variation in number of the transverse bars, and the emphatic difference between the two former and the two latter groups in regard to the same character;

(2) The close agreement between the Plymouth and North Sea fish in regard to the frequency of intermediate spots among the bars, and the emphatic difference between either of these groups and the Kerry fish in regard to the same character;

(3) The correlation of a relatively low average number of first dorsal finrays with a relatively high degree of spottiness in North Sea and Channel fish, and the correlation of the highest observed average number of finrays with the lowest observed degree of spottiness in the Irish fish. These correlated differences could not be expected to occur except in races of fish which had diverged to a different degree from the primitive condition;

(4) The correlated nature of the differences between the same two groups in regard to the number of second dorsal finrays and dorsal finlets.

The discrimination of these races has been made exclusively on the ground of structural differences and resemblances between the fish coming from a number of chosen localities. If the differences revealed by the present investigation should appear to some to be too small to be significant, it should be remembered that large differences could not in any case be expected to occur between the mackerel of any two regions in British seas, partly because of the relative smallness of the total area and the possibility of free intercourse between its different waters, and partly because of the known activity and wandering tendencies of the adult mackerel, in addition to its production of freely floating eggs. If, on the other hand, the differences should be regarded by others as accidental, this idea may be negatived at once by the general conformity of the results obtained for different characters, and by the important fact that those local groups which are shown to resemble one another most closely are exactly those which might have been expected to do so from geographical considerations. If there are no valid differences between any of the British groups of mackerel, it is in the highest degree improbable, when the number of observations is taken into account, that the data accumulated for North Sea and Plymouth fish should coincide so closely as they do, and differ to so considerable an extent from the data determined for the fish from Kerry.

Nevertheless, although certain differences between the Irish fish and those from the Channel and North Sea must, I think, be conceded, it would be a serious error to conclude that the division between these two races of mackerel is hard and fast. I have shown that the Kinsale fish are distinctly intermediate in character between the fish from the west coast of Ireland and those of the Channel in regard to the following features:—(1) number of transverse bars, (2) spottiness, and (3) number of first dorsal finrays. I have also shown that the mackerel caught off Brest and Scilly, though closely related to the Channel fish as a whole, also betray a certain approximation towards the Irish, especially the Kinsale, values in regard to the same characters; and, although the number of fish representing this region is relatively small, I see no reason for doubting that the consensus of evidence on this point is of some significance. These two intermediate cases, therefore, prevent the establishment of any rigid line of separation between the Irish and the Channel races; but they at the same time confirm in a most emphatic manner the one paramount conclusion of the whole inquiry, viz., *that the mackerel which frequent British waters are not exactly alike in all localities, but possess certain average peculiarities which distinguish one local race from another. These peculiarities are greatest between the races of localities which are geographically remote, and least between those which occupy areas that are geographically contiguous. Between the mackerel of the North Sea and English Channel there are no differences at all; but the Irish race is distinctly divisible into two stocks, one of which is restricted to the west coast, the other to the south. A considerable amount of mixture takes place between the southern Irish stock and the fish which frequent the mouth of the English Channel. The western Irish stock represents more closely than any other race the primitive type of mackerel, from which all, whether British or American, have been derived.*

XV. The Migrations of the Mackerel.

The establishment of geographical or local races of the mackerel settles a number of disputed points concerning the migrations of this fish. The theory of long migrations must be altogether given up. The mackerel certainly does not cross the Atlantic; the marked difference between American and European samples shows that at the present period of the earth's history there is no mixture between the two races.

Moreover, in view of the difference between Irish and Channel fish, it can no longer be maintained that the mackerel of these regions wander far in winter from their summer haunts. Each race of fish must possess its own winter habitat, and this must be situated close to the region where the fish make their first appearance in the spring. Indeed, the only migrations which can, for the most part, be conceded, are migrations from shallow to deeper water off the same coasts. The one exception to this rule concerns the North Sea fish. The racial identity of these fish with those of the Channel proper furnishes a conclusive proof of the accuracy of the view that the North Sea fish are derived from the English Channel in the spring, and return to it in the autumn, thus ensuring a complete mixture between the two groups during the winter period. By North Sea fish, however, are meant merely the fish which are taken off the east coast of England from Yarmouth southwards. How far to the northwards the spring migration extends must be settled by further investigation.

The relation between the autumn and spring fish of any locality is also elucidated by the same results. No racial differences between autumn and spring fish have been revealed by my inquiries for any locality which has been represented by samples taken at both periods; and the existence of differences between the fish of different localities renders it practically certain that each locality is frequented by one race only, viz., the race peculiar to the locality. So far as the Irish fish are concerned, the minor racial differences established between the fish of Kinsale and Kerry prevent a special pronouncement upon this matter on the present occasion, since the Kerry fish were exclusively spring fish, and the Kinsale fish almost entirely autumn fish. The evidence, so far as it goes, points to the conclusion that on the Irish coast the small autumn mackerel are young fish which will to a large extent form part of the breeding shoals in the following spring.

This matter, however, is being further investigated, and the same material will furnish a means of testing the accuracy of the conclusions which have here been submitted concerning the characters of the local races.

In conclusion, I may draw attention to the relation of the local races to the conformation of the sea-bed, which appears to me to be of considerable importance in any attempt to delimit the area normally frequented by each race. If reference is made to a properly contoured chart—*e.g.*, the charts of the fishing grounds in Cunningham's *Marketable Fishes of the British Islands* (Macmillan, 1896)—it will be seen that the mouth of the English Channel coincides with the 50-fathom line, that the same line bounds a large plateau of ground off the south coast of Ireland, but that off the west coast of Ireland it runs close to the coast-line. A moderately deep gully of more than 50 fathoms depth separates English from Irish territory.

Accordingly our division of British mackerel into an Irish and a Channel race coincides with the geographical division of the sea-bed by the 50-fathom gully which runs up St. George's Channel.

On the other hand, the 100-fathom line approaches the coast only off the south-west coast of Ireland and separates a considerable plateau of ground off the west coast of Ireland from the great quadrangular plateau which lies to the south of Ireland, and the southern boundary of which coincides with the latitude of Ushant.

Deeper contour lines, up to 1000 fathoms, leave the boundary of the southern plateau practically unaffected, but considerably increase the area of that off the west coast of Ireland, which at 200 fathoms includes the Porcupine Bank, a distance of 250 miles from the mainland. On the other hand, the study of deeper contour lines renders still more evident the geographical distinctness of the two plateaux, which are connected merely by a narrow shelf off the south-west coast of Kerry, 50 miles wide at 100 fathoms, and only 120 miles wide at 1000 fathoms. Thus the separation of the Irish race into a west coast and south coast stock coincides with the division of the Irish submarine plateau into a western and a southern portion by the deep 1000-fathom rift which has been described. As these banks probably form the winter quarters of the mackerel of the adjoining coasts, we can understand how the segregation of the Irish stocks has been induced, and how a certain amount of mixture between the Kinsale stock and the Channel race has taken place. The southern Irish stock is more closely related to the western Irish stock than to the Channel race on account of its proximity to the former during the breeding season. But it approaches the Channel race in character because it shares the same submarine plateau for its winter quarters; and, although this area is too large to bring about complete mixture of the two races, it is not large enough to prevent a certain amount of mixture from taking place. The annual amount probably depends upon the severity of the winter season, which determines the extent and depth to which the fish retire from the shore.

TABLE A. *Size of Fish (inches).*

Place.	Date.	No.	10	¼	½	¾	11	¼	½	¾	12	¼	½	¾	13	¼	½	¾	14	¼	½	¾	15	¼	½	¾	16	¼	½	¾	17	Most frequent size (ins.).
Newport	Oct. 18, 1897 ...	100	—	—	—	—	—	—	—	2	10	16	15	12	9	11	10	3	4	2	3	1	0	1	0	0	0	0	1	—	—	12
Lowestoft	,, 7 ,, ...	100	—	—	—	—	—	—	1	0	3	1	3	7	13	14	19	11	9	9	8	1	1	—	—	—	—	—	—	—	—	13
,, ...	,, 12 ,, ...	50	—	—	—	—	—	—	—	1	3	6	5	2	15	12	4	1	1	—	—	—	—	—	—	—	—	—	—	—	—	13
,, ...	June 28, 1898 ...	50	—	—	—	—	—	1	3	2	6	6	6	7	6	5	1	1	2	1	0	0	1	0	1	1	—	—	—	—	—	12
,, ...	July 12 ,, ...	100	—	—	—	—	—	—	—	—	7	7	7	8	9	9	11	13	9	11	4	5	—	—	—	—	—	—	—	—	—	13
,, ...	(*sum.*) ...	*300*	—	—	—	—	—	*1*	*4*	*3*	*19*	*20*	*21*	*24*	43	*40*	*35*	*26*	*21*	*21*	*12*	*6*	*2*	*0*	*1*	*1*	—	—	—	—	—	*13*
Ramsgate	Oct. 27, 1897 ...	100	—	—	—	—	—	—	1	3	1	6	5	11	10	10	15	5	7	9	6	3	1	1	3	0	0	1	0	0	2	13
Plymouth	July to Oct., '97	76	—	—	4	9	6	7	10	10	8	6	1	1	1	3	3	0	2	3	0	0	0	0	1	1	—	—	—	—	—	11
,, ...	Nov. 16–20 ,,	100	—	—	—	—	—	—	—	2	15	12	14	12	12	12	5	7	4	1	1	0	0	2	0	1	—	—	—	—	—	12
,, ...	July 6, 1898 ...	100	—	—	—	—	—	12	15	12	11	12	7	7	4	7	5	3	3	1	0	0	0	0	1	—	—	—	—	—	—	12
,, ...	,, 11 ,, ...	24	—	2	0	1	3	5	4	2	3	2	0	1	0	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11
,, ...	(*sum.*) ...	*300*	—	*2*	*4*	*10*	*9*	*24*	*29*	*26*	37	*32*	*22*	*21*	*17*	*23*	*13*	*10*	*9*	*5*	*1*	*0*	*0*	*2*	*2*	*2*	—	—	—	—	—	*12*
Scilly	May 8, 1898 ...	12	—	—	—	—	—	—	—	—	1	2	0	4	1	1	0	3	—	—	—	—	—	—	—	—	—	—	—	—	—	12
,, ...	June 2 ,, ...	12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	0	1	1	2	1	1	2	1	—	—	—	15
,, ...	,, 9 ,, ...	50	—	—	—	—	1	2	1	0	8	4	2	3	7	5	1	2	5	3	2	2	1	0	0	0	0	0	0	0	1	12–13
,, ...	(*sum.*) ...	*74*	—	—	—	—	*1*	*2*	*1*	*0*	9	*6*	*2*	*7*	*8*	*6*	*1*	*5*	*6*	*5*	*2*	*3*	*2*	*2*	*1*	*1*	*2*	*1*	*0*	*0*	*1*	*12–13*
Brest	June 20, 1898 ...	100	—	—	—	—	—	—	—	1	0	0	1	1	3	9	14	10	12	13	12	5	4	4	5	1	1	1	1	1	1	14
Kinsale	July 30, 1897 ...	119	—	—	1	1	3	12	27	35	23	8	5	1	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	11
,, ...	Sept. 3 ,, ...	99	—	—	—	—	—	—	2	8	29	27	13	11	5	1	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	12
,, ...	,, 17 ,, ...	92	—	—	—	—	—	—	—	4	17	27	23	11	5	3	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	12
,, ...	July 1, 1898 ...	100	—	—	—	—	1	1	1	2	3	9	10	9	7	17	9	6	12	5	1	3	3	0	1	—	—	—	—	—	—	13
,, ...	(*sum.*) ...	*410*	—	—	*1*	*1*	*4*	*13*	*30*	*49*	*72*	*71*	*51*	*32*	*20*	*21*	*12*	*8*	*12*	*5*	*1*	*3*	*3*	*0*	*1*	—	—	—	—	—	—	*12*
{ Smerwick ...	March 12, 1898	99	—	—	—	—	—	—	—	—	—	—	1	16	10	19	9	8	10	7	4	4	4	4	2	0	1	—	—	—	—	13
{ Brandon	April 16 ,, ...	45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	5	2	2	5	4	10	6	1	5	1	1	15
,, ...	,, 23 ,, ...	101	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	9	9	18	11	12	10	13	4	6	3	3	1	—	14
Co. Kerry	(*sum.*) ...	*245*	—	—	—	—	—	—	—	—	—	—	*1*	*16*	*10*	*19*	*10*	*10*	*20*	*17*	27	*17*	*18*	*19*	*19*	*14*	*13*	*4*	*8*	*2*	*1*	*14*
Irish, Autumn..	*1897*	*310*	—	—	*1*	*1*	*3*	*12*	*29*	*47*	69	*62*	*41*	*23*	*13*	*4*	*3*	*2*	—	—	—	—	—	—	—	—	—	—	—	—	—	*12*
,, *Spring* ...	*1898*	*345*	—	—	—	—	*1*	*1*	*1*	*2*	*3*	*9*	*11*	*25*	*17*	36	*19*	*16*	*32*	*22*	*28*	*20*	*21*	*19*	*20*	*14*	*13*	*4*	*8*	*2*	*1*	*14*

TABLE B. *Transverse Bars—Entire series.*

Place.	Date.	Most frequent size (ins.).	Number of Fish.	Number of Bars. 23	24	25	26	27	28	29	30	31	32	33	Mean.
Newport, U.S.A.	Oct. 18, 1897 .	12	100	—	2	4	13	37	28	11	5	—	—	—	27·38
Lowestoft	,, 7 ,, .	13	100	—	2	5	30	36	20	5	2	—	—	—	26·90
,, ...	,, 12 ,, .	13	50	—	1	4	11	21	8	4	1	—	—	—	26·94
,, ...	June 28, 1898 .	12	50	—	—	7	17	20	6	—	—	—	—	—	26·50
,, ...	July 12 ,, .	13	100	1	2	7	36	37	12	5	—	—	—	—	26·62
,, ...	(*sum.*) .	*13*	*300*	*1*	*5*	*23*	*94*	114	*46*	*14*	*3*	—	—	—	*26·75*
Ramsgate	Oct. 27, 1897 .	13	100	—	—	7	22	52	15	3	1	—	—	—	26·88
Plymouth	July to Oct., '97.	11	76	—	—	10	20	28	14	4	—	—	—	—	26·76
,, ...	Nov. 16–20 ,, .	12	100	—	—	4	35	47	11	3	—	—	—	—	26·74
,, ...	July 6, 1898 .	12	100	1	2	4	28	42	16	4	1	1	0	1	26·91
,, ...	,, 11 ,, .	11	24	1	0	2	7	10	3	0	1	—	—	—	——
,, ...	(*sum.*) .	*12*	*300*	*2*	*2*	*20*	*90*	127	*44*	*11*	*2*	*1*	*0*	*1*	*26·79*
Scilly	May 8, 1898 .	12	12	1	0	0	2	6	2	1	—	—	—	—	——
,, ...	June 2 ,, .	15	12	—	—	—	3	7	1	1	—	—	—	—	——
,, ...	,, 9 ,, .	12–13	50	—	1	2	19	18	7	1	2	—	—	—	26·78
,, ...	(*sum.*) .	*12–13*	*74*	*1*	*1*	*2*	*24*	31	*10*	*3*	*2*	—	—	—	*26·82*
Brest	June 20, 1898 .	14	100	—	—	5	32	40	19	4	—	—	—	—	26·85
Kinsale	July 30, 1897 .	11	119	—	—	6	18	52	34	6	3	—	—	—	27·21
,, ...	Sept. 3 ,, .	12	99	—	1	5	22	30	24	13	3	1	—	—	27·28
,, ...	,, 17 ,, .	12	92	1	1	2	17	40	21	7	2	0	1	—	27·19
,, ...	July 1, 1898 .	13	100	—	—	5	36	34	16	7	2	—	—	—	26·90
,, ...	(*sum.*) .	*12*	*410*	*1*	*2*	*18*	*93*	156	*95*	*33*	*10*	*1*	*1*	—	*27·15*
{ Smerwick	March 12, 1898.	13	99	1	1	1	19	36	26	11	4	—	—	—	27·32
{ Brandon	April 16 ,, .	15	45	—	—	1	6	14	17	5	2	—	—	—	27·56
,, ...	,, 23 ,, .	14	101	—	—	3	25	44	20	6	3	—	—	—	27·10
Co. Kerry	(*sum.*) .	*14*	*245*	*1*	*1*	*5*	*50*	94	*63*	*22*	*9*	—	—	—	*27.27*
PERCENTAGES	.	. .	.	23	24	25	26	27	28	29	30	31	32	33	
Newport, U.S.A.	Oct., 1897 .	12	100	—	2	4	13	37	28	11	5	—	—	—	27·38
Lowestoft	1897 and 1898 .	13	300	$\frac{1}{3}$	$1\frac{2}{3}$	8	31	38	15	5	1	—	—	—	26·75
Ramsgate	Oct., 1897 .	13	100	—	—	7	22	52	15	3	1	—	—	—	26·88
Plymouth	1897 and 1898 .	12	300	$\frac{1}{3}$	1	7	30	42	14	4	1	$\frac{1}{3}$	0	$\frac{1}{3}$	26·79
Scilly	1898 . .	12–13	74	1	1	3	32	42	14	4	3	—	—	—	26·82
Brest	June, 1898 .	14	100	—	—	5	32	40	19	4	—	—	—	—	26·85
Irish : Kinsale ...	1897 and 1898 .	12	410	$\frac{1}{4}$	$\frac{1}{2}$	4	23	38	23	8	3	$\frac{1}{4}$	$\frac{1}{4}$	—	27·15
,, Kerry ...	Spring, 1898 .	14	245	$\frac{1}{2}$	$\frac{1}{2}$	2	21	38	25	9	4	—	—	—	27·27
,, Autumn..	1897 . .	12	310	$\frac{1}{3}$	1	4	18	39	26	8	3	$\frac{1}{3}$	$\frac{1}{3}$	—	27·23
,, Spring ...	1898 . .	14	345	$\frac{1}{2}$	$\frac{1}{2}$	3	25	37	23	8	3	—	—	—	27·17
North Sea and Eng. Channel..	1897 and 1898 .	13	700	$\frac{3}{7}$	1	7	29	42	15	4	1	$\frac{1}{7}$	—	$\frac{1}{7}$	26·79
Brest and Scilly .	1898 . .	13–14	174	$\frac{1}{2}$	$\frac{1}{2}$	4	32	41	17	4	1	—	—	—	26·84
Irish, S. and W.	1897 and 1898 .	12–13	655	$\frac{1}{3}$	$\frac{1}{2}$	4	22	38	24	8	3	$\frac{1}{6}$	$\frac{1}{6}$	—	27·20
Total, except Newport...	1897 and 1898 .	13	1529	$\frac{1}{3}$	$\frac{1}{2}$	5	27	41	19	5	2	$\frac{1}{6}$	$\frac{1}{10}$	$\frac{1}{10}$	26·97

TABLE C. *Transverse Bars which cross or touch the Lateral Line.*

Place.	Date.	Most frequent size (ins.).	Number of Fish.	Number of Bars. 12	13	14	15	16	17	18	19	20	21	22	23	24	25	Mean.
Newport, U.S.A.	Oct. 18, 1897 .	12	100	–	–	–	1	6	10	25	28	14	9	5	2	–	–	18·88
Lowestoft	,, 7 ,, .	13	100	–	–	1	2	7	18	36	20	11	4	1	–	–	–	18·16
,, ...	,, 12 ,, .	13	50	–	–	–	2	1	9	12	11	10	5	–	–	–	–	18·58
,, ...	June 28, 1898 .	12	50	–	–	–	—	1	10	18	12	7	2	–	–	–	–	18·40
,, ...	July 12 ,, .	13	100	1	0	0	6	8	17	28	25	11	2	2	–	–	–	18·04
,, ...	(*sum.*) .	*13*	*300*	*1*	*0*	*1*	*10*	*17*	*54*	94	*68*	*39*	*13*	*3*	–	–	–	*18·23*
Ramsgate	Oct. 27, 1897 .	13	100	–	–	–	1	6	16	31	27	13	4	1	1	–	–	18·43
Plymouth	July to Oct., '97	11	76	–	–	1	3	7	17	19	15	12	1	1	–	–	–	18·03
,, ...	Nov. 16–20 ,,	12	100	–	–	–	—	11	18	33	21	13	3	1	–	–	–	18·20
,, ...	July 6, 1898 .	12	100	–	–	–	3	7	13	26	36	10	2	2	0	1	–	18·40
,, ...	,, 11 ,, .	11	24	–	–	–	1	3	4	7	6	1	1	1	–	–	–	——
,, ...	(*sum.*) .	*12*	*300*	–	–	*1*	*7*	*28*	*52*	85	*78*	*36*	*7*	*5*	*0*	*1*	–	*18·21*
Scilly	May 8, 1898 ...	12	12	–	–	–	1	0	0	5	4	2	—	–	–	–	–	——
,, ...	June 2 ,, .	15	12	–	–	–	—	—	4	0	5	1	1	1	–	–	–	——
,, ...	,, 9 ,, .	12–13	50	–	–	–	—	2	8	12	16	8	4	–	–	–	–	18·64
,, ...	(*sum.*) .	*12–13*	*74*	–	–	–	*1*	*2*	*12*	*17*	25	*11*	*5*	*1*	–	–	–	*18·63*
Brest	June 20, 1898 .	14	100	–	–	1	0	6	9	29	30	18	5	1	1	–	–	18·65
Kinsale	July 30, 1897 .	11	119	–	–	–	1	7	16	31	36	17	9	1	0	1	–	18·62
,, ...	Sept. 3 ,, .	12	99	–	–	1	3	7	15	32	28	7	5	1	–	–	–	18·19
,, ...	,, 17 ,, .	12	92	–	–	–	—	9	15	23	19	17	6	1	1	1	–	18·58
,, ...	July 1, 1898 .	13	100	1	1	1	1	3	16	26	31	15	3	1	0	0	1	18·41
,, ...	(*sum.*) .	*12*	*410*	*1*	*1*	*2*	*5*	*26*	*62*	*112*	114	*56*	*23*	*4*	*1*	*2*	*1*	*18·45*
{ Smerwick	Mar. 12, 1898 .	13	99	–	–	1	2	4	15	24	29	13	9	1	1	–	–	18·58
{ Brandon	Apl. 16 ,, .	15	45	–	–	–	3	2	7	14	9	5	3	1	1	–	–	18·38
,, ...	,, 23 ,, .	14	101	–	–	1	4	8	14	35	21	14	4	–	–	–	–	18·15
Co. Kerry	(*sum.*) .	*14*	*245*	–	–	*2*	*9*	*14*	*36*	73	*59*	*32*	*16*	*2*	*2*	–	–	*18·37*
PERCENTAGES .	.	.	.	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Newport, U.S.A.	Oct., 1897 .	12	100	–	–	–	1	6	10	25	28	14	9	5	2	–	–	18·88
Lowestoft	1897 and 1898 .	13	300	$\frac{1}{3}$	0	$\frac{1}{3}$	$3\frac{1}{3}$	6	18	31	23	13	4	1	–	–	–	18·23
Ramsgate	Oct., 1897 .	13	100	–	–	–	1	6	16	31	27	13	4	1	1	–	–	18·43
Plymouth	1897 and 1898 .	12	300	–	–	$\frac{1}{3}$	3	9	17	28	26	12	$2\frac{1}{3}$	2	0	$\frac{1}{3}$	–	18·21
Scilly	1898 . .	12–13	74	–	–	–	1	3	16	23	34	15	7	1	–	–	–	18·63
Brest	June, 1898 .	14	100	–	–	1	0	6	9	29	30	18	5	1	1	–	–	18·65
Irish: Kinsale...	1897 and 1898 .	12	410	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$	1	6	15	27	28	14	6	1	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	18·45
,, Kerry ...	Spring, 1898 .	14	245	–	–	$\frac{2}{3}$	4	6	15	30	24	13	6	$\frac{2}{3}$	$\frac{2}{3}$	–	–	18·37
,, Autumn..	1897 . .	12	310	–	–	$\frac{1}{2}$	1	7	15	28	27	13	6	1	$\frac{1}{2}$	1	–	18·47
,, Spring ...	1898 . .	14	345	$\frac{1}{3}$	$\frac{1}{3}$	1	3	5	15	29	26	13	5	1	1	0	$\frac{1}{3}$	18·38
North Sea and Eng. Channel..	1897 and 1898 .	13	700	$\frac{1}{7}$	0	$\frac{2}{7}$	3	7	17	30	25	13	3	$1\frac{2}{7}$	$\frac{1}{7}$	$\frac{1}{7}$	–	18·25
Brest and Scilly.	1898 . .	13–14	174	–	–	$\frac{2}{3}$	$\frac{2}{3}$	4	12	26	32	17	6	1	$\frac{2}{3}$	–	–	18·64
Irish, S. and W.	1897 and 1898 .	12–13	655	$\frac{1}{7}$	$\frac{1}{7}$	$\frac{1}{2}$	2	6	15	28	26	14	6	1	$\frac{1}{2}$	$\frac{2}{7}$	$\frac{1}{7}$	18·42
Total, except Newport...	1897 and 1898 .	13	1529	$\frac{1}{10}$	$\frac{1}{10}$	$\frac{1}{2}$	2	7	16	29	26	14	5	1	$\frac{1}{3}$	$\frac{1}{5}$	$\frac{1}{10}$	18·37

