

North Sea Investigations.

(CONTINUED.)

By

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I. THE SIZE OF MATURE PLAICE, TURBOT, AND BRILL, ON DIFFERENT FISHING GROUNDS.

IN the previous number of the Journal, I described my reasons for doubting whether the conclusions drawn by Mr. Holt, concerning the size at which plaice become mature, would hold good for the whole of the North Sea; and also whether the evidence he relied upon, in distinguishing mature and immature plaice, was sufficient. I stated that, as an actual fact, one sample of mature plaice, which were much below the limits of size determined by Mr. Holt, had come into my hands. I suggested, as a probability, that the presence of dead degenerating eggs in the tissue of the ovary was a proof that the fish had spawned, was a spent, and therefore a mature specimen. My words were: "It cannot be asserted as a certainty that these granular masses never occur in an immature ovary; to settle the doubt it will be necessary to make a careful examination of plaice in November and December, when all fish which are about to spawn will have a large amount of yolk in the eggs, and all fish in which the eggs are transparent and yolkless must be immature." It was already known that these degenerating eggs do occur in spent ovaries, from which the ripe eggs have recently been discharged, and which bear

evidence of the fact in their somewhat large size, flaccid and collapsed condition, and usually in the presence of a few detached ripe eggs in their interior. Observers were agreed that the explanation of this fact was that when spawning was finished, a certain number of eggs were still only partly developed, and that these, instead of completing their development, degenerated, and were gradually removed by absorption in their place without being discharged. It seemed natural to infer, therefore, that in every ovary in which microscopic examination showed the presence of these degenerating eggs, spawning had previously occurred.

This supposition has proved, however, to be incorrect. The granular opaque masses have been found in the ovaries of the plaice in every month of the year from February to December, and in November and December have been found to occur nearly always in ovaries, which showed no trace of the development of yolk in the healthy eggs, which were, therefore, undoubtedly immature, the mature ovaries at this time being much enlarged and far-advanced in development. At this time no fish had begun to spawn, and none were in the spent condition. It is clear, then, that aborted partially yolked eggs do occur in immature ovaries. In different specimens these aborted eggs are seen in different stages of degeneration, and it is evident that in an immature ovary a small number of eggs are constantly beginning to develop yolk, as though about to become ripe eggs, but almost immediately die and degenerate instead of continuing their development. The same process is going on in mature ovaries between the spawning seasons. When the fish becomes mature, then some months before the spawning season a large number of eggs continue to develop without check or interruption until the crop of ripe eggs is produced.

The plaice which, on February 27 last, I found to be mature at sizes below Mr. Holt's limits, were said to have been caught off the Leman Shoal, at a depth of 12 to 17 fathoms. I do not feel sure that this was really their place of capture, for reasons which will appear in the sequel. But I have found that the plaice, taken by the Lowestoft trawlers in the neighbourhood of the Brown Ridges, are certainly mature at sizes similar to those which characterise the sample mentioned, and considerably below Mr. Holt's limits. On October 2nd, I made a complete examination at Lowestoft of a box of plaice from the Brown Ridges. As it was so considerable a time before the commencement of the spawning season, I did not attempt to distinguish between mature and immature males. But in many of the females yolk-formation had distinctly commenced, or was even somewhat advanced, and these I put down as mature, the others as immature. The results are as shown in the following table:—

BOX OF PLAICE FROM BROWN RIDGES, OCTOBER 2ND, 1895.

Total number, 176.

Length in inches.	Males.		Females.				Totals.	
			Mature.		Immature.			
9	...	1	...	1 (9 $\frac{3}{4}$ in.)	...	2	...	4
10	...	6	...	—	...	12	...	18
11	...	25	...	6	...	24	...	55
12	...	27	...	12	...	24	...	63
13	...	10	...	14	...	5	...	29
14	...	2	...	1	...	—	...	3
15	...	—	...	—	...	—	...	—
16	...	—	...	3	...	—	...	3
17	...	—	...	—	...	—	...	—
18	...	—	...	—	...	—	...	—
19	...	—	...	1	...	—	...	1
		71		38		67		176

(40·3 per cent.) (21·6 per cent.) (38·1 per cent.)

On November 18, I examined another sample, sent from Lowestoft to me in London. The information given me, concerning the place of capture, was that it was on the track of the Harwich boats, nearer the Dutch than the English coast. This would be somewhere to the west of the Hook of Holland. The condition of these plaice was as shown in the following table:—

PLAICE FROM LOWESTOFT, NOVEMBER 18TH, 1895.

Total number, 197.

Length in inches.	Males.				Females.				Totals.	
	Mature.		Immature.		Mature.		Immature.			
8	...	—	...	1	...	—	...	—	...	1
9	...	6	...	9	...	—	...	4	...	19
10	...	17	...	14	...	2	...	21	...	54
11	...	21	...	7	...	12	...	27	...	67
12	...	17	...	4	...	11	...	9	...	41
13	...	4	...	—	...	5	...	1	...	10
14	...	1	...	—	...	1	...	—	...	2
15	...	1	...	—	...	—	...	—	...	1
16	...	—	...	—	...	1	...	—	...	1
17	...	—	...	—	...	—	...	—	...	—
18	...	—	...	—	...	1	...	—	...	1
		67		35		33		62		197

(34 per cent.) (17·8 per cent.) (16·7 per cent.) (31·5 per cent.)

It is possible that, in this last sample, some of the males set down as immature would have become mature before the end of the spawning season, but this is not a question of great importance. In both samples

the limits of maturity and immaturity in the females agree with those seen in the sample examined at Grimsby: these limits are 9 in. and 14 in. Below 9 in. no females are mature, above 14 in. none immature. The limits at Plymouth were almost exactly the same, except that three specimens were found to be immature at 14 in. Mr. Holt's limits, on the other hand, were 13 in. and 18 in., so that there is a difference of 4 in. between both the upper and lower limits in the two cases. There is every reason to believe that the maximum size actually attained by the fish corresponds to the size at which it begins to spawn. As a matter of observation we find that the largest plaice caught in the neighbourhood of the Brown Ridges are considerably smaller than the largest caught on grounds further to the north. The largest plaice in the samples above described does not exceed 20 in. in length.

The ground named extends between thirty and fifty miles from the Dutch Coast, and to a great distance in a north and south direction. It is limited by the "edge of the deep water" towards the English coast, and this boundary (the twenty fathom line) lies at about fifty-five miles from the coast of Norfolk. The ground is undulating, being traversed by ridges running north and south, over which the depth decreases to a minimum of 11 fathoms, while, in the valleys between, there is, in some places, a depth of 24 fathoms. The ground is therefore neither uniformly shallow, nor close to the land.

I was strongly inclined to think that the small plaice of the German Bight would prove to be of the same character as those from the Brown Ridges. My theory was that the race of smaller plaice actually proved to exist off the coast of Holland would be found to extend along the Dutch and German coasts, probably as far as the Horn Reef, and that this would be the explanation of the small size of the plaice landed at Hull and Grimsby, from the German or Heligoland Bight. In order to examine samples of the plaice caught on these eastern grounds in November and December, I considered whether it would be advisable to go to the Biological Station of Heligoland, or to some fishing port on the German coast, or to have samples sent over the sea to me in London. I made enquiries from Dr. Heincke, the Director, and Dr. Ehrenbaum, the Zoologist of the Biological Station, and have much pleasure in here expressing my thanks for the courtesy and thorough efficiency with which they assisted me to obtain the facilities I required. They informed me that plaice were not landed in Heligoland regularly or in large numbers, but that they would assist me in my undertaking if I visited one of the fishing ports on the mainland. I thought, however, that, under the circumstances, I might just as well have samples sent to me in London, and accordingly Dr. Ehrenbaum put me in communication with Herr Düge, the harbour-master at Geestemünde.

who undertook to forward me samples of plaice, with most careful attention to all the precautions and conditions I required. The first sample reached me on November 20th, and the following table shows the result of their examination :—

PLAICE FROM GEESTEMÜNDE, NOVEMBER 20TH, 1895.

Total number, 186.

In.	Males.				Females.				Total.
	Mature.		Immature.		Mature.		Immature.		
10	—	...	5	...	—	...	2	...	7
11	2	...	43	...	1	...	35	...	81
12	7	...	27	...	—	...	36	...	70
13	1	...	3	...	—	...	17	...	21
14	—	...	—	...	—	...	2	...	2
15	—	...	—	...	—	...	—	...	—
16	1	...	—	...	—	...	—	...	1
17	1	...	—	...	—	...	—	...	1
18	—	...	—	...	1	...	—	...	1
19	—	...	—	...	—	...	—	...	—
20	—	...	—	...	2	...	—	...	2
	12		78		4		92		186

(6.5 per cent.) (41.9 per cent.) (2.1 per cent.) (49.5 per cent.)

It will be seen, at once, what a striking contrast these fish present to those from the grounds south of the Texel. The single mature specimen at 11 in. is of no importance in comparison with the large numbers of immature. We may say that all below 15 in. were immature, so that they correspond very closely with the plaice examined by Mr. Holt, at Grimsby.

Among the males there are a larger proportion mature at 12 and 13 in. than Mr. Holt found, but in the females there is no evidence of maturity at a smaller size than that fixed by him. We must conclude, then, that these fish are small because they are young and immature, not because they are of a smaller race. These fish were stated by Herr Düge to have been caught at 53° 58' north latitude and 7° 10' east longitude from Greenwich, a position about 15 miles north of the island of Nordeney, at a depth of 13 to 14 fathoms.

In a letter which I received on December 5th, Herr Düge informed me that among the plaice landed at Geestemünde, he found the smallest ripe males were 32 cm. long (12½ in.), the smallest mature females 40 cm. (16 in.), an observation which agrees with the results of my examination of the German plaice in London.

The above sample does not afford complete evidence concerning the range of size, or the proportional numbers at different sizes, of the plaice taken on the ground from which it came, because it consists, as Herr

Düge informed me, of the marketable fish selected from the whole number brought up by the trawl, the smaller being rejected. This, of course, makes no difference with regard to the minimum size of mature specimens; all those rejected less than 10 in. in length must have been immature. The smaller fish, which were thrown overboard, however, when the sample was taken, were stated to be very few in number, although Herr Düge tells me that it sometimes happens, even in winter, that, in the same locality, plaice mostly from 9 to 12 in. in length are taken.

I was desirous of obtaining a sample sent, without selection, just as they came on deck, and Herr Düge was good enough to send me a second consignment. These fish were trawled on December 20th, in 54° 35' north latitude, 7° 40' east longitude, at a depth of 11 fathoms. This position is about 24 miles from the Amrum Light, and in the very same neighbourhood in which the steam trawler, *John Bull*, was fishing, in June, when I was on board her. The sizes and conditions of these fish are shewn below:—

PLAICE FROM GEESTEMÜNDE, DECEMBER 20TH, 1895.

Total number, 121.