TABLE D. *Dorso-lateral Intermediate Spots.*

Place.	Date.	No. of Fish.	Number of Spots per Fish. 0	1	2	3	4	5	6	7	8	9	10	11	17	No. of Spotty Fish. Observed	%	Total No. of Spots. Observed	%
Newport, U.S.A.	Oct. 18, 1897 ...	100	34	23	13	9	5	6	1	5	0	0	2	1	1	66	66	215	215
Lowestoft	,, 7 ,, ...	100	81	12	4	1	1	1	–	–	–	–	–	–	–	19	19	32	32
,, ...	,, 12 ,, ...	50	37	11	0	2	–	–	–	–	–	–	–	–	–	13	26	17	34
,, ...	June 28, 1898 ...	50	44	4	2	–	–	–	–	–	–	–	–	–	–	6	12	8	16
,, ...	July 12 ,, ...	100	83	12	3	2	–	–	–	–	–	–	–	–	–	17	17	24	24
,, ...	(*sum.*) ...	*300*	*245*	*39*	*9*	*5*	*1*	*1*	–	–	–	–	–	–	–	*55*	*18*	*81*	*27*
Ramsgate	Oct. 27, 1897 ...	100	72	17	3	3	2	2	0	1	–	–	–	–	–	28	28	57	57
Plymouth	Sept. to Nov., '97	76	54	12	7	2	1	–	–	–	–	–	–	–	–	22	29	36	47
,, ...	Nov. 16–20, 1897	100	75	11	7	2	2	2	0	0	1	–	–	–	–	25	25	57	57
,, ...	July 6, 1898 ...	100	88	9	0	0	1	1	0	1	–	–	–	–	–	12	12	25	25
,, ...	,, 11 ,, ...	24	22	1	1	–	–	–	–	–	–	–	–	–	–	2	—	3	—
,, ...	(*sum.*) ...	*300*	*239*	*33*	*15*	*4*	*4*	*3*	*0*	*1*	*1*	–	–	–	–	*61*	*20*	*121*	*40*
Scilly	May 8, 1898 ...	12	10	0	1	0	1	–	–	–	–	–	–	–	–	2	—	6	—
,, ...	June 2 ,, ...	12	10	2	–	–	–	–	–	–	–	–	–	–	–	2	—	2	—
,, ...	,, 9 ,, ...	50	41	5	3	0	0	1	–	–	–	–	–	–	–	9	18	16	32
,, ...	(*sum.*) ...	*74*	*61*	*7*	*4*	*0*	*1*	*1*	–	–	–	–	–	–	–	*13*	*18*	*24*	*32*
Brest	June 20, 1898 ...	100	74	20	6	–	–	–	–	–	–	–	–	–	–	26	26	32	32
Kinsale	July 30, 1897 ...	119	98	17	3	1	–	–	–	–	–	–	–	–	–	21	18	26	22
,, ...	Sept. 17 ,, ...	92	71	14	4	2	0	0	0	0	0	1	–	–	–	21	23	37	40
,, ...	July 1, 1898 ...	100	84	10	3	2	0	1	–	–	–	–	–	–	–	16	16	27	27
,, ...	(*sum.*) ...	*311*	*253*	*41*	*10*	*5*	*0*	*1*	*0*	*0*	*0*	*1*	–	–	–	*58*	*19*	*90*	*29*
{ Smerwick ...	Mar. 12, 1898 ...	99	92	6	1	–	–	–	–	–	–	–	–	–	–	7	7	8	8
{ Brandon ...	Apl. 16 ,, ...	45	35	7	1	0	1	0	1	–	–	–	–	–	–	10	22	19	42
,, ...	,, 23 ,, ...	101	93	6	2	–	–	–	–	–	–	–	–	–	–	8	8	10	10
Co. Kerry	(*sum.*) ...	*245*	*220*	*19*	*4*	*0*	*1*	*0*	*1*	–	–	–	–	–	–	*25*	*10*	*37*	*15*
PERCENTAGES			0	1	2	3	4	5	6	7	8	9	10	11	17				
Newport, U.S.A.	Oct., 1897 ...	100	34	23	13	9	5	6	1	5	0	0	2	1	1	—	66	—	215
Lowestoft	1897 and 1898 ...	300	82	13	3	$1\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	–	–	–	–	–	–	–	—	18	—	27
Ramsgate	Oct., 1897 ...	100	72	17	3	3	2	2	0	1	–	–	–	–	–	—	28	—	57
Plymouth	1897 and 1898 ...	300	80	11	5	$1\frac{1}{3}$	1	1	0	$\frac{1}{3}$	$\frac{1}{3}$	–	–	–	–	—	20	—	40
Scilly	1898 ...	74	82	10	$5\frac{1}{2}$	0	$1\frac{1}{2}$	1	–	–	–	–	–	–	–	—	18	—	32
Brest	June, 1898 ...	100	74	20	6	–	–	–	–	–	–	–	–	–	–	—	26	—	32
Irish: Kinsale...	1897 and 1898 ...	311	81	13	3	2	0	$\frac{1}{3}$	0	0	0	$\frac{1}{3}$	–	–	–	—	19	—	29
,, Kerry ...	Spring, 1898 ...	245	90	8	$1\frac{1}{2}$	0	$\frac{1}{2}$	0	$\frac{1}{2}$	–	–	–	–	–	–	—	10	—	15
,, Autumn .	1897 ...	211	80	15	3	$1\frac{1}{2}$	0	0	0	0	0	$\frac{1}{2}$	–	–	–	—	20	—	30
,, Spring ...	1898 ...	345	88	8	2	1	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	–	–	–	–	–	–	—	12	—	19

TABLE E. *First Dorsal Fin and Proportion of Sexes.*

Place.	Date.	Most frequent size (ins.).	Number of Fish.	Sex. ♂	Sex. ♀	Number of Fin-rays. 9	10	11	12	13	14	15	16	Mean.
Newport, U.S.A..	Oct. 18, 1897 ...	12	100	55	45	–	1	24	51	20	4	–	–	12·02
Lowestoft	,, 7 ,, ...	13	100	—	—	–	2	24	47	21	6	–	–	12·05
,, ...	,, 12 ,, ...	13	50	15 :	10 (?)	–	2	13	23	12	–	–	–	11·90
,, ...	June 28, 1898 ...	12	50	21	29	–	–	11	20	16	3	–	–	12·22
,, ...	July 12 ,, ...	13	100	39	61	–	1	15	49	30	5	–	–	12 23
,, ...	(*sum.*) ...	13	*300*	*75* :	*100* (?)	–	*5*	*63*	*139*	*79*	*14*	–	–	*12·11*
Ramsgate	Oct. 27, 1897 ...	13	100	55	45	–	4	22	44	26	4	–	–	12·04
Plymouth	July to Oct., '97.	11	76	—	—	–	1	15	40	17	3	–	–	12·08
,, ...	Nov. 16–20 ,, .	12	100	41	59	–	4	14	51	26	4	1	–	12·15
,, ...	July 6, 1898 ...	12	100	42	58	–	3	18	45	21	12	1	–	12·24
,, ...	,, 11 ,, ...	11	24	10	14	–	–	2	14	6	1	1	–	——
,, ...	(*sum.*) ...	12	*300*	*93* :	*131* (?)	–	*8*	*49*	*150*	*70*	*20*	*3*	–	*12·18*
Scilly	May 8, 1898 ...	12	12	6	6	–	–	1	5	6	–	–	–	——
,, ...	June 2 ,, ...	15	12	3	9	–	–	1	5	3	3	–	–	——
,, ...	,, 9 ,, ...	12–13	50	21	29	–	1	8	15	20	4	2	–	12·48
,, ...	(*sum.*) ...	12–13	*74*	*30*	*44*	–	*1*	*10*	*25*	*29*	*7*	*2*	–	*12·50*
Brest	June 20, 1898 ...	14	100	—	—	–	3	22	50	22	3	–	–	12·00
Kinsale	July 30, 1897 ...	11	119	—	—	–	3	28	67	19	2	–	–	11·91
,, ...	Sept. 3 ,, ...	12	99	—	—	1	5	34	43	14	2	–	–	11·65
,, ...	,, 17 ,, ...	12	92	—	—	1	0	18	51	22	–	–	–	12·01
,, ...	July 1, 1898 ...	13	100	44	56	–	1	20	50	23	6	–	–	12·13
,, ...	(*sum.*) ...	12	*410*	—	—	*2*	*9*	*100*	*211*	*78*	*10*	–	–	*11·94*
{ Smerwick	Mar. 12, 1898 ...	13	99	63	36	–	4	18	37	33	7	–	–	12·21
{ Brandon	Apl. 16 ,, ...	15	45	20	25	–	1	19	14	9	1	1	–	11·84
,, ...	,, 23 ,, ...	14	101	43	58	–	2	18	48	31	1	0	1	12·15
Co. Kerry	(*sum.*)	14	*245*	*126*	*119*	–	*7*	*55*	*99*	*73*	*9*	*1*	*1*	*12·12*
PERCENTAGES	. . .	.	.	.	.	9	10	11	12	13	14	15	16	
Newport, U.S.A..	Oct. 18, 1897 ...	12	100	55	45	–	1	24	51	20	4	–	–	12·02
Lowestoft	1897 and 1898...	13	300	43 :	57 (?)	–	2	21	46	26	5	–	–	12·11
Ramsgate	Oct., 1897 ...	13	100	55	45	–	4	22	44	26	4	–	–	12·04
Plymouth	1897 and 1898...	12	300	42 :	58 (?)	–	3	16	50	23	7	1	–	12·18
Scilly	1898 ...	12–13	74	41 :	59	–	1	14	34	39	9	3	–	12·50
Brest	June, 1898 ...	14	100	?		–	3	22	50	22	3	–	–	12·00
Kinsale	1897 and 1898...	12	410	44 :	56 (?)	$\frac{1}{2}$	2	24	52	19	$2\frac{1}{2}$	–	–	11·94
Kerry	Spring, 1898 ...	14	245	51 :	49	–	3	$22\frac{1}{3}$	40	30	4	$\frac{1}{3}$	$\frac{1}{3}$	12·12
Irish: Autumn ...	1897 ...	12	310	?		1	2	26	52	18	1	–	–	11·87
,, Spring	1898 ...	14	345	49 :	51	–	2	22	43	28	4	$\frac{1}{2}$	$\frac{1}{2}$	12·12

Table F. *First Dorsal Fin.*

Distribution of Finray Numbers according to Sex and Size.

Place.	Size (ins.).	MALES. ♂ Number of fish.	Number of Finrays. 10	11	12	13	14	15	Mean.	FEMALES. ♀ Number of fish.	Number of Finrays. 10	11	12	13	14	15	16	Mean.
Ireland, S. and W.	11+	2	–	–	–	1	1	–	13·50	3	–	–	3	–	–	–	–	12·00
viz., Kinsale, 100	12+	25	–	5	9	8	3	–	12·24	23	2	3	6	9	3	–	–	12·35
Smerwick, 99	13+	52	–	8	23	19	2	–	12·29	36	–	7	14	12	3	–	–	12·31
Brandon, 146	14+	55	1	13	25	15	1	–	12·04	47	1	9	29	6	1	0	1	12·02
	15+	30	1	10	10	9	–	–	11·90	44	2	12	18	12	–	–	–	11·91
Total 345	16+	6	–	2	2	2	–	–	12·00	21	1	5	10	3	1	1	–	12·05
	17+	—	–	–	–	–	–	–	—	1	–	1	–	–	–	–	–	11·00
	Total	170	2	38	69	54	7	–	12·15	175	6	37	80	42	8	1	1	12·09
English Channel and North Sea.	10+	1	–	–	–	1	–	–	13·00	2	–	–	–	2	–	–	–	13·00
	11+	31	2	7	17	4	1	–	11·84	34	1	6	15	7	4	1	–	12·29
viz., Plymouth, 224	12+	79	–	14	31	28	5	1	12·34	104	–	18	50	24	11	1	–	12·30
Ramsgate, 100	13+	79	2	15	37	21	4	–	12·13	86	2	18	42	22	2	–	–	12·05
Lowestoft, 175	14+	26	1	2	16	6	1	–	12·15	42	3	8	19	11	1	–	–	11·98
	15+	6	–	2	3	1	–	–	11·83	6	1	0	2	3	–	–	–	12·17
Total 499	16+	—	–	–	–	–	–	–	—	1	1	–	–	–	–	–	–	10·00
	17+	1	–	–	–	1	–	–	13·00	1	–	–	–	1	–	–	–	13·00
	Total	223	5	40	104	62	11	1	12·17	276	8	50	128	70	18	2	–	12·17
PERCENTAGES.	...	♂	10	11	12	13	14	15	...	♀	10	11	12	13	14	15	16	...
Ireland, S. and W.	11+	2	–	–	–	50	50	–	13·50	3	–	–	100	–	–	–	–	12·00
	12+	25	–	20	36	32	12	–	12·24	23	9	13	26	39	13	–	–	12·35
	13+	52	–	15	44	37	4	–	12·29	36	–	20	39	33	8	–	–	12·31
	14+	55	2	24	45	27	2	–	12·04	47	2	19	62	13	2	0	2	12·02
	15+	30	3	33	34	30	–	–	11·90	44	5	27	41	27	–	–	–	11·91
	16+	6	–	33	34	33	–	–	12·00	21	5	24	48	14	5	4	–	12·05
	17+	—	–	–	–	–	–	–	—	1	–	100	–	–	–	–	–	11·00
	Total	170	1	22	41	32	4	–	12·15	175	3	21	46	24	5	½	½	12·09
English Channel and North Sea.	10+	1	–	–	–	100	–	–	13·00	2	–	–	–	100	–	–	–	13·00
	11+	31	6	23	55	13	3	–	11·84	34	3	18	44	21	12	2	–	12·29
	12+	79	–	18	39	36	6	1	12·34	104	–	17	48	23	11	1	–	12·30
	13+	79	2	19	47	27	5	–	12·13	86	2	21	49	26	2	–	–	12·05
	14+	26	4	8	61	23	4	–	12·15	42	7	19	45	26	3	–	–	11·98
	15+	6	–	33	50	17	–	–	11·83	6	17	0	33	50	–	–	–	12·17
	16+	—	–	–	–	–	–	–	—	1	100	–	–	–	–	–	–	10·00
	17+	1	–	–	–	100	–	–	13·00	1	–	–	–	100	–	–	–	13·00
	Total	223	2	18	47	28	5	(½)	12·17	276	3	18	46	25	7	1	–	12·17

TABLE G. *Second Dorsal Fin.*

Place.	No. of Fish.	NUMBER OF FINRAYS. Frequency observed. 9	10	11	12	13	14	15	Frequency per cent. 9	10	11	12	13	14	15	Mean.
Newport, U.S.A.	100	2	3	18	63	13	1	–	2	3	18	63	13	1	–	11·850
North Sea	400	–	3	37	337	23	–	–	–	1	9	84	6	–	–	11·950
Plymouth	300	–	–	37	244	19	–	–	–	–	12	82	6	–	–	11·940
Brest and Scilly	174	1	2	15	143	13	–	–	½	1	9	82	7½	–	–	11·948
Kinsale	410	–	3	41	350	15	1	–	–	¾	10	85¼	3¾	¼	–	11·927
Kerry	245	*1	3	20	209	10	1	1	½	1¼	8	85¼	4	½	½	11·943
North Sea and English Channel	700	–	3	74	581	42	–	–	–	½	10½	83	6	–	–	11·946
Brest and Scilly	174	1	2	15	143	13	–	–	½	1	9	82	7½	–	–	11·948
Ireland, S. and W.	655	*1	6	61	559	25	2	1	⅙	1	9⅓	85	4	⅓	⅙	11·933

* Doubtful, owing to mutilation of fin. The number of rays *may* have been 10.

TABLE H. *Dorsal Finlets.*

Place.	No. of Fish.	NUMBER OF FINLETS; INCIPIENT FINLETS AS ½. Frequency observed. 4	4½	5	5½	6	Frequency per cent. 4	4½	5	5½	6	Mean.
Newport, U.S.A.	100	–	2	79	12	7	–	2	79	12	7	5·190
North Sea	400	3	5	378	6	8	¾	1¼	94½	1½	2	5·014
Plymouth	300	7	3	*277	7	6	2⅓	1	92⅓	2⅓	2	5·003
Brest and Scilly	174	3	4	162	2	3	2	2	93	1	2	4·994
Kinsale	410	1	9	387	8	5	¼	2	94½	2	1¼	5·009
Kerry	245	2	3	231	3	6	1	1¼	94	1¼	2½	5·016
North Sea and English Channel	700	10	8	655	13	14	1½	1	93½	2	2	5·009
Brest and Scilly	174	3	4	162	2	3	2	2	93	1	2	4·994
Ireland, S. and W.	655	3	12	618	11	11	½	2	94½	1½	1½	5·011

* One of these specimens actually possessed only 4 finlets, but the position of the 5th was so clearly indicated, that it was almost certainly lost by accident.

Report on Trawling in Bays on the South Coast of Devon.

SUBMITTED FOR THE INFORMATION OF THE DEVON SEA FISHERIES COMMITTEE.

By

Ernest W. L. Holt.

The investigations dealt with in this memorandum were commenced in the autumn of 1895, and have been carried on, as opportunity permitted, until July of the present year. The observations were made in 1895 and 1896 by Mr. F. B. Stead, in 1897 by Mr. S. D. Scott and myself, and in 1898 by myself. A preliminary memorandum, dealing with the observations made in 1895, has already been submitted to the Committee by Mr. Stead. As a matter of general convenience it is reprinted as an appendix to this Report.

The area included in our enquiry consists of Start Bay, Torbay, and Teignmouth Bay. By a bye-law of the Fisheries Committee, confirmed June 27th, 1893, it was made illegal to use a fish-trawl in these bays, and I presume that the assistance of the Marine Biological Association was invited in order that the Committee might learn to what extent their prohibition of trawling may be justified by the biological conditions of the grounds concerned.

Before proceeding to review our results I must advert to the inadequacy of our records, which is due to the insufficiency of the means at our disposal. The grounds lie at a considerable distance from Plymouth, and in order to carry out our work we have been obliged either to hire a Brixham sailing trawler, or to take round the Laboratory steam-launch, which cannot often be spared from her regular duties. If we hired a trawler, we had to take our chance of the weather, with the probability of finding the wind either too strong or too light for satisfactory working. Moreover, although it was possible at a good deal of personal inconvenience to accurately record the catch, subsidiary observations of great practical importance, such as the examination of the reproductive organs and food of fish taken, of the pelagic ova present in the water, and of the nature of the general fauna inhabiting the grounds, were only carried out with the greatest difficulty on account of the lack of accommodation and apparatus. The Laboratory steam-launch is well equipped, but she is only a 57 ft. boat, and cannot venture round the Start except in fine weather. Once on the ground, a change of wind is very apt to imprison her in Dartmouth or some other harbour. I trust that the above considerations may be held to explain the delay in furnishing the present Report, and its incomplete condition.

In considering the records before me, I do not see that it is possible to proceed except upon the assumption that the various hauls made at the same season, though in some cases in different years, were made under practically identical conditions. I do not suppose that this is really the case, since absolute seasonal regularity is not a characteristic of any fishery with which I am acquainted; but I do not see any possibility of tabulating the possible effects of weather with anything like accuracy, whether from the particulars furnished in the records or from the publications of the Meteorological Office. In so far as the work of the *Busy Bee* is concerned, it is fair to assume that the weather was reasonably fine before and during her operations, as otherwise they would have been prevented; but this takes no account of the general weather of the season, nor can I claim to possess the local knowledge indispensable to a just appreciation of the probable effect on the fishery.

On the whole, while I should be very loath to deduce from our records any positive opinion as to the abundance of fish at particular seasons, I believe that they furnish a fairly exact idea of the proportions of large and small fish likely to be met with; and, as I apprehend, it is chiefly with the question of possible destruction of undersized fish that the Committee is concerned.

It is proposed, whenever sufficient material shall be available, to discuss the general question of the distribution of fish and their migrations in the whole south-western district. It is a question which cannot fail to have an important bearing on practical fishery matters, but I do not think it can be conveniently dealt with in isolated parts. I shall therefore omit from consideration in this memorandum all details of life, history, food, migration, &c., and confine myself to a brief recapitulation of such facts as appear to be of immediate importance.

All food-fishes taken were measured by Mr. Stead to the nearest quarter of an inch, with the exception of skates and rays. The latter were considered by Mr. Scott and myself to be of economic importance, and are therefore included in our records, together with all fish whatsoever, and, in fact, all organisms brought up by the trawl, while efforts were made by us to ascertain what other forms, too small to be retained in the meshes, were present on the grounds over which we worked. In the subjoined lists I have, for the sake of brevity, grouped all food-fishes recorded under inches. It will be understood that a fish of, say, 8 inches may have been either 8, $8\frac{1}{4}$, $8\frac{1}{2}$, or $8\frac{3}{4}$ inches in actual length, measured from the tip of the snout to the end of the tail. Rays are treated exceptionally, the dimension given being the width of the disc, since some part of the comparatively unimportant tail is often missing. Except in the case of plaice, fish of less than 8 inches are grouped together, since I believe that no one will contend that such small creatures can be the object of a legitimate fishery.

In considering the proportional numbers of fish of different sizes, I have grouped together as "unsaleable" all plaice and dabs of *less than 8 inches,* a proceeding which appears to be in accordance with local market custom. The Sea Fisheries Bill of 1898 sought to prevent the sale, &c., of plaice, dabs, and soles *not exceeding 8 inches,* which is a slightly higher standard.

For convenience I have placed the standard of sexual maturity for plaice at 12 inches, though my colleague, Mr. J. T. Cunningham, who investigated the matter in this district, found that the average size at which female plaice, the larger and more numerous sex, begin to breed is slightly above 12 inches. Dabs are small fish, which may be mature even before they are saleable, so that the economic and biological limits sufficiently correspond. Soles are mature at about 12 inches, and until they reach such a length are only "slips" in the eyes of the fish-buyer, and as such do not command a very exalted price. The other species which figure in our records are so far from numerous that it is hardly necessary to discuss the question of their maturity. When taken in any number it will be found that the majority were so small as to be economically worthless, whether mature or not.

In the case of plaice I have introduced a standard of a purely arbitrary nature. Considering that fish reaches, even on the southern and south-western coasts, a length of 25 inches, I do not think that my standard of 15 inches for "large" fish will be held to be ridiculously high.

In reviewing the evidence afforded by our records, it has been unnecessary for me to deal, except very briefly, with the biological conditions affecting the question of the protection of small fish. The matter has already been discussed at some length by Mr. Stead, whose conclusions are in essential agreement with those which I have repeatedly put forward on previous occasions.

START BAY.

LIST OF HAULS.

In the subjoined list the details of locality, &c., entered in the records of the various naturalists who have had charge of the observations have been greatly condensed. For practical purposes the bay appears to be divisible into two parts, the line of demarcation being from the Start to the southern edge of the Skerries bank, along the bank, and from its northern end, marked by the bell buoy, to Combe Point. The area within this line is for the most part a smooth stretch of fine sand, from 6 to 10 fathoms. South of Torcross are a number of outlying rocks, and towards the Skerries the sand gets coarse. Extending the area a little to the north-west, we include all that part of the bay which appears to be of much interest to trawlers. The usual professional haul was made, according to my information, either parallel to the sands or along the inner edge of the Skerries and to some distance along the south edge. The coarse sand and shelly ground alongside of the bank is presumably rich in crabs, since numbers of crab-pots are set there; and it may be well understood that the prosecution of trawling and crabbing on the same ground did not tend to peace and harmony.

Such of our hauls as are described as "off the sands" were made parallel to the shore, usually between Torcross and Rockvale, at distances sufficiently indicated by the soundings. The initials "T." and "B.B." indicate that the hauls so marked were made by the smack *Thistle*, of Brixham, and the Association's steam-yacht *Busy Bee* respectively. The former carries a trawl of 40 ft. beam, the latter one of 27 ft. beam. The difference in the size of the mesh of the two nets is insufficient to require special attention. Sailing trawlers are generally held to catch more soles than steam vessels. Otherwise, given equal speed and equal skill, I suppose there is not much difference in catching power. Everyone knows that trawling is usually more successful by night than by day, but night-work offers great inconvenience when the catch has to be examined and measured. I do not know to what extent the difference of light affects the size as apart from the number of fish caught. With one exception all our hauls were made in the day-time.

I.	T.	Off the Sands .	7 fath.	3 h. 30 m.	20 x. '95
II.	T.	Inside the Skerries	15 to 5 fath.	3 h. 55 m.	29 x. '95
III.	T.	" " .	14 to 8 fath.	3 h. 50 m. (night)	31 x. '95
IV.	T.	Off the Sands .	10 fath.	3 h. 50 m.	4 xii. '95
V.	T.	" " .	9 fath.		12 xii. '95

VI.	T.	Off the Sands .	$8\frac{1}{2}$ fath.	2 h. 20 m. (bad weather)	27 i. '96
VII.	T.	" " .	9 fath.	6 h.	28 i. '96
VIII.	B.B.	" " .	7 to 9 fath.	3 h. 55 m.	11 iii. '96
IX.	T.	" " .	9 fath.		21 x. '96
X.	T.	" " .	8 fath.	55 m.	23 iii. '97
XI.	T.	" " .	8 fath.	2 h. 50 m.	24 iii. '97
XII.	T.	" " .	8 fath.	1 h. 15 m.	24 iii. '97
XIII.	B.B.	" " .	7 to 6 fath.	2 h. 15 m.	26 v. '97
XIV.	B.B.	" " .	9 to 6 fath.	2 h. 20 m.	26 v. '97
XV.	B.B.	" " .	8 to 10 fath.	3 h. 5 m.	27 v. '97
XVI.	B.B.	Outer part of bay, off Dartmouth	14 to 17 fath.	1 h. 20 m.	27 v. '97
XVII.	B.B.	Outer part of bay, off Dartmouth	18 to 24 fath.	2 h. 25 m.	28 v. '97
XVIII.	B.B.	Off the Sands .	$9\frac{3}{4}$ fath.	1 h. 10 m.	3 vi. '97
XIX.	B.B.	" " .	$7\frac{1}{2}$ fath.	1 h. 45 m.	25 vii. '98
XX.	B.B.	" " .	10 fath.	2 h.	26 vii. '98
XXI.	B.B.	Outer part of bay, off Dartmouth	20 to 22 fath.	1 h. 35 m.	28 vii. '98

TABLE I.

List of Fish caught in Start Bay.

PLAICE.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
4 in.	—	—	—	—	—	—	—	9	—	1	—	—	—	—	—	—	—	—	—	—	—
5 ,,	—	—	—	—	—	—	—	22	—	4	7	—	2	5	1	—	—	2	—	—	—
6 ,,	—	—	—	1	1	—	—	9	—	4	13	4	3	6	4	—	—	13	6	3	—
7 ,,	—	—	1	—	—	—	4	14	1	2	11	12	10	7	3	2	—	10	3	5	—
8 ,,	1	1	9	2	1	—	4	26	9	3	21	10	6	12	2	3	—	4	2	5	—
9 ,,	6	1	18	3	10	—	2	21	7	2	25	10	3	8	1	2	1	6	2	5	—
10 ,,	11	10	31	9	20	—	—	29	27	1	7	2	3	2	—	1	—	1	4	5	—
11 ,,	36	13	42	28	26	—	—	23	52	3	22	5	4	1	—	—	1	5	—	6	—
12 ,,	14	14	48	37	29	—	1	17	92	—	12	3	2	2	1	1	2	2	2	—	1
13 ,,	10	7	40	36	29	—	1	8	57	—	11	2	—	2	—	2	1	—	2	2	—
14 ,,	4	9	21	27	15	—	1	5	30	1	10	6	1	1	—	1	—	1	—	2	—
15 ,,	4	4	13	11	11	—	—	5	15	1	3	1	—	—	—	—	—	1	—	3	—
16 ,,	3	1	10	5	4	—	—	2	6	—	4	—	—	1	—	—	—	—	—	1	—
17 ,,	2	—	4	1	4	—	—	1	2	—	2	—	—	—	—	1	—	2	—	—	—
18 ,,	—	—	2	2	—	—	—	1	—	—	2	—	—	—	—	1	—	—	—	—	—
19 ,,	—	—	3	—	—	—	—	1	1	—	—	—	—	—	1	—	—	—	—	—	—
20 ,,	—	—	2	1	—	—	—	1	1	—	1	—	1	—	—	—	—	—	—	—	—
21 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
22 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
23 ,,	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
24 ,,	—	—	2	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	91	60	246	163	150	0	13	195	301	22	151	55	35	48	13	14	5	48	21	37	1

DAB.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
(Under 8 in.)	92	24	271	14	10	—	7	72	7	41	160	70	16	22	28	6	4	36	33	48	—
8 ,,	52	8	198	10	15	—	2	18	18	18	34	19	1	9	4	2	—	5	5	9	—
9 ,,	21	1	132	48	13	—	1	6	32	4	14	8	1	3	2	1	2	5	2	10	—
10 ,,	12	12	47	31	7	—	—	4	15	1	3	3	4	1	—	3	—	3	1	—	—
11 ,,	7	10	14	28	6	—	3	—	6	—	3	1	2	2	3	1	—	3	—	—	—
12 ,,	4	9	6	13	4	—	1	—	3	—	1	—	1	—	1	—	2	1	—	—	—
13 ,,	—	3	—	8	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—
14 ,,	—	2	—	3	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—
15 ,,	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totl.	188	69	668	155	57	—	14	102	82	64	215	102	25	37	38	13	8	53	41	67	—

FLOUNDER.

(Under 8 in.)	—	—	—	—	—	—	—	1	—	—	1	3	—	—	—	—	—	—	—	—	—
8 ,,	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
9 ,,	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—
10 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
12 ,,	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
13 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
Total	—	—	—	—	—	—	—	2	—	—	2	5	—	1	—	—	—	1	—	—	—

LEMON SOLE OR MERRY SOLE.

12 in.	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	1	—	—	—	—
13 ,,	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	1	—	—	—	—	2	—	—	1	—	—	—	—

SOLE.

(Under 8 in.)	—	—	—	—	—	—	—	—	—	—	—	1	—	9	—	—	—	—	—	2	—
8 ,,	—	1	—	1	—	—	1	—	1	—	—	—	—	3	—	—	—	—	—	3	—
9 ,,	—	1	3	1	—	—	—	—	1	1	—	—	1	2	—	—	—	—	2	4	—
10 ,,	2	1	10	—	—	—	2	—	9	—	—	—	—	—	—	—	—	—	3	3	—
11 ,,	3	2	12	—	—	—	1	—	11	—	—	—	—	3	—	—	—	—	1	1	—
12 ,,	—	1	7	—	—	—	—	—	3	—	—	—	1	—	—	—	—	—	1	—	—
13 ,,	1	1	1	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	2	—	—
14 ,,	—	—	—	—	—	—	—	1	2	—	—	—	—	—	—	—	—	—	—	—	—
Total	6	7	33	2	—	—	4	1	28	1	—	1	3	17	—	—	—	—	9	13	—

SAND SOLE.

(Under 8 in.)	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8 ,,	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9 ,,	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10 ,,	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

TURBOT.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
10 in.	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
11 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12 ,,	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13 ,,	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
14 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15 ,,	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	1	—	—	1	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—

BRILL.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
11 in.	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12 ,,	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13 ,,	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	2	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

COD.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
19 in.	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
20 ,,	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—

WHITING.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
(Under 8 in.)	—	—	—	1	11	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—
8 ,,	—	—	—	3	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9 ,,	—	—	—	4	6	—	—	—	1	—	—	—	—	—	—	—	—	1	—	—	—
10 ,,	—	—	—	25	18	—	—	—	7	—	—	—	—	—	—	—	—	—	—	—	—
11 ,,	—	—	—	26	14	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—
12 ,,	—	—	—	13	4	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
13 ,,	—	—	—	3	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
14 ,,	—	—	—	2	2	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—
15 ,,	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	78	63	—	—	—	17	1	1	—	—	—	—	—	—	1	—	—	—

DORY.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
(Under 8 in.)	—	—	2	—	1	—	—	—	—	—	—	—	—	—	1	2	1	—	1	—	—
8 ,,	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10 ,,	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
11 ,,	4	—	—	3	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
12 ,,	4	1	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13 ,,	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14 ,,	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	14	1	4	5	2	—	—	—	—	—	—	—	—	—	1	4	1	—	1	—	—

TUB OR LATCHET.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
(Under 8 in.)	—	—	—	—	2	—	—	—	—	6	14	8	2	5	3	—	—	5	1	2	—
8 ,,	—	—	—	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	1	6	—
9 ,,	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—
10 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
11 ,,	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
12 ,,	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
13 ,,	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
14 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
15 ,,	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	6	—	2	—	—	—	—	6	17	9	2	5	3	4	—	7	3	8	—

GREY GURNARD.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
(Under 8 in.)	—	40	—	—	—	—	—	2	—	1	9	1	3	6	55	2	1	15	17	12	—
8 ,,	24	—	15	1	1	—	—	—	—	—	1	1	—	—	—	—	—	—	1	—	—
9 ,,	—	—	—	1	—	—	—	—	1	—	3	—	—	—	—	—	—	—	—	1	—
10 ,,	—	—	—	1	—	—	—	1	8	—	—	—	—	—	—	—	—	—	—	—	—
11 ,,	—	—	4	5	2	—	—	—	2	—	—	—	—	—	—	—	—	1	—	—	—
12 ,,	—	—	3	7	1	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—
13 ,,	—	—	3	3	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14 ,,	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15 ,,	—	—	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	24	40	27	20	8	—	—	3	13	1	13	2	3	6	55	2	1	16	18	13	—

RED GURNARD.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
(Under 8 in.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	9	—	—	—	—
8 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	—	—	—	—
9 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
10 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	10	—	—	—	—

PARROT GURNARD.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
9 in.	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Total	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—

THORNBACK (Raia clavata).

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
(Under 8 in.)	—	—	—	—	—	—	—	—	—	1	—	—	8	6	8	—	—	1	—	—	—
8 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	2	1	—	—
9 ,,	—	—	—	—	—	—	—	—	—	—	—	—	1	—	2	—	—	—	—	—	—
10 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1	—	—	1	2	—	—
11 ,,	—	—	—	—	—	—	—	—	—	—	—	—	1	—	2	—	—	—	—	—	—
12 ,,	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	1	—	—	—	—	—
13 ,,	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	1	—	—	—
14 ,,	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
15 ,,	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
16 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
17 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
Total	?	?	?	?	?	?	?	?	?	2	1	3	10	10	13	1	—	5	5	—	—

PAINTED RAY (*R. microcellata*).

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
11 in.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
12 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
13 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15 ,,	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
16 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17 ,,	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1	—	—
18 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19 ,,	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
20 ,,	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
21 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
23 ,,	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Total	?	?	?	?	?	?	?	?	?	—	2	2	1	—	1	—	—	—	2	—	—

BLONDE RAY (*R. blanda*). *Large smooth spotted ray.*

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
(Under 8 in.)	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	2	—	—	—	—	—
8 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—
11 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
Total	?	?	?	?	?	?	?	?	?	—	1	—	—	—	—	3	1	1	—	—	—

HOMELYN (*R. maculata*). *Small smooth spotted ray.*

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
(Under 8 in.)	—	—	—	—	—	—	—	—	—	1	—	—	8	7	13	5	1	—	1	1	—
8 ,,	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	2?
9 ,,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—
Total	?	?	?	?	?	?	?	?	?	1	—	—	9	7	14	7	1	—	1	1	2?

Table II.

Numbers and Percentages of Fish at given sizes at different seasons in Start Bay.

PLAICE.

	Season—March.	May, June.	July.	Oct.	Dec.
	Hauls—viii., x.–xii.	xiii.–xv., xviii.	xix., xx.	i.–iii., ix.	iv., v.
	Hours—9 hrs.	8 hrs. 50 mins.	3 hrs. 45 mins.	15 hrs. *ca.*	8 hrs. *ca.*
Unsaleable . .	112	66	17	2	2
Under 8 inches .	26%	46%	29%	0%	0%
Immature . .	322	124	46	276	101
Under 12 inches .	76%	86%	79%	39%	32%
Large . . .	26	8	4	76	31
15 inches and over	6%	6%	7%	11%	10%
Gross number . .	423	144	58	698	313

DABS.

Unsaleable . .	343	102	81	394	24
i.e., under 8 inches	71%	67%	75%	39%	11%
Gross number . .	483	153	108	1007	212

Besides the species entered in Table I. our record includes, of marketable kinds, only a few small **pout** and an occasional **herring**.

In the later records, kept by Mr. Scott and myself, appear **spur-dogs, rough-dogs, angels** or buffoons (*Rhina squatina*), **dragonets,** locally known as miller's thumbs or sting-fish, **scald-fish** (*Arnoglossus laterna*), and **solenettes**. The dog-fish and angels, rapacious creatures all, would be of some importance if very numerous, which they were not. The solenette deserves a little attention, since this small fish, which hardly exceeds a length of five inches, is quite commonly regarded, even by fishermen, as the young of the marketable sole. Readers who, having experience of the bay, may not be familiar with the distinctive character of the several species of sole, will understand that the scanty number of small soles is accounted for by the elimination of solenettes.

Plaice are no doubt the most important fish found in the bay, since, although their individual value is far less than that of soles, turbot, or even brill, they are infinitely more abundant than those species. Glancing at Table II., we see that the proportion of unsaleable fish in October and December is less than 1 per cent. No reliable conclusions can be drawn from the two hauls made in January. The first haul (vi.) in bad weather was utterly blank, while the second (vii.) in six hours produced only 13 plaice. It is impossible to judge to what extent they may be normally present on the ground at this season. It is evident that they are difficult to catch in foul weather, and this, I believe, is the common experience of trawlers on similar shallow grounds. The explanation usually offered is to the effect that the fish bury themselves in the sand, and the little evidence which I have been able to collect on the subject does not contradict this view.

In March the percentage of unsaleable plaice rises to 26; in May and June to 46; while the general supply appears to be less in summer than in spring. In July, if two hauls give any reliable data, the supply remains about the same, but the percentage of unsaleable falls to 29.

Turning to the proportion of immature fish, this from March to July is never less than 76 per cent. In October it falls to 39, in December to 32 per cent.

Large fish, *i.e.*, those of 15 inches and above, appear to be never numerous. In October they stand at 11 per cent.; in the spring and summer at 6 to 7 per cent. only.

Dabs appear to be numerically more abundant than plaice at all seasons except during the month of December. From March to July the proportion of unsaleable is from 66 to 75 per cent., falling in October to 39, and in December to 10 per cent.

The number of **soles** entered in our records is too small to be reduced to percentages, but it is apparent that no "unsaleable" fish were taken except in May and July. A sole, as we have seen, ceases to be a "slip" at about the size at which it becomes capable of reproducing its species; and out of the total of 103 fish taken in all hauls we find only 23 mature. None of them exceed the very modest length of 14 inches. The best sole ground, according to my information, is along the inner edge of the Skerries. Hence our operations, mostly conducted over different ground, cannot be said to be fully representative. I shall have occasion to allude to this matter later on.

Sand soles (*Solea lascaris*) are of little importance unless taken in large numbers and of the full size of about 10 or 12 inches. The so-called lemon sole or **merry sole** (*Pleuronectes microcephalus*) is apparently too scarce in the bay to demand attention. The few **turbot** and **brill** taken were all immature, and too small to be very valuable. If **cod** ever form an important item of a trawler's catch in the bay our records furnish no evidence of the fact. **Whiting**, when encountered, were mostly immature, and nearly all so small as to be hardly worth catching. **Dories** were few and mostly immature and unsaleable, but the destruction of the young of this species appears to be much less here than on offshore grounds generally. **Tub gurnards** were hardly plentiful at any season, and, while the majority were unsaleable, the total does not comprise a single full-grown fish. **Grey gurnards,** abundant at times, were mostly unsaleable, except in December, when only a few were large enough to command the full price. These fish are addicted to rather sudden rovings, so that there is always some risk of error in results deducted from a small number of observations of their capture. Such as it is, our evidence suggests that large numbers of immature forms are liable to be destroyed by trawling in the bay in summer and autumn, without any adequate compensation in the capture of marketable material. **Red gurnards,** as might be supposed, are not found in the shallow part of the bay; **Parrot gurnards**, or "Polperro bull-dogs," only as occasional immigrants from the deeper water which they habitually affect.

With regard to rays, we have no evidence of the supply in October and December. **Painted rays** do not appear to be common in the spring and summer. **Homelyns** are only represented by small examples. **Blondes** are rarer, and, relative to the adult size, very small. **Thornbacks** are the most numerous, and some are of good size; but it may be said of all rays that while the supply in spring and summer appears hardly sufficient to be remunerative, the proportion of unsaleable specimens is very considerable.

TORBAY.

LIST OF HAULS.

According to my information, the best trawling ground in the bay is supposed to lie along the inner side of the Ridge, thence on towards Paignton, and round outside the Ridge towards Brixham. Hauls entered as "round the Ridge" will be understood to have been made as far as possible on these lines.

I.	T.	Across the bay from near Berry Head to ½ m. off Torquay pier . .	3 hrs. 20 min.	1 xi. '95
II.	T.	Inside the Ridge and on to Paignton . . .	2 hrs.	1 xi. '95
III.	T.	Same as II. . . .	1 hr. 50 min.	15 i. '97
IV.	T.	Round the Ridge . .	1 hr. 20 min.	26 iii. '97
V.	T.	" " . .	1 hr. 40 min.	26 iii. '97
VI.	B.B.	" " . .	1 hr. 25 min.	2 vi. '97
VII.	B.B.	" " . .	1 hr. 35 min.	2 vi. '97
VIII.	B.B.	" " . .	1 hr. 40 min.	27 vii. '98
IX.	B.B.	Central part of bay . .	45 min.	27 vii. '98

TABLE III.

List of Fish caught in Torbay.

PLAICE.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.
1 inch	—	—	—	—	—	—	—	1	—
2 inches	—	—	—	—	—	—	—	—	—
3 "	—	—	—	—	1	—	—	—	—
4 "	—	—	11	8	16	8	19	—	—
5 "	—	—	5	7	21	18	108	—	2
6 "	—	—	5	5	16	10	81	1	12
7 "	3	1	4	3	7	1	16	—	12
8 "	5	2	6	5	15	2	7	2	9
9 "	9	5	6	10	19	6	16	2	15
10 "	7	1	8	13	25	9	14	2	20
11 "	17	4	5	24	34	5	20	3	16
12 "	21	7	5	26	30	6	21	5	3
13 "	7	3	2	19	31	3	18	2	—
14 "	3	1	1	1	10	2	7	—	—
15 "	—	2	—	2	7	2	4	1	—
16 "	—	1	—	4	—	6	—	2	—
17 "	1	—	—	1	1	—	—	—	—
18 "	—	—	—	—	—	—	—	1	—
19 "	—	—	—	—	—	1	—	—	—
20 "	—	—	—	—	1	—	—	—	—
Total	73	27	58	128	234	79	331	22	89

DAB.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.
(Under 8 inches)	40	6	83	2	10	22	88	4	155
8 inches	2	—	—	3	6	1	23	—	6
9 „	10	1	1	—	3	2	4	—	1
10 „	2	3	2	—	—	2	2	—	—
11 „	4	2	—	—	—	1	—	—	1
12 „	1	—	1	—	—	1	—	—	1
13 „	1	—	—	—	—	—	2	—	—
Total	60	12	87	5	19	29	119	4	164

FLOUNDERS.