In.	Males.				Females.				Total.	
	Mature.		Immature.		Mature.		Immature.			
9	...	—	...	1	...	—	...	—	...	1
10	...	—	...	4	...	—	...	1	...	5
11	...	—	...	5	...	—	...	6	...	11
12	...	—	...	7	...	—	...	17	...	24
13	...	2	...	8	...	—	...	35	...	45
14	...	3	...	3	...	—	...	13	...	19
15	...	—	...	1	...	1	...	7	...	9
16	...	—	...	—	...	—	...	4	...	4
17	...	—	...	—	...	1	...	—	...	1
18	...	1	...	—	...	—	...	—	...	1
19	...	—	...	—	...	1	...	—	...	1
		6		29		3		83		121

(4.9 per cent.) (24 per cent.) (2.5 per cent.) (68.6 per cent.)

It will be seen that these unselected plaice were, on the whole, not smaller, but somewhat larger than those in the previous sample from German waters, and with the quite insignificant exception of the one specimen at 9 inches, did not include any smaller specimens. With regard to immaturity, the second sample agrees with the first, no less than 92.6 per cent. of the whole number being immature. In both samples the proportion of mature female specimens below 18 inches is even distinctly lower than in Mr. Holt's records taken at Grimsby.

A comparison between these plaice, caught off the German coast in November and December, and those which I have described in the previous number of the Journal, as caught under my own observation in June, in the same neighbourhood, is worthy of careful attention. Firstly, with regard to the locality of capture. The position given by Herr Düge, for the second sample, is 24 miles west of Amrum Light; and in the cruise of the *John Bull*, the Amrum Light was seen, on two nights, at a distance of 20 miles. Thus, the *John Bull* was fishing on these occasions 4 miles nearer the land, and it is true that sometimes she was steered nearer the land than this; but she was also fishing sometimes out of sight of the Amrum Light, and the ground she covered must have included the position where the December sample was taken. Next, with regard to the depth: during the fishing of the *John Bull*, it varied from $7\frac{1}{2}$ to $12\frac{1}{2}$ fathoms, while the December sample was taken at 11 fathoms. At the seventh haul in the record of the trip of the *John Bull* the depth was 12 fathoms, and at this haul a number of plaice, $7\frac{1}{2}$ to 10 inches long, were taken, two baskets 10 to 12 inches long, and two baskets 12 to 15 inches long. The comparison shows, therefore, that although the *John Bull* extended her operations to positions nearer the land than that where the December sample was taken, yet it is clear that she also fished at the same depth and distance from land, and obtained there numbers of plaice of small sizes, which are not represented in that sample. On the other hand, the December sample includes specimens larger than any taken on the same ground in June, when the maximum was $16\frac{3}{4}$ inches. It appears to me quite probable that these differences are due simply to the growth of the fish in the six months' interval. We must either conclude that the fish taken on the German grounds in early summer are of the same race as those taken in December, and therefore, with the exception of a small minority, principally males, immature; or we must suppose that they are fish of a smaller race which migrate to these grounds from some other, *e.g.*, more southern region. This latter supposition is at present unsupported by any evidence, and I think we must seek to explain the facts on the view that the summer and winter fish are of the same race. This is not difficult, if we suppose that the smaller fish—6 to 10 inches long—are the year-old fish, which move out from the shallow inshore waters on to those grounds at the beginning of their second summer. The larger immature fish, broadly speaking, from 10 to 15 inches long, must be two-year-old fish, while the number of mature fish over three years is in small proportion. The dispersal of the year-old fish to greater distances from land, and their gradual increase in size, would account for the fact that the fish on the Eastern Grounds become

both much less numerous, and generally larger in late summer and autumn.

I have found that the condition of the plaice along the English coasts of Norfolk and Suffolk is not the same as along the opposite Dutch coast. It would appear that the Channel conditions extend northwards along the Dutch coast, while the size of the mature plaice, which is characteristic of more northern grounds, extends southwards to some distance along the English coast. Some of the Lowestoft smacks were fishing in October, near the Leman Shoal, and on neighbouring grounds, and were landing plaice considerably larger than those from the Brown Ridges. I examined a box of these large plaice on October 4th, in the same week in which I examined the sample from the Brown Ridges. The results were as follows:—

PLAICE FROM LEMAN SHOAL, OCTOBER 4TH, 1895.

Total number, 115.

Length in inches.	Males.	Females.		Totals.
		Mature.	Immature.	
9 ...	1 ...	— ...	— ...	1
10 ...	5 ...	— ...	4 ...	9
11 ...	15 ...	— ...	6 ...	21
12 ...	6 ...	1 (12 $\frac{7}{8}$ in.) ...	9 ...	16
13 ...	14 ...	— ...	7 ...	21
14 ...	7 ...	5 ...	5 ...	17
15 ...	4 ...	8 ...	1 ...	13
16 ...	— ...	6 ...	2 ...	8
17 ...	— ...	5 ...	— ...	5
18 ...	— ...	3 ...	— ...	3
19 ...	— ...	— ...	— ...	—
20 ...	— ...	— ...	— ...	—
25 ...	— ...	1 ...	— ...	1
	52	29	34	115

(45·2 per cent.) (25·2 per cent.) (29·6 per cent.)

The Leman Shoal is somewhat further north than the Brown Ridges, being in the same latitude as the island of Texel, and the depth in its neighbourhood does not exceed 20 fathoms. The contrast between these plaice and those from the Brown Ridges is very marked. It will be seen that the proportion of mature females among the former is not much greater, 25·2 per cent., as compared with 21·5 per cent. of those from the Brown Ridges. If we take the females separately, the proportion of mature individuals among these is certainly higher in the sample from the Leman Shoal, *i.e.* the sample of larger fish: it is 46 per cent. among these, 36·1 per cent. among the fish from the Brown Ridges. But this is not a very great difference, and appears to be due chiefly to the fact

that, in the one sample, there were more males and fewer immature females than in the other. The general difference in size in the two samples is sufficiently obvious from the fact that one box contained 176 fish, the other only 115, the box in both cases being of the same size. If we compare the limiting sizes of the mature and immature, they are 9 in. and 14 in. in the case of the smaller, 12 in. and 17 in. in that of the larger, a difference of 3 in. By limiting sizes, I mean the smallest mature and largest immature. Thus the relation of size to maturity in the Leman Shoal plaice agrees closely with that observed by Mr. Holt at Grimsby.

I have endeavoured to obtain samples of plaice from the English side, further south than the Leman Shoal. Opposite the coasts of Norfolk and Suffolk there is a depression of the sea-bottom, ranging from 20 to 27 fathoms in depth, its eastern boundary being about midway between the English and Dutch coasts. I tried to obtain a sample taken in this deep water. The box that was sent to me from Lowestoft, in response to a request to this effect, was stated to have been taken 40 to 45 miles E.S.E. of Lowestoft, a position which would be near the eastern limit of the deep water.

The fish proved, on examination, to be much more immature than the samples from more eastern grounds already described, although, if the place of capture is correctly reported, it is only about 20 miles further from the Dutch coast than the Brown Ridges, where the smaller fish were taken. The sizes and condition were as here shown.

PLAICE CAUGHT 40 TO 45 MILES E.S.E. OF LOWESTOFT, DEC. 23RD, 1895.

Total number, 132.

In.	Males.				Females.				Totals.
	Mature.		Immature.		Mature.		Immature.		
9	—	...	1	...	—	...	2	...	3
10	—	...	9	...	—	...	7	...	16
11	9	...	9	...	—	...	9	...	27
12	8	...	5	...	1	...	23	...	37
13	6	...	4	...	1	...	14	...	25
14	—	...	1	...	—	...	7	...	8
15	2	...	—	...	1	...	1	...	4
16	5	...	—	...	2	...	—	...	7
17	—	...	—	...	3	...	—	...	3
18	—	...	—	...	2	...	—	...	2
	30		29		10		63		132

(22·7 per cent.) (22 per cent.) (7·5 per cent.) (47·8 per cent.)

This sample is intermediate in its limiting sizes between the Dutch plaice and the more northern plaice, the limits being 12 in. and 16 in. for females.

In order to make a direct comparison between the samples already mentioned with one from more northern grounds, I obtained a box from Billingsgate. Mr. Richard Vivian, agent of the Hull Steam Fishing and Ice Co., kindly undertook to send me a box, with reliable information concerning the ground on which the fish were taken, and was in a position to obtain this information from the master of the steam carrier which brought the fish from the fishing fleet to London. Accordingly I received, on December 6th, a box of plaice which had been trawled on the south side of the Dogger Bank, in 55° 20' north latitude, 4° 30' east longitude, at a depth of 24 fathoms.

The following is the record of the sizes and condition in this sample:—

PLAICE FROM SOUTH SIDE OF NORTH-EASTERN PORTION OF THE DOGGER BANK, 24 FATHOMS, DECEMBER 6TH, 1895.

Total number, 68.

In.	Males.				Females.				Totals.
	Mature.	Immature.		Mature.	Immature.				
10	—	...	4	...	—	...	2	...	6
11	—	...	4	...	—	...	8	...	12
12	1	...	3	...	—	...	2	...	6
13	—	...	7	...	—	...	3	...	10
14	2	...	1	...	—	...	6	...	9
15	3	...	1	...	—	...	4	...	8
16	9	...	—	...	1	...	1	...	11
17	1	...	—	...	1	...	1	...	3
18	—	...	—	...	—	...	—	...	—
20	—	...	—	...	—	...	—	...	—
21	—	...	—	...	2	...	—	...	2
23	—	...	—	...	1	...	—	...	1
	16		20		5		27		68

(23·5 per cent.) (29·4 per cent.) (7·4 per cent.) (39·7 per cent.)

The upper limit of the immature here is as high as in Mr. Holt's results; the lower limit of the mature is unusually high. The reason of the latter fact is to be found in the small number of specimens at each size in the sample. Mr. Vivian informed me that the plaice were packed in two sets, some boxes containing only large fish, others containing mixed sizes. My sample was one of the latter. We cannot, therefore, look upon this sample as representing the general condition of the plaice caught on the ground from which it came, but it is important to notice that considerable numbers of plaice from 10 in. to 13 in. long, and quite immature, are caught right in the middle of the North Sea, about 150 miles from the coast either on the east or west.

The sizes and conditions of the turbot and brill which I examined in May and June last year, are shown in the two tables here given. Most of them were examined on board the two trawlers on which I made the two voyages described in the previous number of the Journal; but in addition are included 20 brill from the same grounds, which I examined on shore. Some smaller specimens, which were only 8 and 9 in. long, were measured, but their sex not ascertained.

TURBOT ON THE GERMAN GROUNDS, SOUTH OF HORN REEF, AND OFF AMRUM,
7 TO 15 FATHOMS, MAY AND JUNE, 1895.