(Under 8 inches)	—	—	—	—	1	2	2	—	—
8 inches	—	—	1	—	2	—	5	—	—
9 „	—	—	1	—	2	—	1	—	—
10 „	—	—	1	—	1	1	4	—	—
11 „	—	—	2	—	3	—	5	—	—
12 „	—	—	2	1	4	—	3	—	1
13 „	—	—	—	1	3	—	2	—	—
14 „	—	—	—	—	—	—	—	—	—
15 „	—	—	1	—	—	—	—	—	—
Total	—	—	8	2	16	3	22*	—	1

* Noted as in bad condition.

SOLE.

(Under 8 inches)	—	—	—	—	—	—	1	—	—
8 inches	—	—	—	—	—	1	4	—	—
Total	—	—	—	—	—	1	5	—	—

BRILL.

(Under 10 inches)	—	—	—	—	1	—	1	—	—
Total	—	—	—	—	1	—	1	—	—

WHITING.

(Under 8 inches)	33	—	6	—	—	—	—	—	—
8 inches	7	—	8	—	—	—	—	—	—
9 „	5	—	1	—	—	—	—	—	—
10 „	4	—	—	—	—	—	—	—	—
Total	49	—	15	—	—	—	—	—	—

TUB.

(Under 8 inches)	—	—	—	—	8	4	10	—	—
8 inches	—	—	—	—	—	—	1	—	—
9 „	—	—	—	—	—	—	2	—	—
10 „	—	—	—	—	—	—	—	—	—
11 „	—	—	—	—	—	—	1	—	—
12 „	—	—	—	—	—	—	1	—	—
Total	—	—	—	6*	8	4	15	—	—

* Small fish ; actual sizes not recorded.

GREY GURNARD.

No. of Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.
(Under 8 inches)	—	—	—	—	—	—	—	—	7
Total	—	—	—	—	—	—	—	—	7

THORNBACK.

	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.
(Under 8 inches)	—	—	—	—	—	1	6	—	2
8 inches	—	—	—	—	—	1	1	1	—
9 „	—	—	—	—	—	—	—	1	—
10 „	—	—	—	—	—	—	—	—	—
11 „	—	—	—	—	—	—	—	1	—
12 „	—	—	—	—	—	—	1	—	—
13 „	—	—	—	—	—	1	—	—	—
16 „	—	—	—	—	—	—	—	—	1
25 „	—	—	—	—	—	—	—	—	1
Total	?	?	—	—	—	3	8	3	4

Table IV.

Numbers and Percentages of Fish at given sizes at different seasons in Torbay.

PLAICE.

Season—	January.	March.	June.	July.	November.
Hauls—	iii.	iv., v.	vi., vii.	viii., ix.	i., ii.
Hours—	1 hr. 50 mns.	3 hrs.	2 hrs. 55 mns.	2 hrs. 25 mns.	3 hrs. 20 mns.
Unsaleable . .	25	84	261	27	4
Under 8 inches .	43%	23%	64%	25%	4%
Immature . .	50	229	340	96	54
Under 12 inches	86%	63%	83%	87%	54%
Large . .	0	16	13	4	4
15 ins. and over	0%	4%	3%	4%	4%
Gross number .	58	362	410	110	100

DAB.

	January.	March.	June.	July.	November.
Unsaleable . .	83	12	110	159	46
Under 8 inches .	95%	50%	74%	95%	64%
Gross number .	87	24	148	168	72

Our list contains a few kinds of fish not entered in Table III. As in the case of Start Bay, the deleterious kinds are not sufficiently numerous to demand attention, and the others need not here concern us.

It will be noticed that the proportions of **plaice** fluctuate throughout the seasons in a rather irregular manner. This may in part be due to the paucity of our material in January, only 58 fish being recorded. Another explanation, however, is forthcoming, viz., that January is the spawning season, when the bulk of the big fish are out on the spawning grounds, about 15 miles off Berry Head (if I am rightly informed on this point). If plaice spawn at all in Torbay it is contrary to anything that I know of the general habit of the species, so that during the spawning season one would expect to find there only immature fish and a few of the smaller mature ones, which, speaking broadly, ripen later in the season than their larger brethren. This, in effect, is the condition actually indicated by our record. To correspond with the numerical abundance in March, the January figures should be much higher, but the weather in the earlier month was not propitious. The fish taken were in good condition, but 43 per cent. were unsaleable.

In March the proportion of both unsaleable and immature fish falls considerably, though both remain high. The fall may be presumed to be in part accounted for by the return of spent fish from the spawning grounds. The mature fish were noted to be in very poor condition, "running away to water," as the skipper of the *Thistle* expressed it. In June the proportion of "unsaleable" rises very perceptibly, but it must be admitted that in haul vii. we gave the Ridge rather a wider berth, and so hauled closer to the shore than is usual with professional trawlers. The percentage of immature fish shows a corresponding rise in this month.

In July we found the Ridge unfit for trawling owing to the great quantity of drift weed, so made our second haul, a very short one, in the central part of the bay. Here plaice were numerous, but small and nearly all immature. The few that we got round the Ridge comprised a reasonable proportion of good fish, but the two hauls, taken together, put the proportion of immature rather higher than in June of the previous year. In November (1895) fish seem to have been scarce. More than half were immature, but few were unsaleable. I believe, from experience elsewhere, that it is not unusual for the big fish to draw away from the shore in this month to re-assemble later on in the spawning grounds.

Around the Ridge, as may be gathered from Table III., **dabs** are certainly less numerous than plaice, except (always ?) in January. In the central part of the bay this condition is reversed, but the proportion of unsaleable fish is very high throughout the year. It reaches its lowest point, 50 per cent., in March. Dabs are known to spawn, to some extent, in inshore waters, though I have little experience of their doing so in Devonshire bays.

Other marketable flat-fish require, unfortunately, but little consideration. **Soles** are represented by only two small specimens. **Merry soles** were never taken, though I believe that they sometimes, if not often, enter the bay. **Flounders** appear to be permanent inhabitants, or at any rate are to be taken in small numbers throughout the year. No **turbot** were taken, and only one **brill**, of unsaleable size, was observed. **Whiting, tub gurnard** and **grey gurnard** appear to be not only scarce, but too small to be worth catching. The same remark applies almost equally to **thornbacks,** during the months when the rays were recorded. No other kinds of ray were observed.

TEIGNMOUTH BAY.

LIST OF HAULS.

The trawling ground in this bay lies roughly parallel to the shore at depths ranging from 5 to 10 fathoms. Our experiments were made on courses which do not appear to differ from each other to such an extent as to require separate definition. The ground appears to be very liable to become covered with drift weed in the summer.

I.	T.	. . .	30 x. '95
II.	T.	. . .	„
III.	T.	4 hrs. 30 min.	2 xii. '95
IV.	T.	. . .	„
V.	T.	. . .	12 x. '96
VI.	T.	. . .	„
VII.	T.	. . .	„
VIII.	T.	. . .	„
IX.	T.	2 hrs. 25 min.	12 i. '97
X.	T.	2 „ 30 „	„
XI.	B.B.	2 „ 50 „	25 iii. '97
XII.	B.B.	1 „ 5 „	1 vi. '97
XIII.	B.B.	0 „ 50 „	„
XIV.	B.B.	1 „ 40 „	„
XV.	B.B.	2 „ 20 „	„

TABLE V.

List of Fish caught in Teignmouth Bay.

PLAICE.

Haul—	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.*
Inches.															
3	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	45	3	5	—	8
5	—	—	—	—	11	3	—	—	2	6	102	12	10	5	46
6	1	7	2	—	26	11	1	2	29	26	152	21	7	4	17
7	10	46	14	2	38	29	8	5	35	11	91	2	10	6	15
8	14	72	12	6	24	31	12	8	17	12	38	1	1	4	6
9	55	80	18	24	26	64	19	16	6	25	18	—	—	4	1
10	90	124	31	70	27	101	30	25	9	22	15	—	4	6	3
11	47	78	13	81	11	76	29	12	6	21	11	3	3	2	3
12	25	34	8	58	11	52	24	17	2	15	11	1	4	3	—
13	10	9	3	18	7	12	9	10	—	3	3	2	4	2	1
14	1	3	3	6	5	2	2	3	1	1	1	1	—	1	2
15	3	—	—	6	3	2	3	2	—	2	1	2	2	—	2
16	—	—	1	2	2	—	—	—	—	—	—	3	—	—	2
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	1	—	—	—	—	—	—	1	—	1	—
19	1	—	—	—	—	—	—	2	—	1	—	1	—	—	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	257	453	105	273	192	383	137	102	107	145	490	53	50	38	106

* The net came up loaded with weed, which had to be removed by cutting the meshes. In this process many small flat-fish escaped.

DAB.

	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
(Under 8)	53	45	118	94	—	112	4	16	47	101	56	6	4	9	20
8	29	34	28	26	—	26	5	16	—	—	3	—	2	5	2
9	14	24	11	19	—	29	23	13	—	2	—	—	—	1	3
10	—	16	4	12	—	16	9	4	—	1	2	—	—	—	—
11	—	4	4	1	—	1	4	—	—	1	—	—	—	2	—
12	—	1	—	4	—	—	3	—	—	2	—	—	—	—	—
13	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	97	124	165	156	?	184	48	49	47	107	61	6	6	17	25

FLOUNDER.

	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
(Under 8)	—	—	—	—	—	—	—	—	1	—	2	1	—	—	—
8	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—
9	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
Total	—	—	—	—	?	—	—	—	1	—	5	1	—	—	—

LEMON SOLE OR MERRY SOLE.

Haul— Inches.	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
10	—	—	—	2	—	1	1	—	—	—	—	—	—	—	—
11	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
12	—	—	—	—	—	2	9	—	—	1	—	—	—	—	—
13	—	—	—	—	—	1	—	—	—	1	—	—	—	1	—
14	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Total	1	—	1	2	?	4	11	—	—	2	—	—	—	1	—

SOLE.

Haul— Inches.	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
(Under 8)	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
8	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
9	—	—	1	—	—	1	—	4	—	—	—	—	—	1	—
10	—	—	1	—	—	4	—	2	—	—	—	—	—	—	1
11	—	—	1	—	—	1	—	1	—	—	—	—	—	—	—
12	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
13	1	—	1	1	—	—	—	—	—	—	—	—	—	—	1
14	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
Total	1	1	5	1	?	7	—	7	—	2	—	—	—	1	4

TURBOT.

Haul— Inches.	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
12	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
Total	—	—	1	1	?	—	—	—	—	—	1	—	—	—	—

BRILL.

Haul— Inches.	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
(Under 10)	—	—	—	—	—	—	—	—	1	—	2	2	3	2	1
10	—	—	—	1	—	—	1	—	—	—	1	—	—	—	—
11	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
19	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
Total	—	1	—	1	?	2	1	—	1	2	3	4	3	2	1

COD.

Haul— Inches.	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
13	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
14	—	—	—	—	—	1	2	—	—	—	—	—	—	—	—
15	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
Total	—	—	—	—	?	4	3	—	—	2	—	—	—	—	—

WHITING.

Haul— Inches.	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
(Under 8)	—	16	30	—	—	—	—	—	1	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
9	—	—	1	1	—	1	1	—	—	—	—	—	—	—	—
10	—	—	5	2	—	—	5	1	—	—	—	—	—	—	—
11	—	—	2	—	—	3	2	—	—	—	—	—	—	—	—
12	—	—	1	—	—	1	1	—	—	—	—	—	—	—	—
13	—	—	1	—	—	—	2	1	—	—	—	—	—	—	—
14	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
15	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Total	—	16	40	4	—	5	12	2	1	1	—	—	—	—	—

DORY.

Haul— Inches.	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
Under 8	—	—	—	—	—	—	—	—	—	—	—	—	1	3	—
Total	—	—	—	—	?	—	—	—	—	—	—	—	1	3	—

GREY GURNARD.

Haul— Inches.	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
(Under 8)	—	1	—	—	—	—	—	—	—	—	9	1	3	1	1
8	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
9	—	—	—	—	—	2	—	9*	—	—	1	—	—	—	—
10	1	—	—	—	—	10	4	—	—	—	—	—	—	—	1
11	—	—	—	—	—	3	—	—	—	1	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	1	1	—	—	?	15	4	9	1	1	10	1	3	1	2

* Between 9 and 11 inches.

TUB GURNARD.

Haul— Inches.	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
(Under 8)	—	—	—	—	—	—	—	—	1	—	33	4	6	3	3
8	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1
9	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
10	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
Total	—	—	—	—	?	—	—	—	2	—	33	5	7	7	4

THORNBACK.

Haul— Inches.	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
(Under 8)	—	—	—	—	—	—	—	—	—	—	2	3	9	2	8
8	—	—	—	—	—	—	—	—	—	—	1	—	2	—	6
9	—	—	—	—	—	—	—	—	—	—	3	1	2	—	2
10	—	—	—	—	—	—	—	—	—	—	4	4	1	—	3
11	—	—	—	—	—	—	—	—	—	—	2	3	—	—	1
12	—	—	—	—	—	—	—	—	—	—	6	2	2	3	1
13	—	—	—	—	—	—	—	—	—	—	6	4	—	1	2
14	—	—	—	—	—	—	—	—	—	—	3	1	1	—	—
15	—	—	—	—	—	—	—	—	—	—	1	2	—	1	—
16	—	—	—	—	—	—	—	—	—	—	4	—	1	1	—
17	—	—	—	—	—	—	—	—	—	—	2	2	1	2	—
18	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—
19	—	—	—	—	—	—	—	—	—	—	3	2	—	3	—
20	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
21	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
22	—	—	—	—	—	—	—	—	—	—	1	—	—	2	—
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—
Total	?	?	?	?	?	?	?	?	?	?	41	24	19	19	23

HOMELYN.

8	—	—	—	—	—	—	—	—	—	—	3	—	1	—	2
10	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
Total	?	?	?	?	?	?	?	?	?	?	3	2	1	—	2

BLONDE.

(Under 8)	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
Total	?	?	?	?	?	?	?	?	?	?	—	6	—	—	—

Pout (*Gadus luscus* or *G. minutus*) are the only other marketable fish which appear in our records. Their numbers are quite unimportant. Of unmarketable species, solenettes, scald-fish, topknots (*Rh. unimaculatus*), dragonets, angels or buffoons, and various dog-fish appear in hauls subsequent to x. In Haul x. Mr. Scott has noted that dog-fish were abundant, but in subsequent hauls both dog-fish and angels, which may be regarded as deleterious forms, were not taken in any considerable number.

TABLE VI.

Numbers and Percentages of Fish at given sizes at different seasons in Teignmouth Bay.

PLAICE.

Season—	January.	March.	May, June.	Oct.	Dec.
Hauls—	ix., x.	xi.	xii.–xv.	i., ii., v.–viii.	iii., iv.
Hours—	4 hrs. 55 mns.	2 hrs. 50 mns.	5 hrs. 55 mns.	?	?
Unsaleable . .	105	392	171	198	18
Under 8 inches .	42%	80%	69%	14%	5%
Immature . .	227	474	212	1269	273
Under 12 inches .	90%	97%	86%	89%	72%
Large	3	1	14	19	9
15 inches and over	1%	0%	6%	1%	2%
Gross number . .	252	490	247	1424	378

DAB.

Unsaleable . .	148	56	39	230	212
Under 8 inches .	96%	92%	72%	46%	66%
Gross number . .	154	61	54	503*	321

* The record of dabs in Haul 5 has been mislaid.

Fish of species not entered in Table V. were in no way important. Throughout the year it would appear that the **plaice** are for the most part immature, while the percentage of unsaleable is very high in spring and summer, and considerable even in January. In October and in December it is comparatively low. **Dabs** are evidently less abundant than plaice, and, except in October, most of them appear to be unsaleable. **Merry soles**, though not taken in large numbers, were saleable, and probably for the most part mature. **Soles** do not appear to be numerous, though a fair catch might perhaps be made at night, but would consist, as I infer, largely of immature "slips." The few **turbot** recorded are small, and probably all immature. Two mature **brill** were taken, but the rest were mostly unsaleable as well as immature. **Cod** are only represented by a few codling. **Whiting** may, perhaps, be taken in remunerative numbers by night, and appear to be mostly saleable (if rather small), except in October and December. Large **grey gurnard** appear to be scarce, while **tub gurnard** are much too small to be legitimately fished. **Thornbacks** seem to be an important item of the catch. Many are so small as to be comparatively worthless, while a fair number are quite unsaleable, but I cannot say that the proportion of the latter, having regard to the usual distribution of young and old in this species, is unusually high.

General Considerations.

I think it will be conceded that the preceding records indicate, in so far as they can be considered representative, that the three bays do not form a homogeneous area, characterised by similar conditions of fish supply throughout. Start Bay and Torbay show a certain similarity, if we restrict our attention to plaice, but there is a marked difference in the proportion of immature fish in the later months of the year. Thus in Start Bay these fish are 39 per cent. of the whole in October and 32 per cent. in December, while in Torbay they are 54 per cent. in November. Teignmouth Bay differs from either, in that the proportion of immature plaice never falls below 72 per cent. I imagine that the facts are of more interest to the Committee than their explanation, which may probably lie in the close proximity of the estuary of the Exe, apparently the chief nursery of young plaice in the district, to Teignmouth Bay.

Without undertaking the responsibility of suggesting legislative action, I think I may endeavour to indicate, in so far as my acquaintance with the local conditions permits, the probable effects of any modification of the existing bye-laws.

Any interference with the unrestricted prosecution by fishermen of their calling may be presumed to have for its object either the increase of the fish supply or the protection of one class of fishermen at the expense of another. The last case involves social considerations which I am not concerned to discuss, as they lie within the province of the political economist rather than that of the naturalist.

For the protection or increase of the supply a number of methods have been advocated, such as the prevention of the destruction of small fish (different standards of size being suggested), whether by prohibition of capture or prohibition of sale, the institution of a close season, etc. On the whole the imposition of a size limit, however enforced, seems to have found most favour, but opinions differ as to the size. The Sea Fisheries Bill of 1898 sought to make illegal the sale, &c., of plaice and soles not exceeding 8 inches in length. It must be supposed that the Parliamentary Committee, on the recommendations of which the Bill was based, held that the protection of fish of less size would in itself benefit the supply. A Fisheries Committee cannot deal with sales, but the Devon Committee has taken effectual means to prevent the destruction, at least by trawlers, of either large or small fish in the bays. If it be held that the limit proposed by the Parliamentary Committee is adequate, our tables show that the existing bye-law is superfluous in Start Bay, and probably in Torbay during the months of October, November, and December, while it is hardly necessary in Teignmouth Bay in December, since there are hardly any plaice under 8 inches to be caught. It is possible, however, that the Fisheries Committee may consider that the prohibition of sale of fish which are so small as to be practically unsaleable will not greatly alter existing conditions, and that an effort should be made to extend protection until the fish have reached a somewhat larger size. If this be the case the limit advocated will probably coincide with the size at which the fish becomes capable of reproducing its species, and so contributing to the up-keep of the stock. Plaice, the species with which we are almost entirely concerned, mature, as has been shown, at about 12 inches, and if this principle of protection be accepted it is obvious that no modification of the existing bye-law is advisable at any period of the year either in Teignmouth Bay or Torbay. In Start Bay it does not appear that the proportion of immature fish is higher in December than on offshore grounds. What may be the conditions in this bay in January and February the weather has never permitted us to ascertain.

Assuming that the protection of immature fish suffices, and that a proportion of 30 per cent. of such fish is that normally met with in company with large plaice on offshore grounds, it would appear that the bye-law might be relaxed in Start Bay in winter without much injurious effect in so far as the fish supply is concerned. It is not my business to recommend such a relaxation, and the Committee is probably aware that the southern edge of the Skerries, which appears to be a favourite trawling ground, is equally appreciated by the crabbers. Crabbing and trawling are industries little calculated to flourish on the same ground, especially by night. Supposing it to be possible to prevent interference with crabbing by restricting trawling to the northward of a line drawn from the Bell Buoy to Tinsey Head, and if this limit were respected (it is for the Committee to judge by what means respect could be enforced), the bay would remain in part a sanctuary for soles throughout the year. I take it that no one will be inclined to refuse to soles any sort of protection which can be afforded them, whether large or small.

I do not think that the proposal to establish a close time for sea fish has ever been seriously entertained, but I am by no means sure that beneficial results would not be achieved by diverting the attention of trawlers from fish of a given species at the time when the larger members of that species are engaged in spawning. It is well known that in any species the larger mature females yield more eggs than their smaller sisters, and that as a rule they are the earliest spawners. I myself believe that the larger fish produce not only more numerous but more vigorous offspring, capable, speaking generally, of attaining a larger size than the offspring of fish which have only just reached the mature condition. Large plaice are spawning, if I am correctly informed, in January. Means might be taken to tabulate the spawning period with greater exactitude, and I believe that the Committee might profitably consider to what extent the opening of Start Bay during this month (or during the earlier part of the spawning period) would have the effect of diverting the attention of trawlers from the large plaice when the latter are spawning. In this connection the weather is of great importance, since a gale of wind off the land is in itself a most efficient protector of spawning fish on distant grounds, while the opening of the bay would, under such meteorological conditions, submit the species to a persecution which they at present escape. In any modification of existing arrangements intended to protect large fish while spawning it would be essential to avoid any risk, by too early opening of inshore grounds, of molesting the breeders before they have hauled off the land, and I am certain that the date of the outward migration varies somewhat in different years.

A Fisheries Committee appears to have the power of dealing with trawling in inshore waters by various methods besides those already referred to, viz., by regulation of the hour and duration of hauls, and of the size of mesh, and by the prohibiting of the removal of fish from a fishery. It is a well-established fact that small fish, especially the hardier kinds of flat-fish, are not necessarily killed by being caught in the trawl, if the latter is only hauled for a short time and the ground is fairly clean. It is, of course, essential that the small fish, if they are to be saved, should be promptly returned to the sea. With regard to mesh, I doubt whether any alteration of size and pattern is practicable, since to restrict trawling in the bays to the use of a certain kind of net might be equivalent to closing them altogether, on account of the expense entailed by equipping the boats with two sets of gear. There can be no doubt as to the beneficial action of regulations dealing with duration of hauls and removal of small fish, if such can be effectually enforced; but I suppose that a man of affairs, before recommending any legislation on these lines, would consider how far the means at his disposal would be likely to render it effective.

In the above remarks I have directed my attention almost entirely to plaice, and only a few words appear to be necessary in respect of the other fish met with in the bays. Soles require no further notice. Merry soles and flounders appear to be unimportant. Turbot and brill are few and small, and, as such, may very well continue to enjoy the protection of the bye-law; nor can I find any reason to think that the closure of the bays is otherwise than beneficial to whiting and gurnards, which appear to be represented almost entirely by immature and unsaleable individuals.