In.	Males.				Females.			
	Mature.	Immature.			Mature.	Immature.		
11	...	1	...	—	...	—	...	1
12	...	1	...	—	...	—	...	2
13	...	14	...	—	...	—	...	2
14	...	10	...	—	...	1	...	5
15	...	1	...	—	...	—	...	4
16	...	2	...	—	...	—	...	—
17	...	—	...	—	...	—	...	—
18	...	—	...	—	...	—	...	—
19	...	3	...	—	...	—	...	—
20	...	4	...	—	...	1	...	—
21	...	1	...	—	...	—	...	—
22	...	—	...	—	...	2	...	—
23	...	—	...	—	...	—	...	—
24	...	—	...	—	...	2	...	—
25	...	—	...	—	...	1	...	—
26	...	—	...	—	...	—	...	—
27	...	—	...	—	...	1	...	—
28	...	—	...	—	...	1	...	—
29	...	—	...	—	...	3	...	—
30	...	—	...	—	...	—	...	—
31	...	—	...	—	...	1	...	—

BRILL ON THE GERMAN GROUNDS, SOUTH OF HORN REEF, AND OFF AMRUM,
7 TO 15 FATHOMS, MAY AND JUNE, 1895.

In.	Males.				Females.			
	Mature.	Immature.			Mature.	Immature.		
10	...	4	...	—	...	—	...	2
11	...	3	...	5?	...	—	...	16
12	...	1	...	2?	...	—	...	23
13	...	—	...	—	...	1	...	8
14	...	1	...	—	...	1	...	3
15	...	—	...	—	...	2	...	—
16	...	1	...	—	...	1	...	—
17	...	1	...	—	...	3	...	—
18	...	—	...	—	...	1	...	—
19	...	—	...	—	...	—	...	—
20	...	—	...	—	...	1	...	—

2 ft. 1½ in. female, not ripe.

Fifteen more hauls were made in or close to the Sole Pit with varying fortune, but several of them were failures, in consequence of the trawl catching fast and the net being torn. The ground in this part is rough, and necessitates short hauls and much net mending. The scruff was always abundant and of much the same composition. I made a careful examination of all the waste fish from one haul. The marketable fish from this haul was:—1 basket plaice, 1½ baskets kit haddock, ½ basket dabs and codling, ½ basket lemon soles and whiting, 14 soles, 2 cod, 1 crab, 12 small rays.

The waste fish filled nearly a basket, and comprised:—220 dabs, 3¼ in. to 10 in. long; 86 haddock, 7 in. to 11 in. long, measured to the end of the middle ray of the tail; 46 grey gurnard, 6¾ in. to 11¼ in. long; 11 codling, 5¾ in. to 10½ in. long; 3 whiting, 9¼ in. to 10 in.; 8 plaice, 8¼ in. to 10 in.; 7 lemon soles, 7 in. to 10 in., the smallest a ripe male; 3 scad, 11½ in. to 12½ in.; 1 bib (*Gadus luscus*), 6¾ in.;

II.—OBSERVATIONS AT SEA AND IN THE MARKETS.

1. *Grimsby.*

At Grimsby there are a number of trawlers—some steamers and some sailing vessels, which are locally called Cleethorpers, and regularly fish on the grounds near the Humber, returning to port at the end of the week. I went out in one of these, the s.s. *Rhine*, on July 22nd. My object was to examine the grounds near the mouth of the Humber and the Wash, in order to compare them with the grounds off the German coast. We shot the trawl at 2 p.m. the same day, having steamed 55 miles by the log from the Newsand Lightship, at a position a few miles west of the Coal Pit or N.E. Hole, as it is named on the chart illustrating Mr. Holt's description of the Grimsby Trawl Fishery. The depth during the haul was 13 to 18 fathoms. The temperature at the surface was 58° F.

The trawl was hauled up at 7.15 p.m. The scruff was plentiful, and consisted of Hydroids, chiefly *Sertularia* and *Hydrallmania*. *Alcyonidium*, called by the fishermen "curly cabbage," was also extremely abundant. Another Polyzoan, namely *Crisia*, was plentiful, and there were many *Solaster papposus*. The quantity of marketable fish was very small. The smallest plaice was 8 $\frac{3}{4}$ in. long, and there were 7 from this size to 10 $\frac{3}{4}$ in.; these were thrown overboard. Some lemon soles 8 $\frac{3}{4}$ to 9 $\frac{1}{2}$ in., a few haddock of 8 $\frac{1}{2}$ in., and some small dabs 6 $\frac{1}{2}$ in., were also rejected. The fish packed away were:—1 basket plaice, $\frac{1}{2}$ basket haddock, $\frac{1}{4}$ basket lemon soles and whiting, $\frac{1}{2}$ basket dabs, with a few codling, 4 soles. There were also 10 roker, or rays, and 1 lobster, 10 in. long.

The next haul we steered N., down the Coal Pit, and sounded 22 $\frac{1}{2}$ fathoms. The trawl was hauled at 11.30 p.m. The scruff again was very abundant, consisting chiefly of the *Alcyonidium*; Hydroids also were very plentiful. There were present also *Alcyonium*, compound Ascidians, and *Solaster papposus*. Among the Hydroids were large clusters of *Antennularia antennina*.

The smallest plaice was 8 $\frac{1}{4}$ in. long; smallest haddock 7 $\frac{3}{4}$ in.; smallest whiting 8 $\frac{1}{4}$ in.; smallest lemon sole 7 $\frac{3}{4}$ in., a female, immature.

There were 1 solenette 3 $\frac{3}{4}$ in., a mature female, and 2 others; 1 latchet, a small specimen; 1 scad (*Caranx trachurus*), 1 cod, and 2 rays. The other marketable fish were:— $\frac{3}{4}$ basket plaice, $\frac{1}{4}$ basket haddock, $\frac{1}{4}$ basket dabs, $\frac{1}{4}$ basket lemon soles and whiting.

Third haul, also in Coal Pit, 11.45 p.m. to 5.0 a.m. on Tuesday. As before, a large quantity of scruff and a small quantity of fish. Besides the other items seen in the scruff before, there were several

sea-urchins (*Echinus miliaris*). Of the fish, a basketful of small haddock, whiting, and dabs, and a few small gurnard, were thrown overboard; the small haddock measured $6\frac{3}{4}$ to $8\frac{1}{4}$ in., there being only 2 or 3 of marketable size. The smallest dab was 5 in., a male, the largest $14\frac{1}{2}$ in., a female. The smallest plaice was $7\frac{1}{2}$ in., a female, the largest $20\frac{1}{2}$ in., but only 2 were small enough to be thrown overboard. The marketable fish were:—1 basket plaice, $\frac{1}{4}$ basket dabs, 6 rays, and 4 lemon soles.

Fourth haul, in the Sole Pit which lies to the N.W. of the Coal Pit, and has a maximum depth of 43 fathoms. We sounded 40 fathoms once, and afterwards $13\frac{1}{2}$ fathoms. The trawl was hauled at 8.30 a.m. There was less scruff than before, but *Alcyonium*, or "teats," were very plentiful in it. Only a small quantity of fish. The smallest plaice was 10 in., an immature female; there were altogether 28 females, the largest $21\frac{1}{2}$ in.; 19 males, the largest $20\frac{1}{2}$ in. There were a few lemon soles, haddock, roker, cod, grey gurnard, and dabs. Up to this time we had not taken a turbot or brill.

Fifth haul, 11.30 a.m., June 23rd, to 4.30 p.m., along the east side of the Sole Pit. Scruff as usual, with the addition of whelk-spawn and *Flustra*, sometimes known to the fishermen as "scented weed."

The smallest plaice was $9\frac{1}{2}$ in., and only one thrown over: largest $21\frac{1}{4}$ in. Some small haddocks $8\frac{1}{2}$ in. Smallest lemon sole $8\frac{1}{4}$ in. The fish thrown away were $\frac{1}{4}$ basketful of small haddocks, whiting, gurnards, dabs, the haddocks up to $10\frac{1}{2}$ in., dabs up to $9\frac{1}{2}$ in., and all the grey gurnard. The fish kept were $1\frac{1}{4}$ baskets plaice, 1 basket kit haddock, $\frac{1}{4}$ basket dabs and codlings, $\frac{1}{4}$ basket whiting and lemon soles, 3 small roker (*Raia clavata*), and 2 turbot, one 22 in. male, ripe; one 2 ft. $1\frac{1}{2}$ in. female, not ripe.

Fifteen more hauls were made in or close to the Sole Pit with varying fortune, but several of them were failures, in consequence of the trawl catching fast and the net being torn. The ground in this part is rough, and necessitates short hauls and much net mending. The scruff was always abundant and of much the same composition. I made a careful examination of all the waste fish from one haul. The marketable fish from this haul was:—1 basket plaice, $1\frac{1}{2}$ baskets kit haddock, $\frac{1}{2}$ basket dabs and codling, $\frac{1}{2}$ basket lemon soles and whiting, 14 soles, 2 cod, 1 crab, 12 small rays.

The waste fish filled nearly a basket, and comprised:—220 dabs, $3\frac{1}{4}$ in. to 10 in. long; 86 haddock, 7 in. to 11 in. long, measured to the end of the middle ray of the tail; 46 grey gurnard, $6\frac{3}{4}$ in. to $11\frac{1}{4}$ in. long; 11 codling, $5\frac{3}{4}$ in. to $10\frac{1}{2}$ in. long; 3 whiting, $9\frac{1}{4}$ in. to 10 in.; 8 plaice, $8\frac{1}{4}$ in. to 10 in.; 7 lemon soles, 7 in. to 10 in., the smallest a ripe male; 3 scad, $11\frac{1}{2}$ in. to $12\frac{1}{2}$ in.; 1 bib (*Gadus luscus*), $6\frac{3}{4}$ in.;

2 solenettes; 3 *Trachinus vipera*, the lesser weever; 2 thornback rays, 8 in. to 9½ in. across pectorals; 1 long rough dab, 9 in. long.

Plaice up to 24 in. and 26 in. in length occurred in these hauls, and as in the above instance only an insignificant number under 10 in., which were thrown overboard.

After this a haul was made 7 or 8 miles to the east of the Dowsing Lightship, at a depth of 9 to 11 fathoms. The marketable fish caught were:—1¼ baskets plaice, 1¼ baskets lemon soles, codling, and haddock mixed; 2 rays, 2 brill 23¾ in. long. The largest plaice was 24 in., and 4 plaice of 9 in. were thrown overboard.

There was an extraordinary quantity of *Alcyonidium*, or "curly cabbage," about 1½ basketfuls, the scruff consisting almost entirely of this. One horse mussel (*Mytilus modiolus*), and 2 sunstars were seen.

At the next haul the trawl was down 6 hours, from 9 p.m., July 26th, to 3 a.m., July 27th. A still greater quantity of *Alcyonidium* was brought up—3 or 4 basketfuls. The fish were:—2 baskets plaice, ¾ basket kit haddock, ¾ basket lemon soles and whiting, ½ basket dabs and codling, 14 soles, largest 18½ in., smallest 7 in.; 2 cod, 1 ray, 8 crabs.

A basket of plaice is rather more than half a boxful, as the boxes are packed for sale, and the number in a basketful may therefore be estimated at about 50 fish.

Only two short hauls of no importance were made after this on the same ground, and then we returned to Grimsby.