Dabs require separate consideration. They are very abundant in the bays, and, except in Start Bay in December, a very large proportion of them is immature and unsaleable. But the dab is a small fish, which at no time enjoys a very exalted commercial value, while its flesh deteriorates very rapidly. Furthermore, it is commonly regarded by naturalists as a serious competitor in the matter of food with the more valuable kinds of flat-fish, in the company of which it is usually taken. Unlike the plaice, it is not by any means confined in its immature condition to any particular ground, and shows hardly any discrimination in the locality in which it spawns; while in addition to consuming large quantities of organisms, which might be more profitably employed in the architecture of young plaice and soles, it is practically omnivorous. Probably in virtue of this adaptability of feeding and habitat the dab continues to abound. At least, I have never heard it seriously contended by any responsible observer that the species has been greatly reduced in number by over-fishing. That it may have decreased in average size is quite possible, since although, as our records show, the length may occasionally reach 15 inches even in this district, 13 inches is much more frequently the size of the largest individuals met with. It is not unlikely that protection might result in slightly increasing the average size, and so in slightly raising the market value of the fish, but it is more than doubtful whether any useful end would be served by any sort of means specially directed to the preservation of this species. In giving evidence at an enquiry held during the present year with regard to a bye-law prohibiting the use of "tuck-nets" in Start Bay, I had occasion to speak of dabs in the same sense as appears above. Mr. Fryer, in his report to the Board of Trade, considered that my remarks with regard to dabs went a long way towards condemning the bye-law. The responsibility is his, not mine, for it is one thing to say that a dab needs and deserves no protection, and another to hold that small plaice ought not to be preserved for fear that the dabs should benefit by the same protection. The question of "tuck-nets" is outside the scope of our present enquiry. In the case of trawling in the bays our records sufficiently prove that all other considerations must be subordinated to the conditions affecting plaice. I should hesitate to advise that dabs are so deleterious that their extermination in the bays would justify the great destruction of small plaice that must ensue if the process were carried out in the course of ordinary professional fishing. In the good old days of which we hear, when valuable fish are said to have abounded, plaice must be supposed to have been able to maintain a successful competition with dabs, and food-fish generally with worthless or predatory forms. The balance appears to have been upset by the interference of man, but it is very difficult to advise how it may be satisfactorily adjusted again.

There is some risk even in the assertion that such worthless and predatory forms as sharks and dog-fish are wholly noxious, since their depredations among valuable fish may be partly compensated by the destruction which they inflict on each other and on small competitive forms. I am nevertheless inclined to think that the dog-fish commonly met with by trawlers, spur-dogs, nurse, rough-dogs, and angels or buffoons, do more harm than good, and may safely be killed when encountered. From the results of enquiries which I have made I doubt whether trawlers take any trouble in this matter. Spur-dogs, perhaps the most destructive of all, are likely enough to succumb to exposure on deck before they are shovelled overboard, but nurse, rough-dogs and buffoons are very tenacious of life, though easily disposed of by the judicious use of the heel of a sea-boot.

I have endeavoured to set forth above all the more important points raised by our enquiry, in so far as they can be limited to the single industry of trawling. I see no reason to change the opinion which I have long held, that the practical treatment of questions dealing with the supply of flat-fish cannot be limited to trawling alone, but must embrace all fisheries which are prosecuted on any part of the area tenanted, at different phases of their life history, by these fish.

APPENDIX.

Memorandum on the Results of Investigations into the Contents of Certain Bays on the South Coast of Devon.

SUBMITTED FOR THE INFORMATION OF THE SUB-COMMITTEE OF ENQUIRY APPOINTED BY THE DEVON SEA FISHERIES COMMITTEE (SEPTEMBER, 1896).

By

F. B. Stead, B.A.,

Assistant Naturalist on the Staff of the Marine Biological Association.

IN the following Memorandum I propose to lay before the Sub-Committee of Enquiry, appointed by the Devon Sea Fisheries Committee, certain facts with regard to the contents of two of the bays on the South Coast of Devon, in which I have conducted trawling experiments, and then to point out the bearing of these facts on the practical questions before the Committee.

I. The experiments, to which reference will be made, were conducted at different times during the months of October to December of last year (1895); and the bays investigated were Start and Teignmouth Bays. The trawling smack *Thistle*, of Brixham, was engaged by the Association for the purposes of the investigation. All the food-fish which came on board were measured to the nearest quarter of an inch. The results of the several hauls were tabulated and compared with one another, and though these were not as many as I should have desired, the results obtained are such as to lead me to suppose that a fairly correct idea was gained of the relative numbers of fish of different sizes, belonging to the different species, which any similarly equipped vessel, fishing on the same grounds at that time of year, might be expected to catch. It is, of course, quite possible that there is a certain amount of variation in the numbers of fish of different sizes inhabiting these bays from year to year; and in considering the results which will be given below, this fact must be borne in mind.

The first fact which comes out clearly as the result of these experiments is, that *plaice* and *dabs* are far more numerously represented than any other species. Compared to the destruction of plaice and dabs effected by trawling, the destruction of other species is insignificant, and may, I think, for practical purposes, be left out of account.

The following table gives the actual numbers of fish of different species caught in four hauls in Teignmouth Bay (taken on October 30th and December 2nd and 3rd), and in three hauls in Start Bay (taken on October 31st and December 4th).

TABLE I.

Actual numbers of fish of different species caught in the Bays.

	START BAY (3 Hauls).	TEIGNMOUTH BAY (4 Hauls).
Plaice	559	1088
Dabs	890	511
Common Sole	35	8
Merry Sole	—	4
Turbot	1	2
Brill	2	2
Whiting	144	61
Pouting	4	40
Cod	1	—
Grey Gurnard	57	2
Tub	8	—
John Dory	11	—

While plaice and dabs appeared in every haul in considerable numbers, the other species captured were obtained in relatively small numbers, and in most cases not in every haul.

In considering, then, the populations of the two bays in detail, we may confine our attention to the plaice and the dabs.

We may now proceed to set forth the results arrived at, by adding together the numbers of *plaice* of all the different sizes obtained in all the hauls taken in October and December in the two bays. The results are expressed in percentage of the total number of these fish caught in these hauls.

TABLE II.

Showing the relative numbers of plaice *of different sizes taken in Start and Teignmouth Bays in columns* I. *Columns* II. *express the percentage number of plaice up to the corresponding size,* e.g., "43·1 *per cent. of all the plaice caught in Start Bay were* 12 *inches and under in size.*"

Start Bay.			Teignmouth Bay.		
Inches.	I.	II.	Inches.	I.	II.
7	0·35	—	7	3·9	2·9
8	1·4	1·0	8	8·3	9·9
9	3·9	4·1	9	12·1	20·5
10	6·6	10·5	10	22·9	40·6
11	13·6	22·1	11	27·4	69·1
12	20·75	43·1	12	15·2	87·6
13	20·9	62·0	13	6·3	95·4
14	13·7	77·8	14	2·4	98·25
15	9·3	88·5	15	0·4	99·1
16	4·1	94·3	16	0·7	99·6
17	2·7	97·4	17	0·2	100·0
18	0·9	98·2	18	—	—
19	0·35	98·9	19	—	—
20	0·5	99·4	20	—	—
24	0·35	100·0			

We may now point out certain results which may be deduced from an inspection of this table. It will be seen that the plaice in Teignmouth are, on the whole, smaller than those in Start Bay; and that, whereas half the plaice in the former were $10\frac{1}{2}$ inches or under, in the latter, the length on either side of which half the fish are found to lie is $12\frac{1}{2}$ inches. It now remains to consider what percentage of the plaice in either bay fall below the limit of maturity.

Mr. Cunningham's investigations on the limit of maturity of plaice on the South Coast showed that the higher limit for plaice was 15 in.; that is to say, that if it was desired to impose such a size limit as to wholly prevent the capture of immature plaice, the limit we should impose would be as high, but no higher, than 15 in. On the other hand, it has been shown that—with only very occasional exceptions—no plaice under 9 in. is mature. A plaice between 9 and 15 in. in length may or may not be mature.

By imposing a size limit of 15 in. for plaice, we should, as I have just pointed out, wholly prevent the capture of immature plaice; but in so doing we should also prevent the capture of a certain number of plaice which have already arrived at maturity; and on the theory that the sole object to be kept in view is to permit the fish to spawn, it might be reasonably urged that the 15-in. limit is too high—since a considerable number of plaice under this length are mature. Acquiescing in this objection, we may accept 12 in. as a reasonably effective limit, and may now consider what proportion of the plaice in the bays examined fall below this limit of maturity. An inspection of Table II. will show that while 43·1 per cent. of the plaice in Start Bay were 12 in. or under, the percentage of plaice in Teignmouth Bay 12 in. or less in length was no less than 87·6. Or, in round numbers, two-fifths of the fish captured in Start Bay, and more than four-fifths of those captured in Teignmouth, were under the length which I have agreed to call a reasonably effective limit of maturity.

We may now turn to consider the facts ascertained for dabs. These may be best understood from an examination of the table given below:—

TABLE III.

Showing the relative numbers of dabs at the different sizes in all the hauls taken (October and December).

Start Bay. Inches.	No. per cent.	Teignmouth Bay. Inches.	No. per cent.
$7\frac{1}{4}$ (and under)	28·7	$6\frac{1}{4}$ (and under)	26·0
8	17·2	7	17·6
9	29·0	8	23·7
10	11·7	9	17·3
11	7·5	10	10·4
12	3·2	11	2·8
13	1·9	12	1·1
14	0·4	13	0·5
15	0·1	13	0·5

The limit of maturity for the common dab has been placed at 7 in. by one observer, and at 6 in. by another. It has not yet, so far as I am aware, been definitely ascertained for the South-west Coast; and it is known that in the case of the plaice, at least, the limit of maturity varies with the locality. I should hesitate, therefore, to deduce from the figures above what proportion of the dabs captured were "immature," nor is there the same necessity for doing so as in the other case. For if a case is to be made out for prohibiting fishing in the inshore, while permitting it in the offshore waters, it cannot be made to rest on facts connected with the distribution of the common dab. Investigations made in the North Sea have seemed to indicate that the dab "is found everywhere, and at all stages, in every part of the North Sea, both inshore and offshore, and that, except in estuaries, it seems to spawn anywhere, without regard to depth of water or proximity to land." It is far otherwise with the plaice; in the case of which fish it may be said with certainty that they remain for the most part in inshore waters during the period of their immaturity, undergoing a migration seawards when they are ready to spawn.

It follows that the practical question of whether these inshore waters which I have investigated should be closed or not, must depend on whether restrictive measures are necessary for the protection of the plaice.

In bringing this part of the memorandum to a conclusion, I can but express my regret that I have been unable to properly investigate the catches of the deep-sea trawlers in the areas adjacent to the two bays, with a view to making an exact comparison of the percentage of immature plaice among the plaice of the offshore waters with the percentage of immature plaice among those which are captured in the bays.

I have purposely omitted to deal with the relative merits of the pleas offered on behalf of the Start Bay longshoremen on the one hand and the trawlers on the other—partly because the case for the former admittedly rests, in part at least, on grounds which it does not come within my province to consider. I shall be willing to explain myself further on this point, in giving evidence before the Committee, should they desire it.

II. An examination of the figures given above will show that fishing in the two bays considered involves a considerable destruction of immature plaice and dabs. It will be seen also that the destruction of fish of all other species is insignificant. It now remains to consider the bearing of these facts on the practical question before the Committee.

The destruction of immature flat-fish has been held to be injurious to the fisheries for two different reasons by those who regard the question from two distinct points of view. The reason most commonly given for objecting to this destruction is that, by destroying an immature fish, you eliminate not the fish only, but its possible offspring. It is maintained on the other hand (and this view is held by some biologists) that the supply of larvæ is more than sufficient to maintain an adequate stock of large fish, and that the destruction of a certain number of immature fish is not to be deprecated on the ground that the number of eggs and larvæ produced at the next spawning season will be proportionately diminished. Those, however, who hold this view are no less anxious to put a stop to this destruction for quite a different reason.

It has been pointed out that a plaice 14 in. in length weighs twice as much as a plaice of 10 in., and that it would be more profitable to the fisheries if a 10 in. plaice was allowed to grow to 14 in. before being caught, doubling its weight in the process, than if it were destroyed at 10 in. And this statement certainly holds good, unless the mortality of plaice from natural causes is such as to reduce the number of 10 in. plaice by a half in the time they would take to grow to 14 in. And that this is the case is extremely improbable.

It will be seen, then, that the destruction of immature fish is objected to by some because these fish have not yet had a chance of reproducing their species, and by others because they have not yet grown to the size at which it would be most profitable to capture them; and it will be noticed that these two grounds of objection are not in themselves inconsistent with one another.

I have drawn attention to both these grounds of objection, because the criticism mentioned above—to the effect that the supply of larvæ is more than adequate, and that there is no reason for anxiety as to the consequences that may follow the destruction of a certain number of immature flat-fish—is not infrequently urged by those who have no special knowledge of the subject; and I am anxious to point out that whether this criticism be accepted or not, the position generally adopted still holds good—that the destruction of small flat-fish is to be deprecated.

It follows that, looking at the matter from a purely biological standpoint, we cannot regard with favour any proposal to effect a change in the bye-law which will permit the destruction of a greater number of under-sized flat-fish; and if such a change is to be advocated at all, it must be on grounds which it does not come within our province to consider.

It may, however, be reasonably asked whether, and if so to what extent, the fisheries in which the Committee is especially interested are likely to be benefited from a continuance of the restrictions now in force. Granting that an abolition of the restrictions against trawling within the areas under consideration would be detrimental to the fisheries as a whole by decreasing the number of flat-fish, have we any right to expect a material improvement, supposing that these restrictions remain in force? This question does not admit of a simple answer. Looking at the fisheries as a whole, it may, of course, be rightly said that the preservation of young flat-fish will be beneficial for reasons mentioned above; but if I am asked by the Committee to say whether restrictions enforced by them in a particular area will lead to an increase in the number and size of the flat-fishes in that area, I shall be unable to answer the question. I may be allowed to refer in this connection to certain experiments and observations made by the Naturalists under the Scotch Fishery Board.

The experiment of closing certain bays (part of the Firth of Forth and St. Andrew's Bay) to trawlers has been tried since 1886: and hauls have been regularly made in the closed areas, at intervals since that date, to test the effect of the closure. The results show that there have been fluctuations in the number of flat and round fishes in these closed areas, but no steady increase since the dates when the areas were first closed. This statement holds good, not only for the closed areas, but for the open areas adjacent to them.

It might, of course, be urged that this is enough to show that it is useless to close a particular area to trawlers, inasmuch as no increase in the number of fishes results from such a proceeding. But, granting that, as time goes on, the condition of the bays remains what it is—and no increase in the number of flat-fishes they contain is seen to result from the closure—the above conclusion would still, in my opinion, be unjustifiable. It would, in fact, only be justifiable if the flat-fishes inhabitating such a bay at any time were confined to that bay during the whole of their lives. But this is not what happens in Nature. Plaice, for instance, which, as a rule, are confined to inshore waters during the period of their immaturity, go out into deep waters to spawn. But it by no means follows that their offspring will return to the areas whence their parents came. I may quote Dr. Fulton (of the Scotch Fishery Board) on this point:—

"The floating eggs and larvæ derived from a particular spawning area may be carried considerable distances in a definite direction in a comparatively short space of time, and may hence form the source of supply, not to adjacent parts of the coast" (whence, presumably, the spawners came), "but to parts situated a considerable distance from it."

It will be seen, then, that before we can know what will be the effect of closing particular inshore waters, it is necessary to discover the spawning ground to which the fish from these waters resort, and then to determine the direction of the prevailing surface currents. Not till this has been done is it possible to say where the beneficial effect of closing any particular inshore waters is likely to be felt.

In the case of the areas in which I have conducted experimental trawlings, no information at present exists, so far as I am aware, on these points. It is not, therefore, possible to say whether the preservation of immature plaice and dabs in Start and Teignmouth Bays will lead to an increase in the number of these fish in the bays in question, or even in their immediate neighbourhood; but the general proposition still holds true, that the destruction of immature flat-fish is detrimental to the fisheries at large.

Further, it is impossible to give any answer to the question *to how great an extent* are the fisheries likely to benefit from the continuance of the present restrictions, or *what amount* of damage is likely to result from their abolition. It is impossible to make any quantitative estimate of the effect of closing a particular bay, unless we know among other things the proportion which the number of immature fish in the bay bears to the total number of fish of that species in the neighbouring district. And further, though of course it is true that the preservation of the immature fish in such a bay will result directly—and perhaps also indirectly—in an increase in the numbers of the species, the admission has to be made that we cannot be certain that the catches of any individual fishermen will be materially improved in consequence.

Before bringing this memorandum to a close, it is, I feel, necessary to point out that the considerations offered above are an attempt to set forth the view which I think must be taken by those who are interested in the welfare of the fisheries as a whole, of any proposal to remove restrictions which were designed for the preservation of the immature flat-fish. But I am aware that the question before the Committee may be complicated by considerations with which I have not attempted to deal.

The question which the Committee has immediately to consider—whether a particular change in the law should or should not be enacted—is not one which ought, in my opinion, to be directly put to any scientific authority. The immediate effect of such a change—the sudden imposition, for instance, of a size-limit, or the closure of certain inshore waters—may entail great hardship on particular "local communities." The Committee will be cognisant of the fact that a proposal in favour of a restrictive bye-law has been definitely opposed on the ground that particular local interests would be thereby endangered. An argument of this kind can only be dealt with by those who are acquainted with the nature and extent of the local interests involved; and it is possible that the disturbance caused to particular communities by a restrictive measure may be such as to render its enactment undesirable. Whether it is so or not, in any case before the Committee, I am not qualified to judge; and I am here only concerned to point out that, inasmuch as considerations of this kind lie outside the province of a biologist, but may properly be brought to the notice of the Committee, the responsibility of definitely advising the retention or abolition of a bye-law is one which I should do wrong to accept.

Notes on *Pontobdella muricata.*

By

The Hon. Henry Gibbs.

A *Pontobdella* lived in my tanks for about six months of the present year. I first placed it in a wide shallow tank with a variety of Actiniæ and a few Hermit Crabs, but no fish of any sort. When first introduced the leech was very restless, and wandered all over the tank. After a day or so, however, he took up his abode on the glass, close to the surface. He remained in this spot about three months, and if disturbed would always go back to it. He never noticed any of the other animals, and did not appear in the least sensitive to the stinging power of the tentacles of the Actiniæ. I have frequently seen him plunge his head and neck in amongst the tentacles of a large *Anthea cereus* who lived near him, and he treated *T. crassicornis* with a like disrespect.

So soon as the weather grew warm, the leech displayed signs of uneasiness, and finally left his place on the glass, and retired to a cool corner formed by the slate back and side of the tank, close to the syphons of the aerating apparatus, where he remained two months and a half.

He never appeared to notice sticks or nets moving near him in the water, but would remain in his usual position, viz., the base fixed to the wall of the tank, the body sticking out horizontally for about half its length, and the fore part doubled under, so that the mouth was pressed against the under side.

If, however, I placed my hand near him in the water he always displayed excitement; he would raise his head and most of his body completely out of the water and wave himself in the air, or more frequently he would feel about with his head in the water, going over the rocks and sand at the bottom of the tank, as if searching for food. He never detached his base on these occasions, and always drew sharply back if he touched my hand, so that he did not intend to bite me, as I at first suspected.

In *The Aquarium Naturalist* Professor Rymer Jones writes that the skate-leech becomes more active at the approach of evening, and that it rejects all subsistence when in confinement, though extremely voracious in the natural state. My *Pontobdella,* however, was neither more nor less active in the evening than at other times in the twenty-four hours. He certainly abstained from food during the first four months of his residence with me, not decreasing in size or appearing at all out of health during the whole of that time, so that I began to think he must have some miraculous power of fasting. I tried him with all sorts of food, such as raw meat, live shell-fish, live earthworms, live and dead wrasse, etc., but he would have none of them. At last, one day a flounder and a skate (both young) died within a day of each other in another tank, so I placed the flounder, who was only just dead, in the leech's tank, just under the latter's head. As usual, when the leech became aware of my hand being in the tank he began moving his head about, and in doing so touched the flounder several times; however, he took no more notice of it than if it had been a piece of rock, so I gently detached him from his place, and put him on the back of the flounder; the leech, however, instantly got off it and returned to his corner. I therefore concluded that live flat-fish were essential to him if he would feed at all in captiviy, for I did not think that one species of flat-fish would be less acceptable to him than another.

However, the skate died the next day, and I dropped him into the leech's tank, without expecting the latter to take any notice, any more than he had of the dead flounder. To my surprise, the skate had hardly touched the bottom of the tank when the leech detached his base and cast himself upon the skate's body, where he immediately fixed his base and sat upright with his head doubled down in the usual way; after a few minutes, he bit the skate's back in several places, evidently making vigorous but unsuccessful efforts to extract blood. His labours lasted about half an hour, and he then returned to his old corner, and took no further notice of the skate.

I observed that when about to attack his prey he did not move in his usual way, which is that of a fresh-water leech, viz., by first fixing his head and then drawing up his base after it. He simply detached his base, fell to the bottom of the tank, and extended himself till he was over the skate's body, then drew up the rest of his body till it lay sideways in a loose coil on the skate, and then fixed his base, *not* his head, on the lower part of the skate's wing.

Probably this method of attack is less alarming to a live fish than if the leech first seized with his head.

After this episode with the dead skate, I moved the leech into a much larger and deeper tank, wherein were many blennies, gobies, wrasse, etc., thinking that he might secure a wrasse when lying half on its side asleep at nights, as is the frequent custom of these fish.

The fish displayed no fear of the leech; on the contrary, several of them bit at him when he was first put in.

The leech, however, seemed extremely alarmed at the fish, and at once secreted himself between two large stones at the bottom of the tank, where he remained hidden for about a week without moving. I then introduced three young live skate into the tank, and extracting the leech from his hiding-place, put him on the back of one of them; he took no notice of it however, but immediately escaped to a rock fixed to the side of the tank. I left him there for the night, but in the morning the leech was fixed, as to his base, on the lower part of the wing of one of the live skate, in exactly the same place where he had settled on the dead skate.

There were traces of blood on the skate's back, and about an hour later the leech had fixed his mouth on the wing, and immediately in front of the leech's mouth there was a semi-circular mark of blood.

The two other skate died in the course of the day, but the third skate lived on for about twenty-four hours with the leech on his back. The latter must have extracted a quantity of blood, but he did not swell as does a fresh-water leech when gorged.

When *Pontobdella* had had enough he would raise himself upright in his usual position, and with his base still fixed to the skate, until he felt ready for another attack.

Finally he got off the skate, and hid himself completely under a stone, and a quarter of an hour after the leech had disappeared the skate died. The latter would probably have borne the leech's attack longer, had it not been enfeebled by a recent journey from Plymouth to London.

The leech remained in hiding for about a month after his meal, and I then removed him and the other animals from London to the country.

He had always appeared to dislike heat, and unfortunately, on arriving in the country, he was placed in a shallow vessel, the water in which had been greatly heated by the sun. He at once lost the power of attaching his base, and lay for three or four days on his side, coiled like a watch-spring, and then died. Given a live skate or so a year and cool water, I believe *Pontobdella* could be kept alive for an indefinite period.

Notes on the Reproduction of Teleostean Fishes in the South-Western District.

By

Ernest W. L. Holt and L. W. Byrne.

Morone labrax. *Linn.* Bass.

Towards the end of May a large female bass in one of the Aquarium tanks appeared to be approaching ripeness, and constantly swam round the tank followed by one or more of its companions, probably of the opposite sex. A fine-meshed net was accordingly placed over the overflow from the tank in question, and on the morning of the 29th May was found to contain a very large number of eggs, undoubtedly attributable to this species, the only other Teleostean inmates being turbot, congers, pollack, rocklings, and two species of wrasse.

All the eggs proved to be unfertilised, or, at most, showed only an approach to segmentation, which may have been due to the spermatozoa of a rockling. Circumstances seemed strongly to point to the fact that the eggs are not all shed at once, but owing to an unfortunate series of accidents with the net it is impossible to speak on this point with absolute certainty.

Although the bass is a common British fish, its ova find no place in the records of British naturalists, and are only known from the descriptions of Raffaele,* who obtained them both from parents living in the tanks of the Naples Laboratory and from the neighbouring sea.

The eggs observed by us at Plymouth are spherical, and, while living but unfertilised, measure from 1·25 to 1·34 mm. in diameter. Raffaele gives 1·155 to 1·2 mm. as the diameter of Naples examples. The latter have an oil-globule of ·332 to ·366 mm. The Plymouth eggs have often two or more oil-globules, which soon coalesce to form a single globule of ·39 or ·40 mm., pale yellowish to the naked eye, but perfectly colourless by transmitted light under the microscope.

* *Mittheil. Zool. Stat. Neap.*, viii., 1888.

Raffaele's ova are thus smaller than those which we have seen at Plymouth, and have a smaller oil-globule. This difference may perhaps be correlated to the size of the parent fish (as noted by one of us in the case of another species*), but Raffaele does not mention the dimensions of the Naples spawners. The Plymouth female measures about 28 inches, 70·2 cm., so far as we can judge. It is impossible to catch her without emptying the tank, a proceeding at present inconvenient. Bass, according to Risso† and Faber‡, grow, or used to grow, to a larger size than this in the Mediterranean and Adriatic, but Raffaele's examples may have been smaller.

The ova of the bass being easily recognisable, whether from the dimensions and proportionate size of the oil-globule, or from the pigmentation of the embryo, as described by Raffaele, it is somewhat remarkable that they should never have been found in British waters. Raffaele suggests that spawning may take place indifferently in either fresh or salt water, the ova in the former case developing at the bottom. In this district and at Newquay, young bass, from about two inches upwards, are found in the estuaries, and not, so far as we know, in the open sea, and we have taken a large female, with advanced ovaries, in the Tamar estuary. If spawning takes place in the estuary it is not remarkable that the ova should have escaped notice. Those deposited in the Plymouth tanks floated buoyantly in the Aquarium water, which is of somewhat lower specific gravity than that of the open sea, while Raffaele seems to have obtained all his specimens, other than those from the Naples tanks, at the surface. Experiments which he describes suggest that perfectly fresh water is deleterious to the ova (of parents that have been living in sea-water?), while brackish water is rather beneficial than otherwise to the larvæ, and does not injure the ova. As has been indicated by one of us,§ *Motella mustela*, a fish with typically pelagic eggs, almost certainly spawns to some extent in the Plymouth estuary. The local fishermen strenuously assert that the same is true in the case of the flounder, and may be quite correct in their opinion. It is, therefore, by no means impossible that the spawning of the bass takes place, in so far as concerns this district, rather in the estuaries than in the open sea.

Observations of spawning in an Aquarium give no reliable evidence as to the spawning season under natural conditions, since when both periods have been noted they have not been found to coincide. Our

* *Journ. M. B. Assoc.*, N.S., v., 1897, pp. 113 and 117.

† *Ichth. Nice*, p. 300.

‡ *Fisheries of the Adriatic*, p. 71.

§ *Journ. M. B. Assoc.*, N.S., v., No. 2.

large bass are very old members of the Laboratory staff, and, since no reproductive activity has been observed in previous years, it is quite probable that they may have lost count of the seasons.

Gobius niger. *Linn.*

In so far as concerns the neighbourhood of Plymouth, this species appears to be chiefly estuarine in distribution, being common throughout the year in the Hamoaze and in the lower reach of the Lynher river. We have little doubt but that spawning takes place to a large extent in the estuary, though, as a matter of fact, we have only found the ova, identified from Petersen's description and figures,* on an old tin trawled in Cawsand Bay on the 14th July.

Gobius paganellus. *Gm. Linn.*

In Plymouth Sound this Goby is common enough, between tide-marks and elsewhere, on rather rough ground, but has not been taken, to our knowledge, in any part of the estuaries. During the present spring a number of specimens were kept in a large table-tank in the Laboratory. In April two males assumed the breeding livery, which may, for the present, be sufficiently described as a deep purplish madder all over the head and body, and nearly black on the anterior parts, while the border of the anterior dorsal fin is cream-colour or orange. Nests were chosen under a flat stone leaning against the side of the tank, and under the convex valve of a scallop, *Pecten maximus.* Ova were deposited, in all probability by several females, but it is not possible to give the size of the parent of the specimens measured. The latter are from 1·84 to 1·90 mm. in length. The shape is rather regularly fusiform, the greatest width, rather less than half the length, occurring about the middle. The base is about one-tenth to one-twelfth of the length; the apex is in all cases somewhat pointed, in most examples most distinctly so, and never broadly rounded as in *G. niger.* The fixing apparatus differs in no important particular from that of *G. niger.* The yolk is opaque, and yellowish in colour.

Petersen (*op. cit.*, p. 7) has criticised a drawing given by one of us, which purports to represent the ova of *G. niger.* As appears from the text, the drawing and identification are those of Professor M'Intosh. In the light of our present observation it becomes evident that the parent species was *G. paganellus,* and not *G. niger.* In future, where the matter is not complicated by the occurrence of other large Gobies, such as *G. Friesii,* it should be easy to distinguish the ova of *G. niger*

* "On the eggs and breeding of our Gobiidæ." From the Danish Biological Station. 1891 (1892), p. 2, Tav. i. b.

and *G. paganellus* by the apex, which is bluntly rounded in the former and more or less acutely pointed in the latter. Spawn, evidently that of *G. paganellus,* has been found on several occasions, at Easter and in the early summer of 1897, attached to various objects between tide-marks on Drake's Island.

Gobius pictus. *Malm.*

The ova of *G. minutus* and *G. Ruthensparri* have been frequently observed at Plymouth, but require no further description than is afforded by the admirable memoirs of Guitel* and Petersen.† It is, perhaps, worthy of remark that males and females of the former species have been taken by one of us in full breeding condition during the first week of September of this year at Newquay, Cornwall. At Plymouth *G. minutus* begins to spawn at least as early as April.

So far as we are aware Mr. A. O. Walker is the only observer who has noticed (in Colwyn Bay) the occurrence of *Gobius pictus* in British waters *(cf.* Day, *Fish. Gt. Brit.*, i., p. 168), although it is quite possible that the species may have been recorded under other names. It is by no means rare on sandy and muddy ground, and among algæ and zostera in Plymouth Sound (Cattewater, Jennycliff Bay, N.E. of Drake's Island), and in Cawsand Bay. A single specimen has been taken in Bigbury Bay, and probably a little attention would show that the species occurs on many parts of our coasts.

We have not observed ova taken directly from the parent, but consider that this species is probably responsible for some spawn attached to a Pecten shell trawled near the Batten Breakwater on the 12th May, 1898. In dimensions and shape the ova approach the condition of *G. microps* (*cf.* Petersen, *op. cit.*, p. 3, tav. i. b., Fig. 11), a form closely allied to *G. pictus,* but unrepresented, so far as we can determine, in our district. The egg measures ·81 mm. in height. As in *G. microps,* it is swollen near the base, the greatest breadth being ·63 mm. Distally the lateral outline is somewhat compressed, while the apex, sometimes rounded, is usually very slightly acuminate. The shape is, therefore, intermediate between that of *G. Ruthensparri* and that of *G. microps,* but nearest to the latter. A newly-hatched larva measured 2·68 mm. in total length. The pigment differs from that of *G. minutus* in that yellow and black chromatophores extend in almost unbroken series along the dorsum and ventrum, to a point near the caudal extremity. Petersen gives no detailed description

* *Arch. Zool. Exper.*, S. II., x., 1892; S. III., iii., 1895.

† *Op. cit.* The ova and larva of *G. minutus* have also been described by one of us in *Ann. Mag. Nat. Hist.*, S. VI., 1890, p. 30.

of the larva of *G. microps;* but his drawing of the embryo indicates that the pigmentation of the two forms must be rather similar at the time of hatching.

Gobius Jeffreysii. *Günther.*

An old oyster shell, presumably dumped down with other rubbish by a harbour mud-hopper, was dredged on the 3rd July, 1898, about two miles S. by E. of the Plymouth Mewstone in about twenty-three fathoms of water. It was found to be coated on one side by the eggs of a Goby. The shell did not appear to be a recent contribution to the Mewstone ground, while the spawn was in an early stage of development, and may be supposed to have been deposited where found. No Goby was found in the net, but *G. Jeffreysii* is commonly taken on the same ground, where it is the only representative of its genus. In shape the ova differ from those attributed to *G. pictus,* chiefly in that the apex is always rounded and never acuminate. The height varies from ·72 to ·78 mm., the greatest breadth from ·55 to ·58 mm. The yolk is practically colourless. We have no observations of more advanced stages.

Gobius scorpioides. *Collett.*

According to Smitt (*Hist. Scand. Fish.*, Ed. II., i., p. 260) this Goby has hitherto been known from three specimens, of which two, 28 and 37 mm. long, were taken by G. O. Sars at twenty to sixty fathoms outside Stavanger and Hardanger fjords, while the third, 18·5 mm. long, was found by Winther at six fathoms in the S.W. of the Cattegat.

We are able to extend the range of the species to the British area, having taken a specimen on the 13th July, 1897, in the mouth of Falmouth Harbour at about eighteen fathoms, N. by W. of Anthony point, in a dredge full of dead shells, etc. It is a female measuring 21 mm. in total length. The ovaries are much distended, and contain apparently ripe ova loose in the lumen, with the outer layer of the zona everted.

The ova are mostly oval or ovoid in shape, but some show an approach to the shouldered condition common to other small species of the genus. Two measure ·52 and ·60 mm. in height by ·42 and ·39 mm. in greatest breadth, but these measurements do not allow for the expansion which probably takes place when the spawn is deposited in the ordinary way in sea-water, the specimen having been preserved in weak formol before its viscera were examined. The everted outer layer of the zona is similar to that of other Gobies, except that it shows hardly any perforations near the micropylar region, the numerous recticulo-radiate ridges being mostly united by a thin membrane.

G. scorpioides is certainly the smallest British Goby so far recorded. If common it is not likely to be often retained in the meshes of an ordinary net.

Aphia pellucida. *Nardo.*

We cannot find a description of the ova of this fish, though in other respects, thanks to Collett,* the cycle of its life-history is fairly well known. In the early part of July of the present year, adults of both sexes were rather numerous on the zostera and weed beds of the inner part of Cawsand Bay, the females being full of roe. They became scarce towards the end of the month, and none have been since taken. The abundance of this species in the estuary of the Lynher in April has already been noticed by one of us. (*Journ. M. B. A.*, vol. i., p. 89.)

None could be found there on the 21st July of the present year. If the fish is a permanent inhabitant of the estuary this would seem to indicate that the brood of last year, offspring of the half-grown examples met with in April, had already died off, having fulfilled the life-span of a single year allotted to them by Collett.† It is, however, possible that individuals move seawards from the estuary at the approach of maturity, while the larvæ in turn migrate to the estuary.

Though breeding adults were numerous, we failed to find the spawn attached to any object trawled or dredged in Cawsand Bay. Examination of the ovary of a female, 1¾ inches long, taken in the Bay on the 14th July, indicates that the ova are certainly demersal. The yolk, probably not quite mature, was transparent, colourless, and almost free from granulations. It consisted at this stage of an outer layer, enclosing an inner and more refractive part. After 15 hours in sea-water the ovum was evidently dead. It had become opaque and yellowish, the refractive part having been apparently broken up into a number of globules, bearing a general resemblance to those of Gobius. Under natural conditions it is probable that the yolk is not essentially different from that of Gobius, but less opaque and without conspicuous colouration. The zona is thin and without special markings. As in Gobius, it is enveloped in the ovarian condition by an outer membrane, which is everted when the follicle is ruptured, and forms the fixing apparatus. This outer membrane is, however, divided into a number of

* *Proc. Zool. Soc.*, 1878, i., p. 318.

† The brood of 1898, if present, would be too small to be retained in the net employed. It is possible that some larvæ, taken at the mouth of the Lynher in 1897, may have belonged to these species; they were not preserved.

fine threads which may spring directly in a single series from around the micropyle, or may be united for a very short distance proximally. In this respect the condition of Blennius is approached rather than that of Gobius, but the divergence from the latter type is only one of degree.

When freshly removed from the ovary the zona was spherical, and about ·44 mm. in diameter, the perivitelline space being small, but soon expanding in sea-water. About 15 hours after extension, such ova as were at all regular in outline had acquired a broadly oval shape, the yolk mass remaining round. One example measured 1·06 mm. by ·78 mm.; another, 1·25 mm. by ·95 mm. We cannot say how far either dimensions or shape conformed to the natural condition, as we were unable to effect fertilisation.

Crystallogobius Nilssonii. *Düb and Kor.*

This fish is exceedingly abundant on the Eddystone grounds and in the deeper part of Falmouth Bay, forming in these localities, as probably on all offshore grounds in the district, the chief food of half-grown dories (*Zeus faber*) and large scald-fish (*Arnoglossus laterna*). The latter is essentially a bottom fish, and all records with which we are acquainted tend to confirm Collett's opinion that Crystallogobius is an inhabitant of the lower strata of the water, if not actually a bottom fish to the same extent as the Gobies. However, on the 8th of May of last year a female was taken in a surface net near the Eddystone. It measures 22 mm. in total length. The ovaries contain eggs (transparent, like the rest of the animal, in the fresh condition) of which the largest measure about ·12 mm. in diameter. They are spherical, and not sufficiently mature to justify any conclusion as to their appearance in the ripe condition.

CORRIGENDA.

Capros aper (vol. v., pp. 44, 121). Advanced larvæ of about 5 to 6·5 mm., taken off Fowey, have been referred in my previous papers to Capros, chiefly on account of the pigmentation, since the specimens were not in the best state of preservation. This year I have had several opportunities of observing in the living condition a larva which certainly belongs to the same species, and is without doubt a young *Ctenolabrus rupestris.* It would be difficult to find a better illustration of the difficulty of determining a Teleostean larva at a stage when the skeletal characters are insufficiently developed for exact diagnosis, and especially when the conformation has been more or less obscured by post-mortem distortion, since it would appear that the larvæ of Capros, Crenilabrus, and several species of Lepadogaster all pass through phases characterised by one and the same pigmentation pattern. The identity of the pattern seems to be explicable neither by the taxonomic propinquity of the genera nor by protective adaptation.

Caranx trachurus. My attention has been drawn to several errors in my notes on this species (vol. v., p. 116). The yolk in *Temnodon saltator* is actually described by Agassiz and Whitman as having only cortical segments, instead of becoming segmented throughout as in the ova which I attribute to Caranx. The difference is one of degree, since yolk segments when present in ripe eggs seem to be the survivors of the yolk spherules of ovarian stages (*cf.* Raffaele, *Mitth. Zool. Stat. Neap.*, viii., 1888, p. 21), although it is only in the supposed Caranx eggs that these segments have been seen to divide and to encroach upon, and finally occupy all parts of the yolk after deposition. I have also spoken of Raffaele's species, No. 3 (*loc. cit.*, p. 64) as doubtfully assigned by its discoverer to Coryphæna, whereas Raffaele really says that, while recognising the resemblance to Coryphæna, he considers that No. 3 probably belongs to a family nearly related to the Clupeidæ. If this view were correct one would expect to see at the larval stage, depicted in Tav. iv., Fig. 9, some trace of transverse folds in the lining membrane of the intestine.

The young Caranx, mentioned in vol. v., p. 119, were taken between Puffin Island and Bray Head, Co. Kerry. In recording them from the Irish Sea I was misled by a similarity of names in the two localities.

E. W. L. H.

The Great Silver Smelt, *Argentina silus*, Nilss. An Addition to the List of British Fishes.

By

Ernest W. L. Holt.

By the kindness of Mr. J. Jacobs, to whom the Laboratory is already indebted for many specimens of interest, I received on the 15th June a fine example of the species mentioned above, which had been trawled off the south coast of Ireland. The fish weighed 1 lb. 5 oz., and measured 42 cm., or 16½ inches. Though taken at least a day previously, it was in excellently fresh and firm condition. I have already recorded its capture in a letter to the *Field* and at a meeting of the Zoological Society, but the locality was inexactly given in each of these communications. I have since learned that the correct locality is 50° 20′ N., 8° 25′ W., or about seventy-five miles true S. of the Old Head of Kinsale, depth seventy-four fathoms. A number of the same species were trawled, and some were found to be excellent eating. I have no means of deciding whether the occurrence of *A. silus* on the ground indicated is normal or exceptional. If it can be taken in any quantity it should prove a valuable addition to our list of food-fishes.

I can find no previous record of *A. silus* in British waters, since Edward, according to Day, acknowledged that his specimen was identical with the species figured and described by Day, which is the lesser silver smelt, *A. sphyræna*, Linn. Other European records are from the Scandinavian and Jutland coasts, always in water of considerable depth. The species is also known from the Atlantic coasts of North America. A good figure is given by Smitt (*Hist. Scand. Fish.*, Ed. 2, II.), who states that all the examples of which he has acquaintance had the stomach everted by the expansion of the air-bladder, and so yielded no evidence as to the nature of the food. In my specimen the air-bladder was not abnormally dilated, and the œsophagus and stomach were filled with a mass of finely triturated animal matter, which appeared, judging from experience in similar cases, to be the muscular tissue of shrimps or prawns. A much macerated telson, the only hard part found, appeared to belong, most probably, to a shrimp, certainly to that section of the *Crustacea macrura* which embraces the shrimps and prawns. I also found a single copepod, identified by Mr. T. V. Hodgson as *Calanus finmarchichus*. The latter is often met with at the bottom, and has been found by myself in the stomachs of pleuronectids, while all available evidence seems to indicate that *A. silus* is a bottom-haunting fish.

Ichthyologists will observe that this record sensibly extends the range of *A. silus* in a southerly direction. Comment on the matter may well be withheld until we possess even an elementary knowledge of the fauna of the deeper parts of our own region. It is hardly necessary to add that the specimen has been handed over to the custody of the British Museum.

Notes and Memoranda.

Callionymus maculatus. *Bonap.* Since the species was added to the English fauna in the last number of this journal, three specimens have been taken in the neighbourhood of Plymouth. One of these lived for two months in the Aquarium, remaining for the most part half buried in fine gravel. It was only once observed to take a *Nereis diversicolor,* the favourite food, in our tanks, of *C. lyra,* but showed considerable liking for Gammarids.

Phrynorhombus unimaculatus. *Risso.* A male, measuring $4\frac{5}{8}$ inches, was taken four miles south of the Plymouth Mewstone on the 9th May, 1898. It appears to be the only specimen that has been taken near Plymouth since the Laboratory has been in existence.

Motella cimbria. *Linn.* A specimen taken from the stomach of a hake trawled in or off the Bristol Channel, was sent to the Laboratory on the 16th September, 1898. It measures 21·7 cm. ($8\frac{1}{2}$ in.) in total length, and differs from described members of the species in the great length of the first dorsal ray. The length of this structure is 5·2 cm., that of the head being 3 65 cm. I have since seen an Irish specimen with the first ray similarly prolonged. E. W. L. H.

Sepia elegans. *d' Orb.* (Jatta, "Fauna u. Flora d. Golfes v. Neapel, Cefalopodi" = *S. biserialis,* Verany; Gwyn Jeffreys, Brit. Conch.). During the summer of last year (1897) this species was taken not infrequently on the trawling grounds inside the Eddystone. This year three examples have been brought to the Laboratory. The largest of these, measuring in length 7·5 cm., including the sessile arms, was obtained on the trawling ground off Plymouth, while the others were taken off Bolt Head ($3\frac{1}{2}$ m. S., 33 fms.).

Since there appears to be some confusion with regard to the species of this genus, especially in the use of the name *Sepia elegans,* it is necessary to state that our specimens agree with the figures and description of *S. elegans* given by Jatta in the Naples monograph (the shell in particular is characteristic). They also agree with Gwyn

Jeffreys' description of *S. biserialis,* Verany, which is considered by Jatta to be synonymous with *S. elegans,* d'Orb., as is also *S. rupellaria,* d'Orb., these two latter having no sufficiently important characters to entitle them to separate specific rank. On the other hand, the *Sepia elegans,* de Blainville, of Gwyn Jeffreys' Brit. Conch., is a distinct species equivalent to the *S. orbignyana,* Férussac. This, according to Jatta, is the *S. elegans* of Norman's Revision of the Brit. Moll. (*Ann.* and *Mag.*, 1890) also. Previous British records for our species are Polperro and Mawgan Porth in Cornwall, Swansea, North Coast of Ireland, and Northumberland. Apparently in some, if not most, cases dead shells only were obtained. E. W. L. H. and W. I. B.

Mysis longicornis. *Milne Edwards.* This species, which we believe to be an addition to the known fauna of the Atlantic area, was found to be somewhat abundant in Start Bay, S. Devon, at the end of July last (1898). It was taken on fine gravel and sandy ground off Blackpool and Slapton Sands in from 5 to 8 fathoms, in company with *Mysidopsis gibbosa* and *M. Angusta,* these in comparatively small numbers, and single specimens of *Siriella armata,* and of a form approaching, though not agreeing exactly with, *S. Clausii.*

So far as we have been able to ascertain, *M. longicornis* has not previously been obtained outside the Mediterranean, and therein only at Naples (M. Edwards, G. O. Sars, &c.), and according to Carus (*Prod. Faunæ Mediterr.*), at Algiers (Lucas).

This species can hardly be assigned to any of the genera of Mysinæ, as defined by Norman ("British Mysidæ," *Ann.* and *Mag.*, 1892). It would appear to come near to *Neomysis,* with which it agrees in having the third pair of pleopods in the male unmodified, and like the first, second, and fifth pairs differing in no material respect from those of the female.* Were Norman's definition of the sub-family strictly enforced, both would, as a matter of fact, be excluded from the Mysinæ by this character.

Mysidopsis angusta. *G. O. Sars.* This species was found in Start Bay on the same ground as *Mysis longicornis* in July, 1898, as noted above. It was taken in the same locality in the early part of the summer of the previous year.