It will be seen that the grounds visited in this voyage were all too far from the English coast to be considered as corresponding to the grounds visited in the s.s. *John Bull*. The nearest of them is the Outer Dowsing Ground; the Outer Dowsing Light is 30 miles from the nearest coast, and we fished on the farther side of the Lightship. The depth off the Dowsing was scarcely greater than off the Island of Amrum. We sounded 11 fathoms, and, doubtless, trawled in shallower water than that. The other grounds are narrow gullies, surrounded by fairly level ground less than 20 fathoms in depth. In the character of the bottom, these grounds differ very greatly from those visited in both my voyages on the German side. The latter were nearly all sandy, and very little scruff was brought up: pieces of *Flustra foliacea*, and *truncata*, and *Hydrallmania* were entangled in the net, but the total bulk was inconsiderable. On the English Grounds, on the contrary, the quantity of scruff was enormous, and indicates a coarse varied ground of stones and shells.

With regard to the character of the fish, the grounds above described resemble those to the south of the Horn Reef Lights, a voyage to which

was described by me in the previous number. That ground was farther seaward than the ground where the small plaice were taken; it was mostly from 24 to 30 miles from Blaavand Point, the nearest land, and the depth 11 to 15 fathoms. The plaice were in both voyages mostly between 12 and 26 inches in length, although about twice as abundant on the German side. The haddock, too, were abundant at the Horn Reef, scarce in the voyage of the *Rhine*, and most other kinds of fish were more abundant on the German Ground, but in the absence of small turbot and brill the two grounds agree. My expectation, therefore, of examining during the voyage of the *Rhine*, grounds which corresponded in their depth and distance from the Lincolnshire coast with the small plaice grounds to the north of Heligoland, was disappointed. Nor could I find other opportunities of making such an examination. I questioned some of the skippers of sailing smacks which fished the home grounds near the Humber, and was informed that they trawled chiefly in the Yorkshire Hole or Little Silver Pit, and the Westernmost Rough, grounds mostly about 20 miles from the coast. The plaice which I saw landed from these boats were small, but there was no great quantity of them, not more than one box from any one boat. Besides the plaice they had about 3 boxes of soles, 3 or 4 boxes of haddocks, and a few cod, lemon soles, and turbot. I bought a sample of the small plaice, and found there were 18 females $8\frac{1}{2}$ in. to $12\frac{1}{2}$ in. long; 19 males $8\frac{1}{2}$ in. to $12\frac{1}{4}$ in. long.

The evidence is, therefore, still incomplete, but as far as it goes it does not support a supposition I had formed that large plaice 20 in. and upwards were found in shallower water, and nearer the land on the English coast than on the German. This supposition was suggested to me by the fact that whereas only small plaice were brought from certain grounds on the German side, I could not discover that there were any grounds off the Lincolnshire coast where only small plaice were caught. At present we have no proof, however, that the larger plaice are to be taken at depths of 7 to 12 fathoms on the Lincolnshire coast. The shallow grounds, close to that coast, are not so extensive as on the German side, and according to my experience the Grimsby trawlers usually find more profitable fishing in the deep gullies, to which there is nothing corresponding on the German coast, and in which large plaice are taken. It may also be noticed that even in the voyage of the *John Bull* the small plaice became scarce as soon as the ship steamed to a somewhat greater distance from the land. Thus our course from the Spurn Lightship was E. $\frac{1}{2}$ S., which would take us to a position S.E. of the Sylt Island: at our first haul the depth was 13 to 14

fathoms, and we got none of the small plaice, that is to say, none under about 12 inches. The captain said we were 18 or 20 miles west of the Sylt, but this was merely an approximate estimate, and we were probably somewhat farther out. Again, in the fourth haul, the vessel was steered away from the coast out to the depth of 12 to 13 fathoms, and small plaice were taken in insignificant numbers.

2. Scarborough.

I was at Scarborough from August 12th to August 21st, and during that time was not entirely occupied in the study of the fishing industry. Consequently I do not pretend to give a complete description of the fishing at this place. Scarborough did not present any features of sufficient importance to demand a long and close investigation.

The harbour is small, and situated in the angle between the south side of the Castle Rock and the shore of the bay, which runs towards the south-east. A large number of drift-net boats belonging to Lowestoft were fishing out of Scarborough, and landing their catches there, but they did not use the harbour much, anchoring for the most part outside in the bay in the morning, and sailing out to shoot their nets in the evening. There were a considerable number, about twenty, of similar boats belonging to Scarborough. These had a fore-and-aft rig like the Lowestoft boats, with a foremast which could be lowered on to the deck. But I found that none of them were engaged in drift-net fishing: they were all employed in long lining. I asked a man belonging to one of them, why it was that Scarborough drift-net boats had thus abandoned the work for which they were built, and left the herring fishery in the neighbourhood, which was by no means unimportant, to be carried on entirely by boats from Lowestoft. He said the Scarborough boats could not make the herring fishing pay, and that the Lowestoft men only made a profit out of it because they fished on Sundays.

The real reason is probably that increasing competition has led to more complete specialisation in fishing operations. A few boats which remain at one station and change their mode of fishing according to the season, cannot compete with the large number of Lowestoft and Scotch boats, which are always employed in drift-net fishing, and fleets of which move from one part of the coast to another, making their headquarters wherever herring or mackerel are to be found at the time. The Scarborough boats were forced by circumstances, either to become nomads in the same way, or to find some other profitable employment, and they have found the latter in the long-lining which, in the deeper waters off the north-eastern

coast usually affords some return, while off the Norfolk and Suffolk coasts, the conditions favourable to long-lining do not exist.

I was told by a fish buyer that there were only eighteen sailing trawlers and nine or ten steamers belonging to Scarborough, and most of these were landing their fish elsewhere during the herring season. The fish trade at Scarborough Harbour is of no great extent, and when herrings are being landed there is very little market for trawl fish, the salesmen and buyers being unable to spare much attention for them. Many of the steamers are old paddle boats, but there are a few modern screw trawlers.

So far as I could ascertain the question of immature fish does not present itself in an acute form at Scarborough. Inshore trawling has been prohibited by a bye-law of the North-Eastern Committee. When I was there no hand-net shrimping was being carried on, the long-shore men being more profitably employed in taking out visitors to sail or to fish in the "cobles" and "mules," as the local shore boats are called. The trawlers fish for the most part in the neighbourhood of the port, on the Scarborough Off Ground, where, the depths being from 30 to 40 fathoms, the fish chiefly taken are large plaice, lemon soles, and haddocks. Plaice, from the German side or Eastern Grounds are not landed at Scarborough. Fishing for soles by hook and line is a remarkable local feature, not to be met with, I believe, anywhere else. I did not gain any personal experience of this mode of fishing, concerning which a good deal of information was indirectly given by Mr. Holt in his account of the Territorial Fishing Grounds of Scarborough in this Journal, Vol. III, p. 176. I ascertained, however, from one of the practitioners, that the instruments used are long lines, furnished with hooks at intervals, and set after sunset in the evening. The lines are of course on a much smaller scale in every way than those used in deep-sea work for larger fish. I examined the hooks, and found them to be 1 in. long and $\frac{3}{8}$ in. from the shank to the barb. The peculiar character of the narrow sandy wykes, supporting a numerous population of annelids, and so attracting numbers of soles in the summer season, is perhaps the reason of the development of line fishing for soles in this locality.

A Fishery Exhibition was held at Scarborough last season, and I had the pleasure of giving a short lecture at it daily for a week. It was organized by Mr. J. W. Woodall, and occupied a wooden building, specially erected for the purpose in that gentleman's grounds on the foreshore. Among the exhibits were a model of Captain Dannevig's Arendal Fish Hatchery, and the collection of various stages of marine food fishes and marine animals, specially mounted for exhibition by our Association.

3. *Hull.*

THE ADOPTION OF THE OTTER TRAWL IN STEAM TRAWLING.

When I was at Scarborough and Hull, last summer, a remarkable revolution was taking place in the steam trawling industry; the old-fashioned beam-trawl, previously in universal use, was being rapidly discarded and replaced by a beamless trawl constructed on the principle of the otter trawl, used formerly only by yachtsmen and amateurs, or for scientific purposes. The innovation was due to the ingenuity and enterprise of Mr. Scott, son of the manager of the General Steam Fishing Company, of Granton, on the Firth of Forth. The modification of the otter trawl, which Mr. Scott invented, will be understood from the following description, and the figures which accompany it, and which are reproduced from those circulated by the inventor's firm. The boards (Figs. 1 and 2) are each 10 feet long by $4\frac{1}{2}$ feet broad, shod with iron, and very thick and heavy. In the centre of the hinder edge of the board is fixed an iron ring, to which the ends of both the head-line and the foot-rope are attached. The head-line is 75 feet long, the ground-rope or foot-rope is 120 feet. The attachment of both head-line and ground-rope to a single ring placed at the end of the axis of the board, is one of the features in which the new gear differs from the ordinary otter trawl, and which are patented. In the ordinary otter-trawl the head-line is attached to the upper corner of the board, the foot-rope to the lower corner, and both are of the same length. Consequently the advantage of the beam-trawl in having the ground-rope, when the trawl is working, some distance behind the head-line, is lost in the ordinary otter-trawl, and a fish disturbed by the ground-rope may swim upwards and rise above the head-line, and so escape the net altogether. In Scott's patent gear this particular advantage in the construction of the beam-trawl is retained, and as shown in Fig. 3, the trawl, when working, has the same shape as the beam-trawl. The net is, therefore, constructed with a square piece of netting in the front part of the upper side or back, a piece technically known as the "square," and 58 feet in length. (Fig. 1.) The only other peculiarity on which the patent depends is the arrangement of the two triangles of iron on each board, to which the towing ropes are attached. The advantage claimed for these is, that being rigid, they ensure that the strain on the board shall always be in the right direction, and if the strain should be temporarily interrupted so that the boards fall on the ground, nothing can easily get foul.

The trawl is towed, not by means of two bridles and a single towing rope, but by two separate ropes, one from each board, one of which is

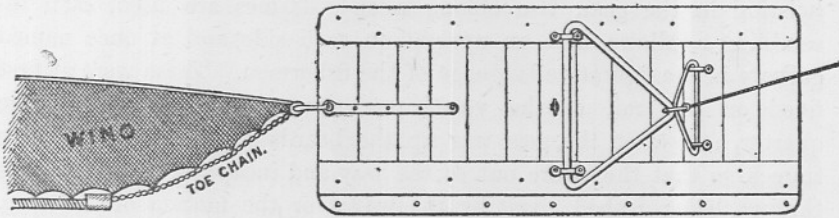


FIG. 1. Side view of Board.

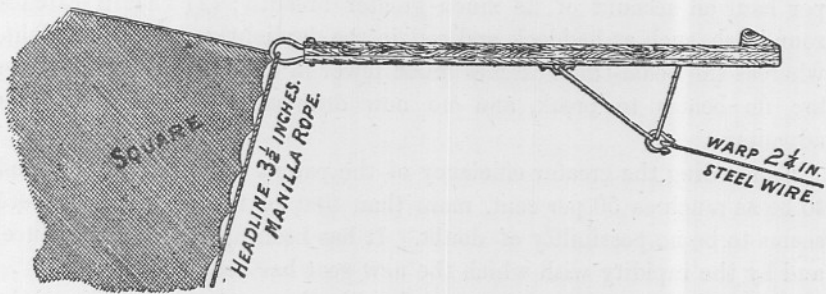


FIG. 2. Board seen from above.