The finding of *Mysidopsis angusta* on the South Devon coast adds considerably to the known range of the species in North-Western European waters, where it had not previously been taken further south than the Dogger Bank (Scott, "Crustacea from the Dogger Bank,

* Compare the figures of Sars: *Middelhavets Mysider*, Pl. X., Fig. 13, and *Monograph over Mysider*, Pl. XXXIV., Fig. 17.

collected by Ernest W. L. Holt," *Ann.* and *Mag.*, 1894). It was, however, known to occur at Naples (G. O. Sars, *Middelhavets Mysider*).

We hope to prepare a further publication on the Schizopoda of the Plymouth district shortly.

NOTE.—Since the above was written we have found that *Mysidopsis angusta* is recorded from Valencia Harbour, on the west coast of Ireland, by A. O. Walker. (*Trans. Liverpool Biol. Soc.* xii. 1898, p. 164.)

E. W. L. H. and W. I. B.

Malformation of the Mouth in the Common Sea-Bream.—Yarrell has published in his work on British Fishes (vol. i., p. 110) a sketch of Couch's, which represents an abnormal condition of the mouth in the Common Sea-Bream (*Sparus centrodontus*), caused, according to Yarrell, by the "want of intermaxillary bones." The effect is to give the fish a characteristic "short-nosed" appearance, and to cause the lower jaw to protrude considerably in front of the head. At the same time the mouth is reduced to a small tubular orifice, which leaves the anterior half of the lower jaws permanently exposed. Mr. Dunn, of Mevagissey, recently forwarded to the Laboratory a Bream which exhibited this same abnormality. It was caught in a seine at Mevagissey on September 30th, and in all other respects was in good condition. Its length, from the tip of the lower jaw to the fork of the tail, is $9\frac{1}{2}$ inches; its maximum depth, $3\frac{1}{4}$ inches. The puzzle propounded by Mr. Dunn was how a fish with such a mouth could manage to eat anything, especially as in his specimen the aperture of the mouth is reduced to an even greater extent than in Couch's, the fleshy cheek and nasal membranes having grown forwards and downwards, so as to leave only the teeth on the anterior extremity of the lower jaw exposed, the lateral teeth being completely covered. The aperture of the mouth is spoon-shaped, and measures $\frac{1}{4}$ inch in long diameter, and slightly more than $\frac{1}{8}$ inch across. It is quite incapable of closure or of expansion. As I had seen a similar "short-nosed" Bream at Plymouth earlier in the summer, it would appear that this extraordinary abnormality is curiously common in this species and in this locality—a matter which seemed to merit enquiry. I have, therefore, carefully compared Mr. Dunn's specimen with a normal Bream, and, with Mr. Dunn's assistance, am able, I think, to offer a complete explanation.

The stomach of the abnormal fish was greatly distended with food, which consisted principally of pieces of green algæ, both *Ulva* and *Enteromorpha*, among which were to be found a small number of

Amphipod Crustaceans and the late larva of a shrimp or prawn, which was too much digested to admit of closer identification. The stomach also contained, remarkably enough, the cleanly excised stomach of another fish, which contained Copepods and other small plankton organisms in a sufficiently fresh state to admit of easy identification. The stomach was clearly that of a Clupeoid, with a characteristic tough, gizzard-like pyloric portion, and it is, in fact, the stomach of a pilchard, as I have found by comparison. Mr. Dunn tells me that, along with the abnormal Bream, there were taken in the seine about a dozen other Bream, about 30 Red Mullets, a few flat-fishes, and about 3000 pilchards. He says that the fishermen were very anxious to see if the pilchards were fat or not, and that, in order to see their condition, the men may have unmeshed and opened one before tucking the seine, and thrown its stomach in the sea. There can be no doubt that this explanation is correct, but it is curious that this bit of jetsam should have fallen to the lot of the fish which was worst provided with organs of prehension. Although, however, the abnormality described undoubtedly deprives the fish of all power of using its teeth, it does not affect its powers of suction; and, as observations in the Aquarium have shown that this means of catching small prey is very commonly employed by fishes, it is no doubt by this means that the abnormal Bream succeeded in securing its supply of Amphipods and other booty.

As regards the structure of the abnormal mouth, Yarrell is right in attributing its main peculiarity to the absence of the intermaxillary (or premaxillary) bone. But in the specimen examined by me this is not the only defect, for one of the maxillary bones, viz., the right, is also wanting, while the left persists. This asymmetry in the abnormality suggests the result of injury rather than a congenital malformation, and confirms a view as to the origin of the abnormality which has been communicated to me in a letter from Mr. Dunn. I will quote his remarks *verbatim* :—

"It is known to our people, when they anchor on certain high rocks, that the Sea Bream, in all its stages, is the most pertinaceous, persistent, and obdurate enemy that our Pollack fishers have, never leaving the bait rest one moment, if the Pollack is not in the immediate neighbourhood of the end of the line. This vexes the fisherman very much, and when he feels them tearing and mangling his bait, and making it unfit for Pollack food, in his excitement he often jerks the line with all the might of his arm. Sometimes one of the batch (for there are generally several there) will be hooked on the outside, but if hooked on the top of the mouth his top jaw is sure to be pulled away. This I have seen done more than once."

Mr. Dunn adds that the specimen forwarded to us was by no means unique, as similar ones occur at Mevagissey from time to time, one of which, caught in 1896, he still preserves. He concludes that the deformity is caused by the fishermen in the above-mentioned way, the injury to the mouth being gradually repaired, although its structure is permanently modified, by the forward growth of the soft cheek tissues, as already described. My observations entirely support this view of the origin of the abnormality.

There is one point to which I will draw attention in conclusion. Hitherto, to the best of my knowledge, this deformity has not been recorded as occurring elsewhere than on the Cornish coast. I should be glad, therefore, if fishermen and sea-anglers generally would be good enough to forward to the Director of this Laboratory any similarly abnormal specimens of the Sea Bream which they may come across, in order that the distribution of the abnormality may be recorded. It would appear to be possible to make use of the facts as evidence in connection with the winter movements of the fish, especially if such specimens should be captured in the early part of the season. In such a case the injury must have been produced in the preceding season, before the winter migration.

WALTER GARSTANG.

Marine Biological Association of the United Kingdom.

Report of the Council, 1897–98.

The Council and Officers.

Four ordinary meetings of the Council have been held during the year, at which the average attendance has been 9.

The Council records with regret the death of Lord Revelstoke, who for the past eight years has been one of the Vice-Presidents of the Association, and rendered it much valuable assistance in connection with dredging and oyster culture in the river Yealm, near Plymouth.

The Council has again to acknowledge the courtesy of the Royal Society in granting the use of its rooms for the meetings of the Association.

The Plymouth Laboratory.

The buildings, fittings, and machinery have been maintained in good condition.

An apparatus designed for the purpose of keeping pelagic animals alive in small aquaria, by maintaining a constant movement in the water, has been fitted up in the Laboratory, and has given satisfactory results. This apparatus was originally designed by Mr. E. T. Browne, in conjunction with the Director of the Laboratory, for keeping medusæ in a healthy condition, and amongst the animals which have been successfully reared through their larval stages to the adult form are *Chætopterus*, *Cladonema radiatum* (hydroid reared from the medusa), *Syncoryne sp.* (from the medusa), *Nika edulis*, and *Capitella capitata*.

The Boats.

The *Busy Bee* has been constantly at work, and a great deal of dredging and trawling has been satisfactorily done in the immediate neighbourhood of Plymouth, especially around the Eddystone. In addition to this, expeditions have been made to the eastward to

Dartmouth and Exmouth, and to the westward to Fowey and Falmouth. The sailing boat *Anton Dohrn* has also been used for collecting in Plymouth Sound.

The Staff.

No change has taken place in the staff during the year.

The Council would again draw attention to the fact that the equipment of the Laboratory and boats is now sufficiently complete to allow of a very much larger amount of scientific work being done, if the services of more naturalists could be retained for lengthened periods. It is in this direction that the Council looks forward to the development of its work, although any such development is impossible without an adequate increase in the income of the Association.

The Library.

The thanks of the Association are due to Mr. J. P. Thomasson for a donation of £20 for the purchase of books for the Library and for binding, and to the Zoological Society of London for an almost complete set of their publications from the year 1832. With the help of Mr. Thomasson's donation Smitt's valuable work on Scandinavian fishes has been purchased, and the publications of the Zoological Society have been bound.

It has been necessary to fix a number of new shelves in the Library in order to accommodate the increasing number of books.

The Council has again to thank the Royal Society, the Zoological Society, the United States Commissioner of Fish and Fisheries, the Royal Microscopical and many other societies, for copies of their current publications, as well as those authors who have presented separate copies of their works.

General Report.

In compliance with the requirements of H.M. Treasury, mentioned in last year's Report of Council, special attention has been given to investigations relating to the habits and migrations of the mackerel. In addition to the preparation of the report on the subject forwarded to H.M. Inspectors of Irish Fisheries, which has since been published in the Journal of the Association, Mr. Garstang has been specially engaged in studying the characteristics of mackerel captured in various localities and at different seasons of the year, in order to determine whether distinct races of this fish can be recognised. Samples have been obtained from the western portion of the English Channel, the west coast of Ireland (through H.M. Inspectors of Irish Fisheries), the North Sea, from America, and from other localities, and a report on the subject is in preparation. At the same time systematic investigations are in progress with reference to the general question of the movements of the migratory fishes, more especially of the mackerel, in connection with the periodic movements of the floating organisms upon which these fishes, directly or indirectly, depend for their food supply, and also with the changes in the physical conditions of the sea, especially with regard to density and temperature.

Mr. Holt has paid much attention to questions connected with the reproduction and development of the fishes living in the neighbourhood of Plymouth, and their distribution at different ages. A memoir dealing with these questions has been published in the Journal of the Association, and Mr. Holt has also given evidence on the subject at an enquiry, held by the Board of Trade, having reference to a bye-law proposed by the Devon Sea Fisheries Committee.

The experiments with floating bottles for determining the surface-drift in the English Channel have been continued, and a report upon the results of the first year's work in this direction has been published.

The systematic dredging and trawling of the grounds between the Eddystone and Start Point have been proceeded with, and the results are now being prepared for publication.

A collection of specimens of fishes, and other marine animals which serve as food for fishes or are used as bait, was arranged and exhibited by the Association at the Yachting and Fisheries Exhibition, held during the summer of 1897 at the Imperial Institute. This collection has since been on view at the Laboratory at Plymouth.

Occupation of Tables.

The following naturalists have been engaged in research work at the Plymouth Laboratory during the year:—

W. I. Beaumont, B.A., Cambridge (Nudibranchiata).
F. P. Bedford, B.A., Cambridge (Myriothela).
G. Brebner, University College, Bristol (Algæ).
E. T. Browne, B.A., University College, London (Medusæ).
L. W. Byrne, B.A., Cambridge (Teleosteans).
A. H. Church, B.A., Oxford (Algæ).
J. T. Cunningham, M.A., Penzance (Crabs).
G. Duncker, Ph.D., Kiel (Variation of Fishes).
F. W. Gamble, M.Sc., Owens College, Manchester (Nervous System of Polychætes).
E. S. Goodrich, B.A., Oxford (Polychætes).
N. B. Harman, M.B., Cambridge (Eyes of Fishes).
T. V. Hodgson, Plymouth (Crustacea).
J. W. Jenkinson, B.A., Oxford (Larvæ of Crustacea).
W. F. Lanchester, B.A., Cambridge (Phoronis).

M. Lubbock, M.D., London (Fishes).
E. W. MacBride, M.A., Montreal (Development of Echinodermata).
E. A. Minchin, M.A., Oxford (Protozoa).
S. D. Scott, B.A., Cambridge (Ascidians).
T. H. Taylor, M.A., Yorkshire College, Leeds (Polyzoa).
W. F. R. Weldon, F.R.S., University College, London (Variation of Crabs).
N. Wylde, London (Variation of Galathea).

Prof. Hickson, F.R.S., of Owens College, Manchester, sent his assistant to the Laboratory, to collect material for his researches on the development of Alcyonium.

Mr. Garstang again conducted a vacation class in Marine Biology, which was attended by eight students from Oxford, Cambridge, and the Yorkshire College.

Published Memoirs.

Amongst the papers, either wholly or in part the outcome of work done at the Laboratory, which have appeared elsewhere than in the Journal of the Association, are the following:—

Bethe, A.—*Das Nervensystem von Carcinus Mænas*, i., ii., and iii. Archiv für Mikroskopische Anatomie, l., 1897, pp. 460-546, 589-639; and li., 1898, pp. 383-452.

Browne, E. T.—*On British Medusæ.* Proceed. Zool. Soc. London, Nov. 16, 1897, pp. 816-835.

Brumpt, E.—*Sur un Copépode nouveau parasite de Polycirrus aurantiacus, Grube.* Comptes rendus, June 21, 1897.

Church, A. H.—*The Polymorphy of Cutleria multifida.* Annals of Botany, xii., No. 45, pp. 75-109.

Cunningham, J. T.—*On the Early Post-Larval Stages of the Crab (Cancer pagurus), and on the Affinity of that Species with Atelecyclus heterodon.* Zoological Society, March 15, 1898.

Garstang, W.—*On some Modifications of Structure subservient to Respiration in Decapod Crustacea which burrow in Sand.* Quart. Journ. Micr. Sci., vol. 40, pp. 211-232.

Harmer, S. F.—*On the Development of Tubulipora, and on some British and Northern Species of this Genus.* Quart. Journ. Micr. Sci., vol. 41, pp. 73-157.

Holt, E. W. L.—*On the breeding of Callionymus lyra in the Marine Biological Association's Aquarium at Plymouth.* Zoological Society, April, 1898.

Donations and Receipts.

The Receipts for the year include the Annual Grants from H.M. Treasury (£1000), and the Worshipful Company of Fishmongers (£400), Composition Fees (£30), Annual Subscriptions (£144), Rent of Tables in the Laboratory (£84), Sale of Specimens (£232), Admission to the Aquarium (£76), Special Donations (£35). The total receipts for the year amount to £2039.

Vice-Presidents, Officers, and Council.

The following is the list of gentlemen proposed by the Council for election for the year 1898-99:—

President.

Prof. E. RAY LANKESTER, LL.D., F.R.S.

Vice-Presidents.

The Duke of ARGYLL, K.G., K.T., F.R.S.
The Duke of ABERCORN, K.G., C.B.
The Earl of ST. GERMANS.
The Earl of MORLEY.
The Earl of DUCIE, F.R.S.
Lord TWEEDMOUTH.
Lord WALSINGHAM, F.R.S.
The Right Hon. A. J. BALFOUR, M.P., F.R.S.
The Right Hon. JOSEPH CHAMBERLAIN, M.P.
The Right Hon. Sir JOHN LUBBOCK, Bart., M.P., F.R.S.
Prof. G. J. ALLMAN, F.R.S.
Sir EDWARD BIRKBECK, Bart.
Sir WM. FLOWER, K.C.B., F.R.S.
A. C. L. GÜNTHER, Esq., F.R.S.
Prof. ALFRED NEWTON, F.R.S.
Rev. Canon NORMAN, D.C.L., F.R.S.
Sir HENRY THOMPSON.
Rear-Admiral Sir W. H. L. WHARTON, K.C.B., F.R.S.

Elected Members.

F. E. BEDDARD, Esq., F.R.S.
Prof. F. JEFFREY BELL, F.Z.S.
G. C. BOURNE, Esq., F.L.S.
Sir JOHN EVANS, K.C.B., Treas. R.S.
G. HERBERT FOWLER, Esq.
S. F. HARMER, Esq., F.R.S.
Prof. W. A. HERDMAN, F.R.S.
Prof. S. J. HICKSON, F.R.S.
J. J. LISTER, Esq.
SIR JOHN MURRAY, F.R.S.
P. L. SCLATER, Esq., F.R.S., Sec. Z.S.
D. H. SCOTT, Esq., F.R.S.
Prof. CHARLES STEWART, F.R.S.
Prof. W. F. R. WELDON, F.R.S.

Hon. Treasurer.

J. A. TRAVERS, Esq.

Hon. Secretary.

E. J. ALLEN, Esq., The Laboratory, Citadel Hill, Plymouth.

The following Governors are also members of the Council:—

ROBERT BAYLY, Esq.
J. P. THOMASSON, Esq.
THE PRIME WARDEN OF THE FISHMONGERS' COMPANY.
E. L. BECKWITH, Esq. (Fishmongers' Company).
Prof. BURDON SANDERSON, F.R.S. (Oxford University).
Prof. MICHAEL FOSTER, F.R.S. (Cambridge University).
Sir WILLIAM FLOWER, K.C.B., F.R.S. (Brit. Assoc. for Advmnt. of Science).

Dr. *Statement of Receipts and Expenditure for the Year ending 31st May, 1898.* Cr.

Receipts.	£	s.	d.	£	s.	d.
To Balance from last year, being Cash in hand, less Overdraft at Bank				198	11	4
,, H.M. Treasury				1000	0	0
,, Fishmongers' Company				400	0	0
,, Composition Fees and Donations—						
J. P. Thomasson	20	0	0			
J. Straker	15	15	0			
W. F. Lanchester	15	0	0			
W. F. Sinclair	10	10	0			
W. J. Adams	3	3	0			
L. W. Byrne	1	1	0			
				65	9	0
,, Annual Subscriptions				143	17	0
,, Rent of Tables	84	3	0			
,, Sale of Specimens	232	3	0			
,, Sale of Journal	17	19	9			
,, Admission to Tank Room	76	3	9			
				410	9	6
,, Interest on Investment				19	6	8
				£2237	13	6

Expenditure.				£	s.	d.	£	s.	d.
By Salaries and Wages—									
Director				200	0	0			
,, Allowance for Assistant				5	11	0			
Naturalist				239	11	8			
Wages				485	1	6			
							930	4	2
,, Stationery, Office Printing, Postages, &c.							170	12	8
,, Printing and Illustrating Journal							98	13	6
,, Sundry Expenses—									
Gas, Water, Coal, Oil, &c.	£100	11	6						
Coal and Water for Steamer	40	17	6						
				141	9	0			
Insurance of Steamer				12	7	6			
Stocking Tanks, Feeding, &c.				76	12	10			
Glass, Chemicals, Apparatus, &c.	£104	10	2						
Less Sales of Glass	15	13	8						
				88	16	6			
Maintenance and Renewals of Buildings, Boats, and Nets	£270	0	2						
Less Sales of Nets and Gear	17	16	5						
				252	3	9			
Rates and Taxes				4	6	0			
Boat Hire				10	0	0			
Travelling Expenses				31	0	6			
Expenses of Exhibition of Specimens				37	0	6			
Library				80	18	9			
							734	15	4
,, Balance forward, being Cash at Bank and in hand, 31st May, 1898							303	7	10
							£2237	13	6

Investment held May 31st, 1898, £500 Forth Bridge Railway 4% Guaranteed Stock.

Examined and found correct,

(Signed) Edwin Waterhouse,
Stephen E. Spring Rice,
W. F. R. Weldon,
G. Herbert Fowler,
} *Auditors.*

June 23rd, 1898.

Director's Report.

THE paper by Mr. Garstang in the present number of the Journal contains a full account of his researches, so far as they have at present proceeded, on the question of the different races of the mackerel. In addition to this work Mr. Garstang has been investigating the food of the mackerel, for which purpose a large number of the stomachs of the fish have been preserved and their contents examined. At the same time the distribution in the sea of the various floating and free-swimming organisms, which constitute the greater part of the food of the mackerel and other migratory pelagic fishes is being investigated, and an attempt is being made to correlate the movements of these organisms with changes in the physical conditions of the sea-water, as indicated by observations of its temperature and density. The experiments with floating bottles for determining the direction and rate of the surface drift are also being continued.

At the beginning of September, Mr. Garstang attended the International Fisheries Congress at Dieppe, and there submitted a proposal for a joint Anglo-French investigation of the physical and biological conditions of the English Channel during the year 1899. This proposal met with the support of the French naturalists, and a resolution was passed expressing the desirability of forming an Anglo-French committee to co-operate with the Marine Biological Association in the matter. At the meeting of the British Association in Bristol, a grant of £100 was made towards carrying out the suggested scheme of investigation, and Mr. H. N. Dickson promised his assistance in carrying out the physical parts of the work.

Mr. Holt, who during the summer continued his observations on the distribution of young stages of fishes in this neighbourhood, has now proceeded to the west coast of Ireland, where he is taking charge of the fishery investigations, which are being resumed by the Royal Dublin Society in that district.

On p. 296 will be found the report on the trawling experiments in the Bays on the South Coast of Devon, which were carried out at the instance of the Devon Sea Fisheries Committee. These experiments were commenced by Mr. Stead in 1895, and have since been continued by Mr. Scott and Mr. Holt. The present report, drawn up by Mr. Holt, deals with the experiments in their more immediately practical aspect, as affecting those problems which the Sea Fisheries Committee has had under consideration. The investigations have at the same time furnished valuable material for the discussion of general questions relating to the distribution of fishes at different ages, and of the food upon which they live in the various localities. It has been thought better however not to include this material in the present report, but to reserve it, together with much similar material collected in the neighbourhood of Plymouth, until sufficient observations have been brought together to form the basis for a comprehensive discussion of these subjects.

The following is a list of the naturalists who have occupied tables at the Laboratory since the publication of my last Report, and of the subjects which have specially engaged their attention:—

Beaumont, W. I., B.A., May 2nd to October 5th (*Mollusca and Nemertina*).

Brebner, G., April 2nd to April 19th, and July 26th to August 6th (*Marine Algæ*).

Browne, E. T., B.A., April 4th to June 4th (*Hydrozoa*).

Byrne, L. W., B.A., May 27th to June 3rd (*Pisces*).

Church, A. H., M.A., D.Sc., March 30th to April 16th (*Marine Algæ*).

Gamble, F. W., M.Sc., March 28th to April 29th (*Nervous system of Polychæta*).

Gemmill, J. F., Ph.D., August 30th to September 6th (*Polychæta*).

Gilson, Prof., August 29th to September 6th (*General*).

Goodrich, E. S., B.A., April 2nd to April 19th (*Polychæta*).

Gurney, E., July 1st to July 25th (*Echinodermata*).

Harman, E. B., M.B., March 19th to April 2nd (*Pisces*).

MacBride, Prof., M.A., May 17th to June 30th (*Echinodermata*).

MacMunn, C. A., M.D., June 7th to June 18th (*Aplysia*).

Moore, J. E. S., September 6th to September 14th (Collecting).

Pethybridge, G. H., B.Sc., Sept. 5th to October 8th (*Marine Algæ*).

Scott, S. D., B.A., April 18th to April 26th (*Tunicata*).

Taylor, T. H., M.A., March 26th to April 9th, and August 3rd to September 30th (*Polyzoa*).

Todd, R. A., B.Sc., September 19th to October 8th (*Mollusca*).

Weldon, Prof., F.R.S., July 12th to August 22nd (*Variation of Crabs*).

Woodward, M. F., August 2nd to September 14th (*Mollusca*).