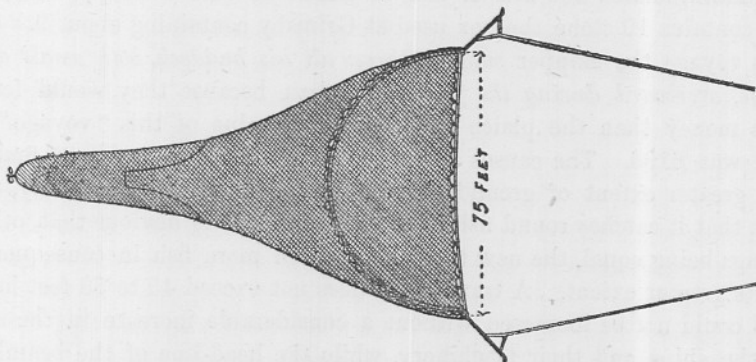


FIG. 3. Trawl. Seen from above.

SCOTT'S PATENT BEAMLESS TRAWL.

brought up over each quarter of the vessel to the steam winch. For hoisting in the gear, two oblong wooden frames are used, each resembling a gallows, with an upright on each side, and at once named gallows in the figurative language of the fishermen. These were at first fixed on the rail of the vessel, one near the bows, one on the quarter, and, when the gear was up, the boards were secured to these frames, so that they were out of the way and incapable of doing harm through being dashed about by the waves or the motion of the ship. The frames were afterwards fixed on the deck inside the bulwarks, the boards being allowed to drop between them and the latter when not in use, an arrangement which was thought to be still more convenient.

The advantages claimed for this gear are (1) That it catches more fish per haul on account of its much greater breadth; (2) That it catches round fish, such as haddock and cod, in the daylight as well as at night, whereas the beam-trawl catches much fewer in daylight; (3) That there are no beams to break, and no new drawbacks to neutralise this advantage.

Concerning the greater efficiency of the patent trawl, which is stated to be as much as 50 per cent. more than that of the beam-trawl, there seems to be no possibility of doubt. It has been proved by experience, and by the rapidity with which the new gear has been adopted.

At Hull the steamers first fitted with the patent gear frequently caught twice as much fish, and made twice as much money, as those still using the beam-trawl. One steamer, after a voyage of seven days, fishing on the Holman Ground, *i.e.*, off Hantsholm, in the North of Denmark, landed 400 kits of fish, of which 80 kits were plaice. The kit contains 10 stone, the box used at Grimsby containing about 9. On this voyage the skipper said *he threw all his haddock, both small and large, overboard during the first three days*, because they would fetch less money than the plaice and cod. The value of this "voyage" of fish was £196. The causes of this greater efficiency are two; firstly, the greater extent of ground covered by the new trawl; secondly, the fact that it catches round fish in the daytime. It is obvious that, other things being equal, the new trawl must catch more fish in consequence of its greater extent. A trawl beam does not exceed 45 to 50 feet long, and could not be increased without a considerable increase in the size of the ships and their machinery, while the head-line of the beamless trawl is 75 feet long, and may be more. I have not heard that the beamless trawl catches as many soles in the daytime as at night, the reason for the fact that these are caught more at night being their nocturnal habits; in the day they remain buried in the sand. But with the beam-trawl it was nearly always found that more cod and haddock were caught at night, and some fishermen believed that this was because

they swam some distance above the bottom during the day. The fact appears to be that the movement of the beam through the water, and its size, alarms the fish in daylight, and that they see it while they have time to avoid it. With the beamless trawl, on the other hand, there is scarcely anything to be seen or to create alarm. It is probable, too, that the head-line of the beamless trawl is not stretched quite straight in the water by the boards, but rises upwards towards the centre, and for this reason a fish would have more difficulty in avoiding the mouth of the net.

Mr. Scott was led to turn his attention to the improvement of the trawl, in consequence of the gradual diminution in the earnings of the Granton Steam Fishing Company. After various experiments he elaborated and patented the mode of construction above described, and the new apparatus was fitted to some of the Granton Company's vessels in June, 1894. He then chartered three steamers on his own account, had them fitted with his patent gear, and caused them to fish for a time out of different ports in succession, finally taking them to Hull, where he was established at the time of my visit. The new gear was first adopted in Hull by the Anglo-Norwegian Steam Fishing Company, and afterwards by other firms. Mr. Scott informed me that, at the time I was in Hull, it was in use on sixteen or seventeen steamers in that port, on eight at Granton, on one at Boston, two at Grimsby, and two at Milford Haven, and I also saw it on one at Scarborough.

The patentee, however, charged a considerable sum for the right of using his patents. I heard that the charge was £100 a year, but it will be understood that I was not anxious to obtain, or to publish, information which business men might consider to be in some degree of a private nature, and am only concerned with these matters as far as they are of public interest. Whatever the amount of the charge, it is a fact that many owners of steam trawlers in Hull thought they might obtain the advantages of the beamless trawl without rendering themselves liable for the charges of the patentee, or infringing the patent rights. Their view was that the principle of the otter-trawl was free to everyone, and that the patented special features were not essential. Accordingly, a large number of steamers were fitted with beamless or otter-trawls of a somewhat different construction. The boards of these were smaller and lighter than those of the patent gear, being each about six to eight feet long, and four feet broad. The hinder edge of the board was provided with holes along its whole length at equal distances, and the ends of the head-line and ground rope were shackled into these holes separately. Thus the attachments of the two ropes could be made near together or far apart at pleasure. The head-line was made 74 to 94 feet long, and the ground rope longer, and the net was made with a

“square” in the back as in the patent trawl. The attachment of the towing rope to the board was made by means of four short iron chains fixed to the board at four separate points.

These unpatented beamless trawls were working with apparently satisfactory success at the time of my visit, which lasted from August 27th to September 5th. In working them no frames were used for hoisting, but the towing ropes were brought in over the pulleys fitted in the bulwarks forward and on the quarter rail for hoisting the beam trawl. The boards were simply hoisted over the rail, and stowed on deck when the trawl was hauled. Other contrivances were being tried for greater convenience in handling the gear. On one vessel I saw an aperture being made and fitted with rollers in the bulwarks of the quarter, similar to that which was used in the fore part of the ship in hoisting the beam trawl. In fact, at the time I was in Hull, it was very remarkable to see the amount of work going on all about the fish dock, in connection with the construction of new trawls and the fitting of new contrivances on the vessels for their more convenient operation, while collections of discarded beams and iron trawl-heads were lying neglected in various places.

From the circumstances of the case, and from a few trials that had been made, it did not appear possible to use the beamless trawl with advantage on sailing vessels. Its use apparently requires a strain that shall be constant and not below a certain degree of strength, so that a sailing smack could only use it when the wind was steady, and fairly strong, and, under ordinary conditions, would be better off with the beam trawl. It is evident, therefore, that the greater efficiency of the new gear on steam trawlers makes the inferiority of the smacks greater than it was before—and even before they had considerable difficulty in earning enough for their maintenance.

Another question which arises from a consideration of the greater efficiency of the beamless trawl, is its probable effect on the available fish supply. It is true that its chief advantage lies in the greater number of haddocks and cod it captures to supply a demand which is usually all but insatiable, and a failure in the supply of haddock has not yet made itself very evident. I have not at present any evidence of importance of the use of the new gear on grounds which produce soles, but it certainly brings in an increased number of plaice, *e.g.* from the Holman Ground. Probably, therefore, as the supply of plaice has already diminished, the advantage of the new gear with respect to this fish can be only temporary, and we may expect that, in a few years, a trawl spreading 75 ft. will not be able to capture more plaice than the beam-trawl of 50 ft. could in the year 1895.

Although compelled to adopt it by the necessity of self-preservation,

many of those who depend on the fishing industry at Hull have not rejoiced at the introduction of the new gear. When I was at Scarborough I attended, by Mr. Woodall's invitation, a small conference, held at the Exhibition, to discuss the artificial propagation of marine fishes. One of the gentlemen present, who belonged to Hull, argued that it was absurd to consider the proposal to hatch fish-eggs, when the new beamless trawl was bringing in such numbers of small haddock that the market was glutted with them. Another gentleman replied to this that, in the warm weather of the middle of summer, gluts of haddock had occurred in previous years, though always of very temporary duration, and that there was never any glut of plaice, soles, or turbot, which were the fish it was proposed to propagate.

The following week I was at Hull, and enquired, as far as I could, into the circumstances of the glut. I found there had been no excess in the supply of any other fish but the small haddock, and satisfied myself that the use of the new trawl did not involve the capture of any more small fish of any kind in proportion to the total catch, than the beam-trawl. It was the fact that the supply of small haddocks in the previous week had exceeded the demand. But these were haddocks of a size which are always brought to market, namely, from 9 in. to 12 in. in length, and they are chiefly bought for the fried fish shops, whose custom falls off in summer time. One vessel landed 500 kits of these, and only 200 kits were sold. The manure works took a good many, but they were also glutted. During the week that I was in Hull, many of the vessels threw overboard their small haddock, to avoid the same disappointment again, and it happened that prices were so good that they had reason to regret doing so. On September 2nd the price was 8s. to 10s. a kit, while on the next day it fell from 6s. to 2s. in the course of sale.

The headquarters of the fishing industry at Hull are at the St. Andrew's Dock, the most western of all the docks of the port. A new and larger dock for fishing vessels is in course of construction, on adjoining ground on the west side of the existing dock, which does not now contain sufficient accommodation for the increased business. No other fishing is now carried on from this port except deep-sea trawling, and long lining, and the latter branch of the industry is only pursued by about a dozen steamers. A large number of sailing smacks, 250 according to the annual reports of the Inspectors, are still owned and managed at the port. All of these are worked on the fleeting system. The principal fleets are the Red Cross and the Great Northern, and the fish from these is conveyed to London by steam carriers. At present a considerable number of steamers are regularly employed in fishing with

the fleets, and the statement in the *Eastern Morning News* of September 1st, that, on the previous day, the "cutter," or carrier, from the Red Cross Fleet was in London with fish from 19 steam trawlers and 64 smacks, and the Great Northern cutter with fish from 10 steamers and 70 smacks, illustrates the extent to which this practice has been carried.

The local market at the St. Andrew's Dock is supplied almost entirely by steam trawlers. A great deal of the variety in the modes of fishing and in the kinds of fish brought to market at Grimsby, is missed by the visitor to Hull. The Hull market has not such extensive relations as that at Grimsby, and does not offer the same demand or price for prime fish. The Hull trawlers, therefore, attach more importance to quantity than quality, and one does not find either smacks or steamers there, as at Grimsby, which make a special point of fishing for soles, turbot, and brill. There are no welled cod-smacks, or cod-chests, in the dock, and the line fishing for halibut, tusk, cod, ling, skate, etc., on the distant grounds of Farøe and Iceland, is not pursued to the same extent as at Grimsby. During my visit a number of the steamers landing their fish at Hull were fishing on the Holman Ground, and in the Skager Rack, or Sleeve, as the fishermen call it. One steamer, using the otter-trawl without the patented arrangements, landed 82 kits of plaice, 45 kits of large haddock, 58 kits of medium haddock, 24 kits of cod, 5 kits of codling, 2 kits of hake, 6 kits grey gurnard, 8 stone turbot, 13 stone halibut, 3 score cat-fishes, 5 score ling, 5 score skate, 4 score rays.

The Hull market does not offer such good facilities for observation as that at Grimsby. The fish, as it is landed in baskets on the quay, is nearly all weighed, and then thrown into the kits, which are somewhat narrow deep open casks, and when these are moved away for sale, the various parts of a single vessel's catch are not kept together. To ascertain the nature and amount of a vessel's catch, it is necessary, therefore, to watch the whole process of landing, whereas at Grimsby the wide shallow boxes, and the fact that the whole of a vessel's catch is placed together in one spot on the pontoon, enable one to see at a glance what a vessel has landed.

The Hull steamers, and the fleets too, fish a good deal in spring on the Eastern or small plaice grounds, but while I was in Hull the quantity of fish on these grounds was too small to remunerate them. I ascertained in the case of three steamers that they had visited these grounds and fished there for a part of their voyage, but none of them landed the smallest plaice which are usually there. None of the plaice landed in these cases were less than 9 in. long, and the largest quantity landed from one vessel was 30 kits, the largest fish not exceeding 16 in.

It is important, however, to note that the beamless trawl, with its enormous spread, has been already used on these grounds, and it may be expected that next spring it will sweep up the small plaice in more wholesale fashion than the beam trawl has done in previous years.

The other vessels concerning which I made enquiries, had been fishing in the neighbourhood of the Dogger, from which one vessel, after a voyage of eight days, landed 31 kits of rather small plaice, 12 kits of large plaice, and 180 kits of haddock.

I did not see at Hull any small vessels employed in fishing in the Humber, or in territorial English waters.

4. *Lowestoft.*

I arrived in Lowestoft on September 5th, and the next day saw a heap of small soles in a fishmonger's shop. I bought a sample of these and found it consisted of 4 immature females $7\frac{1}{4}$ in. to $8\frac{3}{4}$ in., and 3 immature males 7 in. to $8\frac{1}{4}$ in. No less than 4 of these 7 soles were under 8 in. in length, and I found afterwards that soles similar to this sample were frequently on sale at the same shop. It naturally occurred to me that this observed fact was strikingly inconsistent with the statement made to the Parliamentary Committee of 1893, that soles under 8 in. in length were never brought into the Lowestoft market in sufficient quantities to make a sale of them. On referring to the Report of the evidence taken by that Committee, however, it appeared that the statement in question was made in reference to the trawl market, and was intended to refer to the trawlers. I found that the soles which I examined were caught in the inshore waters by the shrimpers, two of whom gave evidence before the Parliamentary Committee. One of them stated that they threw the undersized soles overboard alive, the smallest kept being between 7 and 8 in. My own observation shows that the limit is as low as 7 in.

On September 17th, I had a conversation with the master of one of the shrimping boats in Lowestoft Harbour. He had just come in from his morning's work. The boat was open, and rigged with two masts, carrying two lug sails. There was only one trawl on board, an ordinary beam-trawl of 15 feet beam, the net of shrimp-mesh at the cod end. The man informed me that there were about forty such boats at Lowestoft, and they were to be seen moored in the outer harbour, though I could not count them. They were not all at work at this season, many of the men being employed in the herring and mackerel boats. The principal shrimping season is from May to August.

The shrimps brought in by this boat had been sent away for sale; but there were some fish on board—plaice, soles, and whiting—evidently of no great value, as the man allowed me to take what I pleased from them for a shilling. Those that particularly interested me were 3 small soles, true *Solea vulgaris*. They were $2\frac{1}{4}$ in. to $2\frac{5}{8}$ in. long, and could be confidently considered to be of the year's brood, hatched in May and June, and therefore three or four months old. I have shown that in the Plymouth Aquarium a sole $\frac{5}{8}$ in. long in April grew to $3\frac{3}{4}$ in. on the following September 2nd. These small soles were not brought in intentionally, but had simply been overlooked when the rest of the valueless part of the catch was thrown overboard. The other fish in the boat were brought in for sale. I took all the soles; their sizes were—3 at $6\frac{3}{4}$ in. length, 2 males, 1 female; 1 at $7\frac{1}{4}$ in. length, female; 1 at $7\frac{7}{8}$ in. length, female; 1 at $8\frac{1}{4}$ in. length, female; 1 at $8\frac{1}{2}$ in. length, female; 1 at $9\frac{1}{8}$ in. length, male.

All these were immature. If we apply here the method of the Danish biologist, Petersen, and notice the sizes at which the greater number of specimens group themselves, although the number of specimens is small, it is clear that we have at least two groups, those of the first year and those of the second, the former being 2 to 3 in. long, the others mostly about 7 in.

The plaice from this boat were few in number. Their sizes were—1 at $7\frac{7}{8}$ in., female; 2 at 8 in., female; 1 at $9\frac{1}{2}$ in., female; 1 at $9\frac{1}{4}$ in., male; 1 at 11 in., female.

In order to examine the ground where the small boats worked, and their methods of operation, I accompanied the master of this boat on one of his trips. We went out at 6.30 a.m., on September 18th. The trawling took place on the Newcome Sand, which stretches parallel to the shore from Lowestoft southwards. It is separated from the beach by a channel 4 to 5 fms. deep at low water, the depth on the sand itself being only $1\frac{1}{2}$ to 2 fms. The flood was going up, *i.e.* south, and we towed with the tide, with the wind on the starboard side, off the land.

When the net was hauled the first time, there were a large number of the small soles of the year's brood, about $2\frac{1}{2}$ in. long. I counted 42.

Plaice of corresponding size were extremely scarce; there was only 1 $2\frac{1}{4}$ in. long, and 1 dab $1\frac{1}{4}$ in. 7 soles were kept for market, 6 to 9 in. long; there were 2 marketable dabs, and 4 marketable plaice, 7 to 10 in. long; also 1 large plaice, $22\frac{3}{4}$ in. long. There were 9 marketable whiting.

Second haul, same direction. Of the smallest soles, 22 were thrown overboard, besides some which I kept.

After this, having passed the Barnard Buoy, which is near the end of the Newcome, we shot off Kissingland Lifeboat House, and steered north again nearer the shore.

Third haul, a short one, the trawl having caught fast. There were 17 soles 2 to 2½ in. long, 6 soles about 6 in. long.

Fourth haul, same direction. There were caught 23 small soles about 2¼ in. long, a number of whiting, some of the previous year's and some of the same year's broods. Many of the latter were thrown overboard; the size of these is stated below.

Fifth haul, a long haul northwards towards Lowestoft Harbour on the ebb tide. I counted 38 of the small soles when the cod end was first emptied out, besides a large number picked out in the process of sorting afterwards. There were also some whiting and small plaice, mostly kept for market.

The mode of working was as follows:—When the trawl was hauled, the cod end was emptied out into a wooden box in the boat. There were always a number of the little soles in the meshes of the net, alive and apparently, in most cases, uninjured. Except those which I kept, they were all thrown overboard alive. There was always a large quantity of Hydroids, chiefly *Hydrallmania* and *Sertularians*, with pieces of red seaweed occasionally. A considerable number of fish of unsaleable kinds were also taken, namely, *Agonus cataphractus*, *Trachinus vipera* (the lesser weever), *Gobius minutus* (the sand goby), one or two small *Syngnathus* (pipe-fish), a small *Acanthias vulgaris* (spiny dog-fish), and a small *Galeus vulgaris* (locally called "Sweet William"). The invertebrates were some *Portunus*, or swimming crabs, *Carcinus*, the shore crab, one *Cancer* (edible crab), a number of Isopods and Amphipods, including *Idotea* and others. We also took several living specimens of the bivalve *Mactra stultorum*, var. *cinerea*, Gwyn Jeffreys. These things were all thrown overboard. The marketable fish were placed in a separate box, and then the shrimps were riddled over the side and the sorting completed, after which they were placed in a basket to be taken ashore. The shrimps were thus not as in the Thames shrimping boats, which are much larger, boiled on board. There were no *Pandalus*, or pink shrimps, only the brown *Crangon vulgaris*, and the catch of the whole trip amounted to about two pecks. The man told me that there had been little "call" for shrimps that season, and his earnings had not averaged more than £1 a week. The only assistance he had in the work was that of his son, a lad of seventeen. The boat was the property of a widow, whom he paid for the use of it.

I brought ashore a large number of the whiting caught, and measured them to see if I could distinguish the broods of different

years by Petersen's method. The lengths in inches were as follows:

Length.	Number of Whiting.
3 in.	9
4 in.	12
5 in.	12
6 in.	2
7 in.	4
8 in.	7 maximum.
9 in.	4
10 in.	2
11 in.	2
12 in.	1

It will be seen that the number of fish was at a maximum at two sizes, namely 4 to 5 in., and 8 in. The former length is, therefore, that of the majority of the whiting of the year, hatched in the previous spring, and the latter that of those in their second year.

The results of examination of the contents of the stomachs in the small soles are of interest. It is known that the larger soles feed almost entirely on worms, but in these young specimens I found only small Crustacea, with a certain quantity of sand. In one was a Copepod, in three were specimens of Cumacea, minute Crustacea which live on sandy ground. The smallest sole was only $1\frac{1}{2}$ in. long. Plaice and dabs of the year's brood were remarkably scarce; there were 3 dabs $1\frac{1}{2}$ to $1\frac{3}{4}$ in., 1 plaice $1\frac{7}{8}$ in., and 4 plaice $3\frac{3}{4}$ to $4\frac{1}{2}$ in.

Of larger soles which I brought ashore there were 8 of 5 in., 2 of 6 in., 1 of $9\frac{1}{2}$ in. The food in all these was the tail end of the lug-worm, *Arenicola*.

The chief interest of this ground is, of course, the very considerable number of soles of the year's brood, as well as of those of a larger size, 6 to 8 in., and a year old, which occur upon it in September. It is by no means certain that any great injury is done to the little soles which are trawled and thrown overboard again, though probably a certain percentage of them are thereby killed. But it is clear, I think, that a limit of 10 in. for the landing and sale of soles would be a distinct and very beneficial protection to this species on this ground, and could do no great injury to the men who get their living from the inshore trawling.