In addition to the above, eight students from Oxford, Cambridge, and Yorkshire College, Leeds, attended Mr. Garstang's class during the Easter vacation.

A party of members of the International Congress of Zoology, which met this year in Cambridge, visited the Laboratory, and took part in two dredging excursions in the *Busy Bee* on August 31st.

During the Bristol meeting of the British Association a number of marine tanks were exhibited by the Marine Biological Association at the Zoological Gardens, Clifton.

Some alterations have been made in the arrangement of the Aquarium, which have proved advantageous in rendering the tanks more attractive, and in effectively exhibiting some of the smaller fishes and invertebrates. Additional storage room, which has long been badly needed, has been added to the Laboratory by the erection of a galvanized-iron shed at the back of the building.

E. J. ALLEN.

October, 1898.

LIST

OF

Governors, Founders, and Members.

1st OCTOBER, 1898.

I.—Governors.

The British Association for the Advancement of Science, *Burlington House, W.*	£500
The University of Cambridge	£500
The Worshipful Company of Clothworkers, 41, *Mincing Lane, E.C.*	£500
The Worshipful Company of Fishmongers, *London Bridge*	£4705
The University of Oxford	£500
Bayly, Robert, *Torr Grove, Plymouth*	£1000
Bayly, John (the late)	£600
Thomasson, J. P., *Woodside, near Bolton*	£970

II.—Founders.

* Member of Council. † Vice-President. ‡ President.

1884	The Corporation of the City of London	£210
1888	The Worshipful Company of Drapers, *Drapers' Hall, E.C.*	£315
1884	The Worshipful Company of Mercers, *Mercers' Hall, Cheapside*	£341 5*s.*
1884	The Worshipful Company of Goldsmiths, *Goldsmiths' Hall, E.C.*	£100
1889	The Worshipful Company of Grocers, *Poultry, E.C.*	£120
1884	The Royal Microscopical Society, 20, *Hanover Square, W.*	£100
1884	The Royal Society, *Burlington House, Piccadilly, W.*	£350
1884	The Zoological Society, 3, *Hanover Square, W.*	£100
1884	Bulteel, Thos., *Radford, Plymouth*	£100
1884	Burdett-Coutts, W. L. A. Bartlett, 1, *Stratton Street, Piccadilly, W.*	£100
1888	Bury, Henry, M.A., *Trinity College, Cambridge*	£100
1884	Crisp, Frank, LL.B., B.A., Treas. Linn. Soc., 17, *Throgmorton Avenue, E.C.*	£100
1884	Daubeny, Captain Giles A., 30, *Cornwallis Crescent, Clifton, Bristol*	£100
1884	Eddy, J. Ray, *The Grange, Carleton, Shipton, Yorkshire*	£100
1884	Gassiott, John P., *The Culvers, Carshalton, Surrey*	£100
‡*1884	Lankester, Prof. E. Ray, F.R.S., *British Museum (Natural History), South Kensington, S.W.*	£100
1885	Derby, the Rt. Hon. the late Earl of	£100
1884	Lister, S. Cunliffe, *Swinton Park, Masham, Yorkshire*	£100

†1884 Lubbock, The Rt. Hon. Sir John, Bart., M.P., F.R.S., *High Elms, Bromley, Kent* £100
1884 Poulton, Prof. Edward B., M.A., F.R.S., *Wykeham House, Oxford* ... £100
1889 Revelstoke, The late Lord £100
1890 Riches, T. H., B.A., *Kitwells, Shenley, Herts.* £130
1884 Romanes, G. J., LL.D., F.R.S. (the late) £100
†1889 Thompson, Sir Henry, 35, *Wimpole Street, W.* £110
*1887 Weldon, Prof. W. F. R., F.R.S., 30A, *Wimpole Street, W.* £100
1884 Worthington, James (the late) £100

III.—Members.

ann. signifies that the Member is liable to an Annual Subscription of One Guinea.
C. signifies that he has paid a Composition Fee of Fifteen Guineas in lieu of Annual Subscription.

1897 Adams, W. R., 59, *Fleet Street, E.C.* .... *ann.*
1884 Alger, W. H., *Manor House, Stoke, Devonport* .... *C.*
†1884 Allman, Prof. G. J., F.R.S., *Ardmore, Parkstone, Dorset* £20
*1895 Allen, E. J., B.Sc., *The Laboratory, Plymouth* .... *ann.*
1889 Anderson, Dr. John, 71, *Harrington Gardens, S.W.* £20
†1884 Argyll, The Duke of, K.G., *Argyll Lodge, Kensington, W.* .... *C.*
1885 Armstrong, Lord, C.B., F.R.S., *Crag Side, Rothbury* .... *C.*
1893 Ascroft, R. L., 11, *Park Street, Lytham, Lancs.* .... *ann.*
1892 Assheton, R., *Birnam, Cambridge* £20

1884 Bailey, Charles, F.L.S., *Ashfield, College Road, Whalley Range, Manchester* *ann.*
1893 Bailey, W. E., *Porth Enys Museum, Penzance* .... *C.*
1884 Balfour, Prof. Bayley, F.R.S., *Royal Botanic Gardens, Edinburgh* ...... *C.*
1893 Bassett-Smith, P. W., Staff-Surgeon, R.N., 118, *North Side, Clapham Common, London, S.W.* .... *ann.*
1884 Bateson, Wm., F.R.S., *St. John's College, Cambridge* .... *ann.*
1897 Baxter, G. H., *Hutton Road, Brentwood, Essex* .... *ann.*
1884 Bayliss, W. Maddock, B.Sc., *St. Cuthberts, West Heath Road, Hampstead.* *ann.*
1884 Bayly, Miss, *Seven Trees, Plymouth* £50
1884 Bayly, Miss Anna, *Seven Trees, Plymouth* £50
1897 Baynes, R. W., 4, *Saltram Place, Plymouth* .... *ann.*
1884 Beaumont, W. I., B.A., *The Laboratory, Plymouth* .... *ann.*
1885 Beck, Conrad, 68, *Cornhill, E.C.* .... *C.*
*1889 Beckwith, E. L., *The Knoll, Eastbourne* .... *ann.*
*1887 Beddard, F. E., F.R.S., *Zoological Society's Gardens, Regent's Park, N.W.* *ann.*
1884 Beddington, Alfred H., 8, *Cornwall Terrace, Regent's Park, N.W.* ...... *C.*
1897 Bedford, F. P., B.A., 326, *Camden Road, London, N.* .... *ann.*
*1884 Bell, Prof. F. Jeffrey, 35, *Cambridge Street, Hyde Park, W.* .... *ann.*
1887 Berrington, A. D., *Pant-y-Goitre, Abergavenny* .... *ann.*
1890 Bidder, George, B.A., *Ravensbury Park, Mitcham, Surrey* .... *C.*
1885 Bignell, Geo. Carter, F.E.S., *The Ferns, Home Park Road, Saltash, Cornwall* .... *ann.*
†1885 Birkbeck, Sir Edward, Bart., 10, *Charles Street, Berkeley Square, W.* ... *ann.*
1893 Bles, A. J. S., *Palm House, Higher Broughton, Manchester* .... *ann.*
1889 Bolitho, T. B., M.P., *Chyandour, Penzance* .... *ann.*
1884 Bompas, G. C., 121, *Westbourne Terrace, Hyde Park, London, W.* .... *ann.*

1884 Bossey, Francis, M.D., *Mayfield, Redhill, Surrey* .... ann.
1884 Bostock, E., *Stone, Staffordshire* .... ann.
1890 Bourne, Prof. A. G., F.R.S., *The Presidency College, Madras* .... ann.
*1884 Bourne, Gilbert C., M.A., *Savile House, Mansfield Road, Oxford* .... ann.
1898 Bowles, Henry, M.P., *Forty Hall, Enfield* .... ann.
1895 Bridge, Prof. T. W., D.Sc., *Mason College, Birmingham* .... ann.
1890 Brindley, H. H., M.A., 9, *Richmond Road, Cambridge* .... ann.
1886 Brooksbank, Mrs. M., *Leigh Place, Godstone, Surrey* .... C.
1884 Brown, Arthur W. W., 37, *Evelyn Mansions, Carlisle Place, Victoria Street, S.W.* .... C.
1893 Browne, Edward T., B.A., 141, *Uxbridge Road, W.* .... ann.
1893 Buchanan, Miss Florence, B.Sc., *The Museum, Oxford* .... ann.
1884 Buckton, G. B., *Weycombe, Haslemere* .... ann.
1886 Bullar, Miss Anna K., *Westbourne Hill, Southampton* .... ann.
1896 Bulstrode, H. P., M.D., 4, *The Mansions, Earls Court, S.W.* .... ann.
1887 Burd, J. S., *Cresswell, Higher Compton, Plymouth* .... ann.
1889 Burnard, Robert, 3, *Hillsborough, Plymouth* .... ann.
1897 Byrne, L. W., B.A., 33, *Lancaster Gate, London* .... ann.

1884 Caine, H. T., 5, *Upper Wimpole Street, London, W.* .... C.
1884 Caine, W. S., *The Terrace, Clapham Common, S.W.* £21
1887 Caldwell, W. H., *Birnam, Cambridge* .... C.
1884 Canterbury, His Grace the Archbishop of, *Lambeth Palace, S.W.* .... ann.
†1884 Chamberlain, Rt. Hon. J., M.P., 40, *Princes Gardens, S.W.* .... ann.
1884 Christy, Thomas Howard, *Malvern House, Sydenham* .... ann.
1887 Clarke, Rt. Hon. Sir E., Q.C., M.P., 5, *Essex Court, Temple, E.C.* £25
1884 Clay, Dr. R. H., *Windsor Villas, Plymouth* .... ann.
1885 Clerk, Major-Gen. H., F.R.S., 40, *St. Ermin's Mansions, Caxton Street, S.W.* £21
1886 Coates and Co., *Southside Street, Plymouth* .... C.
1885 Collier Bros., *Old Town Street, Plymouth* .... C.
1890 Cook, C. H., M.A., *Elmlea, South Stoke, Reading* .... ann.
1889 Crossman, Major-General Sir William, K.C.M.G., *Goswick House, Beale, R.S.O., Northumberland* .... ann.

1885 Darwin, Francis, F.R.S., *Botanical Laboratory, Cambridge* .... C.
1885 Darwin, W. E., *Ridgemount, Bassett, Southampton* £20
1889 Davies, H. R., *Treborth, Bangor* .... ann.
1884 Dewick, Rev. E. S., M.A., F.G.S., 26, *Oxford Square, Hyde Park, W.* ... C.
1885 Dixey, F. A., M.A., Oxon., *Wadham College, Oxford* ....£26 5*s.* *and* ann.
1890 Driesch, Hans. Ph.D., *Stazione Zoologica, Napoli* .... C.
†1889 Ducie, The Rt. Hon. the Earl of, F.R.S., *Tortworth Court, Falfield, R.S.O.* £50 15*s.*
1884 Dunning, J. W., 4, *Talbot Square, W.* .... £26 5*s.*
1884 Dyer, W. T. Thiselton, M.A., C.M.G., F.R.S., *Director of the Royal Gardens, Kew* .... C.

1893 Edward, S. Stanley, F.Z.S., *Kidbrook Lodge, Blackheath, S.E.* .... ann.
1898 Eliot, C. N. E., *The British Embassy, Washington, U.S.A.* .... ann.
1891 Ellis, Hon. Evelyn, *Rosenais, Datchet, Windsor* .... C.
1893 Enys, John Davies, *Enys, Penryn, Cornwall* .... ann.
*1884 Evans, Sir John, D.C.L., Treas. Roy. Soc., *Nash Mills, Hemel Hempstead* £20
1885 Ewart, Prof. J. Cossar, M.D., *University, Edinburgh* £25

1894 Ferrier, David, M.A., M.D., F.R.S., 34, *Cavendish Square, W.* .... *ann.*
1884 Fison, Frederick W., *Greenholme, Burley-in-Wharfedale, Leeds* .... *C.*
*†1884 Flower, Sir W. H., K.C.B., F.R.S., 26, *Stanhope Gardens, London, S.W.* *C.*
1897 Foster, Richard, *Windsworth, Looe, R.S.O.* .... *ann.*
*1885 Fowler, G. Herbert, B.A., Ph.D., 12, *South Square, Gray's Inn, W.C.*... *ann.*
1884 Fox, George H., *Wodehouse Place, Falmouth* .... *ann.*
1886 Freeman, F. F., *Abbotsfield, Tavistock, S. Devon* .... *C.*
1884 Fry, George, F.L.S., *Carlin Brae, Berwick-on-Tweed* £21
1884 Fryer, Charles E., *Board of Trade, S.W.* .... *ann.*

1898 Ganz, C., 5, *Kildare Terrace, Bayswater, London* .... *ann.*
1892 Galton, F., F.R.S., 42, *Rutland Gate, S.W.* .... *ann.*
1885 Gaskell, W. H., F.R.S., *The Uplands, Shelford, Cambridge*.... .... *C.*
1885 Gaskell, E. H., *North Hill, Highgate, N.* .... *C.*
1893 Gatty, Charles Henry, LL.D., F.L.S., *Felbridge Place, East Grinstead* ... *C.*
1897 Gibbs, Hon. Henry, 10, *Lennox Gardens, S.W.* .... *ann.*
1884 Gibson, Ernest, F.Z.S., c/o Fraser, Stoddart, and Ballingall, 16, *Castle Street, Edinburgh*.. *ann.*
1885 Gordon, Rev. J. M., *St. John's Vicarage, Redhill, Surrey* .... *ann.*
1885 Gotch, Prof. F., F.R.S., *University Museum, Oxford* .... *ann.*
1888 Goulding, F. H., *George Street, Plymouth* .. .. *C.*
1884 Grove, E., *Norlington, Preston, Brighton* .... *ann.*
1884 Groves, J. W., *Wargrave Lodge, Wargrave-on-Thames* .... *ann.*
†1884 Günther, Dr. Albert, F.R.S., 2, *Lichfield Road, Kew Gardens* .... *ann.*

1884 Haddon, Prof. Alfred C., M.A., *Innisfail, Hills Road, Cambridge* ...... *ann.*
1884 Halliburton, Prof. W. D., M.D., B.Sc., 9, *Ridgmont Gardens, Gower Street, W.C.* .... *ann.*
1884 Hannah, Robert, 82, *Addison Road, Kensington, W.* .... *C.*
1897 Hargreaves, P., *The Fishery, North Hayling, Hants.* .... *ann.*
*1885 Harmer, S. F., D.Sc., F.R.S., *King's College, Cambridge*..................... *C.*
1889 Harvey, T. H., *Cattedown, Plymouth* .... *ann.*
1888 Haselwood, J. E., 3, *Lennox Place, Brighton*...................................... *C.*
1884 Haslam, Miss E. Rosa, *Ravenswood, Bolton* £20
1884 Hayne, C. Seale, M.P., 6, *Upper Belgrave Street, S.W.* .... *ann.*
1884 Head, J. Merrick, F.R.G.S., J.P., *Ardverness, Reigate*........................ *ann.*
1884 Heape, Walter, *Heyroun, Chaucer Road, Cambridge*.......................... *C.*
*1884 Herdman, Prof. W. A., F.R.S., *University College, Liverpool* .... *ann.*
1884 Herschel, J., Col., R.E., F.R.S., *Observatory House, Slough, Berks.* ...... *C.*
1884 Heywood, James, F.R.S., 26, *Palace Gardens, W.* .... *C.*
1889 Heywood, Mrs. E. S., *Light Oaks, Manchester* .... *C.*
*1884 Hickson, Prof. Sydney J., M.A., D.Sc., F.R.S., *Ellesmere House, Wilenslow Road, Withington, Manchester*... *ann.*
1897 Hodgson, T. V., 7, *Addison Road, Plymouth*...................................... *ann.*
1884 Holdsworth, E. W. H., F.L.S., F.Z.S., *Lucerne House, Dartmouth* . .... *ann.*
1893 Holt, Mrs. Vesey W., 104, *Elm Park Gardens, S.W.* .... *ann.*
1887 Howes, Prof. G. Bond, F.R.S., F.L.S., *Science and Art Department, South Kensington* .... *ann.*
1884 Hudleston, W. H., M.A., F.R.S., 8, *Stanhope Gardens, South Kensington, S.W.* .... *ann.*

1891 Indian Museum, *Calcutta* .... *ann.*
1888 Inskip, Capt. G. H., R.N., 22, *Torrington Place, Plymouth* .... *ann.*

1885 Jackson, W. Hatchett, M.A., F.L.S., *Pen Wartha, Weston-super-Mare* ann.
1893 Jago, Edward, *Menheniot, Cornwall* .... ann.
1887 Jago-Trelawny, Major-Gen., F.R.G.S., *Coldrenick, Liskeard* .... C.
1890 Johnson, Prof. T., D.Sc., F.L.S., *Royal College of Science, Dublin*......... ann.
1892 Joshua, Mrs., 57, *Cadogan Square, S.W.* .... ann.
1894 Justen, F. W., F.Z.S., c/o Dulau and Co., 37, *Soho Square, W.* .... ann.

1884 Kellock, W. B., F.L.S., F.R.C.S., 94, *Stamford Hill, N.*..................... ann.

1897 Lanchester, W. F., B.A., *King's College, Cambridge* .... C.
1885 Langley, J. N., F.R.S., *Trinity College, Cambridge* .... C.
1885 Lea, A. S., M.A., *Caius College, Cambridge* .... ann.
*1895 Lister, J. J., M.A., *St. John's College, Cambridge* .... ann.
1888 Lopes, The Rt. Hon. Sir Massey, Bart., *Maristow, Roborough, South Devon* .... ann.

1885 Macalister, Prof. A., F.R.S., *St. John's College, Cambridge* .... ann.
1884 Mackrell, John, *High Trees, Clapham Common, S.W.* .... C.
1886 MacMunn, Charles A., *Oak Leigh, Wolverhampton* .... ann.
1889 Makovski, Stanislaus, *Fairlawn, Red Hill* ... . ann.
1885 Marr, J. E., M.A., *St. John's College, Cambridge* .... C.
1884 Mason, Philip Brookes, *Burton-on-Trent* .... ann.
1884 McAndrew, James J., *Lukesland, Ivybridge, South Devon* .... ann.
1884 McIntosh, Prof. W. C., F.R.S., 2, *Abbotsford Crescent, St. Andrews, N.B.* C.
1884 Michael, Albert D., *Cadogan Mansions, Sloane Square, S.W.*............... C.
1885 Mocatta, F. H., 9, *Connaught Place, W.* .... C.
1886 Mond, Ludwig, F.R.S., 20, *Avenue Road, Regent's Park, N.W.*............ C.
1884 Morgan, Prof. C. Lloyd, *University College, Bristol* .... ann.
1891 Morgans, Thomas, 60, *Queen Square, Bristol*.................................... ann.
†1889 Morley, The Rt. Hon. the Earl of, 31, *Prince's Gardens, S.W.* .... ann.
1885 Morrison, Alfred, 16, *Carlton House Terrace* ....£52 10s.
*1896 Murray, Sir John, K.C.B., F.R.S., *Challenger Lodge, Wardie, Edinburgh* ann.

†1884 Newton, Prof. Alfred, M.A., F.R.S., *Magdalen College, Cambridge* £20
†1884 Norman, Rev. Canon, M.A., D.C.L., F.R.S., *The Red House, Berkhamsted, Herts.* .... ann.

1884 Ommanney, Admiral Sir Erasmus, K.C.B., F.R.S., 29, *Connaught Square, W.* .... ann.

1885 Paget, Sir James, Bart., F.R.S., 5, *Park Place, W.*............................ C.
1898 Parkinson, J., 251, *Camden Road, London, N.*.................................. ann.
1884 Parsons, Chas. T., *Norfolk Road, Edgbaston, Birmingham* .... ann.
1888 Pennsylvania, University of, *Philadelphia, U.S.A*............................ ann.
1885 Phillips, Chas. D. F., M.D., 10, *Henrietta Street, Cavendish Square, W.* C.
1887 Phipson, Mrs., *Cumballa Hill, Bombay* .... ann.
1886 Power, Henry, F.R.C.S., 37A, *Great Cumberland Place, W.* .... ann.
1885 Pritchard, Prof. Urban, 26, *Wimpole Street, W.* .... ann.
1884 Pye-Smith, P. H., M.D., 48, *Brook Street, W.* .... C.

1897 Quentin, C., *Milland, Liphook, Hants.* .... ann.
1893 Quintin, St. W. H., *Scampstone Hall, Rillington, Yorks* .... ann.

1884 Radford, Daniel, *Mount Tavy, Tavistock* .... ann.
1884 Ralli, Mrs. Stephen, 32, *Park Lane, W.* £30
1885 Ransom, W. B., *The Pavement, Nottingham* .... C.
1893 Rashleigh, E. W., *Kilmarth, Par Station, Cornwall* .... ann.
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OBJECTS

OF THE

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THE ASSOCIATION was founded at a Meeting called for the purpose in March, 1884, and held in the Rooms of the Royal Society of London.

The late Professor HUXLEY, at that time President of the Royal Society, took the chair, and amongst the speakers in support of the project were the Duke of ARGYLL, the late Sir LYON PLAYFAIR, Sir JOHN LUBBOCK, Sir JOSEPH HOOKER, the late Dr. CARPENTER, Dr. GÜNTHER, the late Lord DALHOUSIE, the late Professor MOSELEY, the late Mr. ROMANES, and Professor LANKESTER.

The Association owes its existence and its present satisfactory condition to a combination of scientific naturalists, and of gentlemen who, from philanthropic or practical reasons, are specially interested in the great sea fisheries of the United Kingdom. It is universally admitted that our knowledge of the habits and conditions of life of sea fishes is very small, and insufficient to enable either the practical fisherman or the Legislature to take measures calculated to ensure to the country the greatest return from the "harvest of the sea." Naturalists are, on the other hand, anxious to push further our knowledge of marine life and its conditions. Hence, the Association has erected at Plymouth a thoroughly efficient Laboratory, where naturalists may study the history of marine animals and plants in general, and where, in particular, researches on food fishes and molluscs may be carried out with the best appliances.

The Laboratory and its fittings were completed in June, 1888, at a cost of some £12,000. Since that time investigations, practical and scientific, have been constantly pursued at Plymouth. Practical investigations upon matters connected with sea-fishing are carried on under the direction of the Council; in addition, naturalists from England and from abroad have come to the Laboratory, to carry on their own independent researches, and have made valuable additions to zoological and botanical science, at the expense of a small rent, for the use of a working table in the Laboratory, and other appliances. The number of naturalists who can be employed by the Association in special investigations on fishery questions, and definitely retained for the purpose of carrying on those researches throughout the year, must depend on the funds subscribed by private individuals and public bodies for the purpose. The first charges on the revenue of the Association are the working of the sea-water circulation in the tanks, stocking the tanks with fish and feeding the latter, the payment of servants and fishermen, the hire and maintenance of fishing boats, and the salary of the Resident Director and Staff. At the commencement of this number will be found the names of the gentlemen on the staff. In no case does any one salary exceed £250.

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