The next branch of the industry at Lowestoft to be considered, and one which is vastly more important than the inshore trawling, is the deep-sea trawling. This is carried on exclusively by sailing smacks. The absence of steamers at Lowestoft is largely due probably to its

greater distance from the coal and iron centres as compared with Hull and Grimsby, and the more northern ports generally. It is true that the steamers could be built elsewhere, and the coal and other requisites could be conveyed to Lowestoft. But the grounds in the immediate vicinity are not extensive enough, nor productive enough, to enable a steamer to pay a profit on her working, and if she is to work the grounds more to the northward, she finds a more convenient port for landing and working from, in Hull, or Grimsby, or Boston. In fact, the scarcity of haddock and cod in the shallower waters of the narrow southern part of the North Sea is alone enough to account for the absence of steam trawlers, and their failure, when they have been tried, at the East Anglian ports.*

The number of trawling smacks at Lowestoft is stated, in the Inspector's Report for 1894, to be 320. They are all ketch-rigged and provided with steam capstans. In size they are smaller than the majority of the Hull and Grimsby smacks, the largest being not more than 60 tons. The crew of each consists of four men and a boy, the latter acting as cook. It is a remarkable fact that all these vessels land their fish at Lowestoft, each one landing its own. The boats do not practise the fleeting system, and none of the fish is sent to London direct from the smacks by sea. At Yarmouth it is just the opposite, the trawlers there all fish in fleets, and their fish is conveyed to London by steam carriers. Some few years ago there were few fish buyers at Lowestoft; the usual custom of smack owners was to send the fish to London by railway, and there it was sold on commission by the salesman at Billingsgate or other market. But now the fish is sold by auction when landed, as at Grimsby or Hull, and the smack owners and fishermen have no further interest in it. The same man is sometimes both buyer and smack owner, or has interests in both branches of the business, but, nevertheless, the two branches are perfectly distinct. I was assured, and the prosperity of the industry at Lowestoft is good evidence of the fact, that prices have been better, and the profits of fishermen and smack owners greater, under the present system. This is certainly one case in favour of the much-accused middleman. It is not difficult to understand that under the circumstances of the fish trade the "buyer" performs a very useful function. It is his special business to know where to place his fish according to the demand, and thus the Lowestoft smacks have the whole country opened to them, instead of being restricted to London, or any other single market. Moreover, a man who has paid for the goods he has to sell, and deals with them at his own risk, is naturally more interested

* In the Inspector's Report for 1894 it is stated that 10 steamers were working from Yarmouth. Probably several of these act as carriers for the fleets.

in finding a market for them than the man who sells on commission, the chief risk being borne by the consigner.

The harbour at Lowestoft is divided by wooden piers into several compartments, and one of these is allotted to the use of the trawlers, the market for trawled fish extending along the side of it. During my stay I was allowed to use one of the small offices in this market for my work, and I received a great deal of assistance and courtesy from members of all classes of men engaged in the fish business, from fishermen, smack owners, and dealers, for which both personally, and on behalf of the Association, I am glad to express my thanks. I was especially indebted to Mr. Sladden for permission to make a voyage in one of his boats, and to Mr. Alfred Turner for information and guidance in the market.

I have mentioned in the first section of this paper that the Lowestoft smacks were during my visit trawling partly in the neighbourhood of the Brown Ridges, partly around the banks and shoals off the English coast to the northward, from the Smith's Knoll and Winterton Ridge to the Outer Dowsing. The smacks usually remain out for seven or eight days and more of them land fish on Sunday than on Saturday, for the reason that buyers prefer to send fish for Monday's market on the former day than on the latter. On September 9th a smack, which had fished 55 miles E.S.E. of Lowestoft, at depths of 11 to 23 fathoms, landed 18 boxes of rather small plaice; 4 boxes of dabs; 1 box (level) of soles; $\frac{1}{2}$ box of turbot; 2 or 3 rays. A box of these plaice contained 109 males, 117 females, and the size was $9\frac{1}{4}$ in. to 15 in. The price was 8s.

A catch on the same date from the Swarte Bank, which is on the English side, a long way to the N.W. of the Brown Ridges, consisted of $8\frac{1}{2}$ boxes plaice; 1 box dabs; 1 box (level) of soles; 1 box turbot and lemon soles; 1 box dabs; 1 box rays; 1 box haddock. The largest plaice was $21\frac{1}{2}$ in., the smallest $9\frac{1}{2}$ in.

There were frequently seen in the market large heaps of mixed fish of little value. They consisted of a few small plaice, dabs, and chiefly of gurnards and large weevers (*Trachinus draco*). I afterwards found that these fish came from the neighbourhood of the Brown Ridges. The gurnards in these heaps were the grey gurnard (*Trigla gurnardus*) by far the most numerous, the red gurnard (*T. cuculus*) and the tub or the latchet (*T. hirundo*). Catches from the eastern side also often included a box or half a box of large latchets. The number of boxes of plaice varied from 15 to 25. Haddocks and lemon soles were conspicuous by their absence. On September 20th, at 10.30 a.m., I counted all the small plaice in the market, and found there were 440 boxes; but this does not include all landed in the day—some had already been removed, and others were landed later. The fishermen, in packing their

plaice, reserve all the largest for putting at the tops of the boxes, and for this reason the appearance of the small plaice from the eastern side is quite different from that of the plaice from the banks off the Norfolk coast, the largest visible fish in the former case seldom exceeding 16 in., in the other reaching 22 in. or more.

In the catches landed from the Norfolk coast, latchets and weevers are not seen, while some haddocks and lemon soles are usually present; but the number of both these kinds is very small, one box of haddocks and half a box of lemon soles being the usual limit. Plaice from these grounds are less plentiful than from the eastern. A voyage from Smith's Knoll and Leman Shoal comprised 3 boxes plaice; 2 boxes lemon soles; 1 box soles; 1 box turbot and brill; 1 box dabs; 3 boxes whiting.

Another voyage from the Leman Shoal was $12\frac{1}{2}$ boxes plaice; 3 boxes dabs; 1 box soles; $2\frac{1}{2}$ boxes lemon soles; 1 box turbot and brill; $1\frac{1}{2}$ boxes codling; $1\frac{1}{2}$ boxes of haddock; $\frac{1}{2}$ box whiting; 3 boxes rays or roker.

A voyage, stated to be caught off the Winterton Shoal, landed on October 9th, contained 8 boxes rather large plaice; 1 box roker and whiting; 1 box dabs; 1 box soles; $\frac{1}{2}$ box turbot and brill; 1 box cod, and haddock; 3 boxes whiting. The Winterton Shoal is about 15 miles from the coast to the north of Yarmouth, the depth where these fish were caught 16 to 19 fathoms.

A voyage from the "deep water," 20 miles off Lowestoft, consisted of 10 boxes small plaice; $1\frac{1}{2}$ boxes soles; $\frac{1}{2}$ box lemon soles; 4 boxes cod, 2 boxes whiting; 4 conger.

On Wednesday, October 9th, I saw a boat landing a catch with scarcely any plaice, only a dozen small specimens altogether. The skipper said he went out on the previous Saturday, and had been fishing in the "deep water." He had $1\frac{1}{2}$ boxes of soles, $\frac{1}{4}$ box of slips or small soles, $1\frac{1}{2}$ boxes of rays, $\frac{1}{2}$ box of lemon soles, a few soles, a few brill, 1 box of whiting, and 1 box of whiting and codling. The number of small soles was remarkable, many were under 10 in., and some no more than 7 in. in length. The box of soles was sold for £9 15s., the slips for 25s.

It is well known that level ground, less than 20 fathoms deep, stretches in a W.N.W. direction from the Dutch coast to the Swarte Bank. I cannot say how far the *smaller race* of plaice, which I have shown to exist at the Brown Ridges, extends, but a voyage landed on October 8th, caught 25 miles east of the Swarte Bank, was apparently similar to one from the Brown Ridges. It included 40 boxes of small plaice, 1 box of latchets, $\frac{1}{2}$ box of soles, 1 box of turbot and brill, 1 box of cod, 3 boxes of dabs. There were no haddock or lemon soles.

These indications are useful in giving a correct picture of the character of the trawling at Lowestoft, but the products of the grounds can be more completely examined on board a vessel during her fishing. I made one voyage on a smack from Lowestoft, and was able to ascertain very thoroughly the character of the ground called the Brown Ridges.

We sailed out of the harbour on Monday, Sept. 23rd, and steered to the east in fine weather, with a light breeze. The skipper informed me that £20 was a large sum for the catch of one of these vessels, that they did well if they got £800 in a year as total gross receipts.

At noon on Tuesday our skipper took an observation of the sun, and made our latitude to be $52^{\circ} 41'$. We shot the trawl at 2.30 p.m. Our distance from the English coast I do not know exactly, as we could not log it as the steamers do, but it was between 50 and 60 miles, and about 40 or 50 miles from the Dutch coast. At first we towed towards the south, and at 5 p.m. we tacked round, and towed northwards. At 6 p.m., the depth was between 19 and 20 fathoms.

The trawl was hauled at 11.30 p.m., having been down nine hours. There was a fair quantity of fish in the net, consisting of rather small plaice, whiting, weevers, latchets, and gurnards. There were a large number of small whiting, dabs, and grey gurnards. The smallest plaice was $9\frac{3}{4}$ in. long, the largest $17\frac{3}{4}$ in., and none were thrown overboard. The fish kept for market were: $3\frac{1}{2}$ baskets of plaice, $9\frac{3}{4}$ in. to $17\frac{3}{4}$ in.; $\frac{1}{2}$ basket of dabs; $\frac{1}{2}$ basket of latchets, largest 20 in. long; 1 brill; 1 turbot; 9 pair of soles. The larger dabs were saved, and all the smaller thrown overboard; the smallest was $4\frac{1}{2}$ in. long. All the whiting, weevers, and gurnards—about a trunk full altogether—were thrown overboard, but not the latchets (*Trigla hirundo*), which, though a species of gurnard, are of larger size. These fish—weevers, small dabs, whiting, and gurnards—are saved from the last hauls, but do not pay for icing if kept from the first day or two of the voyage. The weevers were of two kinds, the small (*Trachinus vipera*) and the larger (*Trachinus draco*). There was one scaldback (*Arnoglossus laterna*), a female mature, and two dragonets (*Callionymus lyra*). Of invertebrates there were 1 squid, starfishes, a few hermit crabs, and whelks.

The trawl was shot again at once, and the second haul was made at 10 a.m. on Wednesday, trawl having been down about 10 hours. At 9 a.m. we sounded 13 fathoms, being then on one of the ridges. The marketable fish from this haul were: 2 trunks of plaice; $\frac{1}{2}$ basket of dabs; $\frac{1}{2}$ basket of gurnards, whiting, and weevers; 10 latchets; 5 pair of soles.

The largest plaice was $16\frac{1}{4}$ in., evidently ripening for next season, the smallest was $9\frac{1}{4}$ in., a female immature. The smallest sole was 10 in. long.

About a trunk of small whiting, dabs, gurnards, and weevers were thrown overboard. The largest weever (*T. draco*) was $13\frac{1}{4}$ in. long, the smallest (*T. vipera*) $2\frac{3}{4}$ in. There was one solenette (*Solea lutea*).

Of invertebrates there was 1 edible crab, 1 *Astropecten*, 1 *Spatangus purpureus*, and a great number of large hermit crabs (*Eupagurus bernhardus*) in whelk shells.

We did not shoot again at once, but sailed to the southward and eastward, the wind having taken us too far to the north, or "down," as the fishermen term it.

At noon our latitude was $52^{\circ} 44'$. At 3 p.m. I took the surface temperature of the sea, and found it was $62^{\circ}.0$ F. The density was 1027, as well as I could read it in a bucket on deck.

At 5.45 p.m. the trawl was shot again, the ship's head being N.E., and the wind from the east. We hauled at 6.30 a.m. the next day. There had been a calm all night, and in the net were only 1 pair of soles, about 12 plaice, and a few small gurnards, dabs, and weevers. The net was much torn.

We could not shoot all day for lack of wind, but put the trawl over at 6.30 p.m., again towing to the north with the wind from the eastward. We hauled at 7.45 a.m., and again had scarcely any fish, the wind having been very light. There was 1 turbot $18\frac{1}{2}$ in. long, a male, mature. There was about $\frac{1}{4}$ of a trunk of plaice, 8 soles, $10\frac{3}{4}$ in. to $16\frac{1}{2}$ in. long, and, as usual, some small whiting, gurnard, weevers. The plaice were 11 in. to $16\frac{3}{4}$ in. long. There were 1 *Astropecten*, 1 sandstar (*Ophioglyphya lacertosa*), and several *Echinus miliaris*, and common starfishes.

The trawl was shot again at once, and hauled at 7 p.m. The latitude at noon was $52^{\circ} 36'$. Still the wind was deficient. The novel occurrence this haul was a piece of black friable substance, which the men called "moor-log," apparently a submarine soil or peat.

There were 1 turbot $17\frac{1}{4}$ in., and 1 brill $16\frac{1}{4}$ in., the latter a mature male, half a box of plaice and dabs, and 1 pair of soles. There were 5 dragonets (*Callionymus lyra*) and the usual invertebrates.

The trawl was shot again immediately, and hauled at 8 a.m. the next day, after about 12 hours. This time a fair quantity of fish was brought up. The marketable portion was, 5 trunks of plaice, largest $16\frac{1}{2}$ in.; 3 trunks of whiting and dabs, smallest dab 7 in., largest 13 in.; $\frac{1}{2}$ trunk of soles, 40 pairs and 2 or 3 slips; 3 latchets, 3 rays, 12 in. across pectorals.

The largest whiting was only $12\frac{1}{2}$ in. long, the smallest 8 in. There were two scaldbacks, one $3\frac{3}{4}$ in., and one 5 in., neither having the fin-rays elongated. The smallest sole was $8\frac{1}{4}$ in. long, the largest 18 in. About a trunk of small gurnards, small dabs, small whiting, and a few weevers were thrown overboard.

In one of the plaice which I opened, the food was chiefly *Pectinaria*, a worm which builds a pretty, smooth, conical tube out of grains of sand. The invertebrates, as usual, included starfishes and hermit crabs, but there were also numerous lumps of *Alcyonium*, or dead man's fingers, and one piece of *Antennularia*. Hydroids were absent from all the other hauls.

The trawl was not shot again until 12.30 p.m., the interval having been spent in sailing to windward, *i.e.* to eastward. It was hauled at 10.15 p.m. There was a great mass of "moor-log" in the net, measuring 2 ft. by 18 in. by 8 in. It contained a number of specimens of a boring mollusc, probably *Pholas*. The marketable fish were:—2 trunks of plaice; $\frac{3}{4}$ trunks of dabs; 10 soles, $9\frac{3}{4}$ to $14\frac{1}{4}$ in.; 3 lachets, largest $17\frac{1}{2}$ in.; $\frac{3}{4}$ trunk grey gurnards, 7 to 12 in. long; weevers many, largest 13 in. long. The smallest plaice was $9\frac{1}{4}$ in. long. The gurnards and weevers were saved for market, as in consequence of the lack of wind and scarcity of fish, they were expected to make 1s. a box. Among the worthless fish were some solenettes, one scaldback (*Arnoglossus laterna*), one tope (*Galeus vulgaris*), and a few dragonets. In the stomach of one large weever which I opened were two sand-eels. The invertebrates were large numbers of common starfishes and *Astropecten*, and some anemones (*Actinoloba dianthus*).

The trawl was shot again immediately, and was hauled again for the last time at 10.30 a.m. on Sunday, September 29th. On the net were a piece of *Halidrys siliquosa*, two pieces of *Tubularia larynx*, and swarms of small Amphipods; also some pieces of a branching Polyzoan.

The marketable fish were:—2 trunks plaice: 1 trunk dabs; 2 trunks gurnards, mostly rather small; 8 pair soles; 2 turbot; 1 brill. One of the turbot was $19\frac{1}{2}$ in., male mature; one $18\frac{1}{4}$ in., female, apparently mature. The brill was $17\frac{1}{4}$ in., female mature. There was one lemon sole. The smallest plaice was $9\frac{1}{4}$ in. long. There were no whiting, some larger weevers, but few of the smaller species. Of invertebrates there was one living *Natica*, and there were several shells of this form containing hermit crabs.

After this we made sail for Lowestoft; our latitude, at noon, after a short run, was $52^{\circ} 19'$.

A comparison between the above observations and those made on the ground off the German coast, north of Heligoland, at the beginning of June, and recorded in the previous number of the Journal, shows completely the differences and resemblances between the two districts. The difference in latitude is about 2° , the central part of one district being $52^{\circ} 30'$; of the other $54^{\circ} 30'$. The distance from the Dutch coast of the southern ground is mostly between 30 and 50 miles, of the northern from the German islands, between 10 and 25 miles. The depth on the

southern ground was 13 to 20 fathoms, on the northern $7\frac{1}{2}$ to 14 fathoms. It is plain, therefore, that the ground of the Brown Ridges is considerably deeper and farther seaward than that which I studied in June, in the s.s. *John Bull*, from Grimsby.

The comparison of the fish on the two grounds is as follows:—

The *plaice* on the northern ground did not exceed 17 in.; the largest was $16\frac{3}{4}$ in. long. On the southern ground very few plaice exceeded this limit, but I measured one which was $17\frac{1}{2}$ in. long. On the northern ground the minimum length of plaice was only 5 in., while in the southern none were taken which were under 9 in. On the northern ground two or three basketfuls, or even more sometimes, of small plaice under 10 in. were thrown over at each haul; on the southern ground there were no such fish to throw away. The difference in the maturity of the plaice has been fully stated in a previous part of this paper. The relative abundance of the plaice it is not possible to estimate, as the fishing in one case was by a steamer, in the other by a sailing smack.

Turbot and brill. The smallest turbot on the Brown Ridges was $17\frac{1}{4}$ in. long, the smallest brill $16\frac{1}{4}$. Off the German coast, in June, numbers of brill and turbot, 11 to 14 in. long, were taken, and one turbot taken was only $8\frac{1}{2}$ in. Sometimes 29 per cent. of the number taken were under 12 in., and, of course, quite immature.

Soles. The smallest sole caught off the German coast was $9\frac{7}{8}$ in. long, on the Brown Ridges $8\frac{1}{4}$ in. In both cases a large proportion of the soles were adult, and of fair size.

Lemon Soles absent on both grounds.

Dabs. In both cases numbers of dabs, both small and large, were captured, and the larger, about 10 to 13 in., were kept for market.

Haddock. Absent on the Brown Ridges, few small on the northern ground, but some larger. These were less abundant than the plaice, and decreased towards the land and the shallower water.

Cod. Absent on the Brown Ridges, scarce on the German coast.

Whiting. Numbers about 13 in. long on both grounds, but only saved from the last hauls of the voyage.

Latchets. A considerable number taken on both grounds, and mostly mature and of large size.

Gurnards. Grey abundant on both grounds, red (*cuculus*) in smaller numbers.

Weevers (*Trachinus draco* and *vipera*). The abundance of these, especially of the larger species, is very characteristic of the Brown Ridges. I saw none on the German coast.

Sand-eels. I frequently found one or two of these entangled in the net on the German coast.

Some solenettes occurred on both grounds, but dragonets (*Callionymus*

tyra) I saw only on the Brown Ridges; a few specimens of scaldbacks also occurred only on the latter ground. Scruff, in the form of Hydroids, was very scarce on both grounds. *Alcyonium*, or "teats" as the men call it, was abundant, as were starfishes and hermit-crabs, whelks, and whelk spawn. *Natica* occurred on the Brown Ridges, and its semicircular band of spawn, believed to be turbot spawn by the fishermen, on the German coast.

I examined a piece of the "moor-log" which I brought ashore, with the microscope, and saw only vegetable tissue-cells, brownish in colour. I also saw, with the naked eye, some grass-like stalks in it. It is evidently turf or peat.

I also made a study of some of the waste fish which I brought ashore. There were 105 *Trigla gurnardus*, 7 in. to 13 in. long, and I brought these chiefly to examine the very conspicuous change of coloration which takes place in this species during growth. At first sight the younger and smaller fish might be taken for a different species. They are of a uniform reddish colour, without spots, but not so bright a red as *Trigla cuculus*. The elements of coloration are the same as in the grey or older stage, namely red chromatophores, with definite outline and rounded form, yellow chromatophores less distinctly defined, black chromatophores, and small granular iridocytes, with indistinct outlines. In the older livery the red elements are diminished in comparative abundance, and all the rest increased. Iridocytes massed together with yellow pigment, but without either black or red, form bright, yellow spots, usually surrounded by a black ring, forming ocelli. Elsewhere the skin is mottled with yellow and black and grey, with red patches here and there. The intermediate stage is at 9 in. in length, in which only a few of the yellow spots are present.

I also examined the specific characters of the two species of weever. I had 15 *T. draco* 9 $\frac{3}{4}$ in. to 12 $\frac{3}{4}$ in. long, and 8 of 5 in. to 9 $\frac{1}{4}$ in. Of *T. vipera* I had 18 of 2 in. to 4 $\frac{3}{8}$ in. in length.

A comparison of the smallest *draco* and the largest *vipera*, showed the specific characters to be perfectly constant. They are:—

(1) Greater vertical depth of body in *vipera*, especially from the angle of the jaw to the anus.

(2) Oblique lines of scales in *draco*, with yellow patches along the sides; *vipera* is silvery, without yellow spots or lines.

(3) Scales longer than broad in *draco*, broader than long in *vipera*.

(4) Two spines on front of orbit in *draco*, none in *vipera*.

(5) Second dorsal in *vipera* has 24 fin-rays; in *draco*, 30.

The herring and mackerel fishery, at Lowestoft, has a separate part of the harbour, and a separate market to itself, and is of very considerable

magnitude and importance. In September there were no herrings to be caught at Lowestoft, and a large proportion of the boats were away fishing for these fish off the coast to the north of the Humber. Some boats were catching mackerel at Lowestoft during this month. I several times opened the stomach of mackerel to see what the food was, and only twice found anything except a little white chyme. In both these cases the tail and backbone of a fish were present, and belonged apparently to a clupeoid: very probably they were feeding on sprats. I saw no Copepods or other Crustaceans in any of the stomachs. Up to the date of my departure from Lowestoft—October 22nd, the herrings, though full, had not begun to spawn.

III. CAUSES OF THE OBSERVED DISTRIBUTION OF FISH IN THE NORTH SEA.

As my paper in the previous number indicates, my interest in these investigations was chiefly excited by the fact that no satisfactory explanation appeared to have been discovered for the remarkable abundance of small plaice in the German Bight of the North Sea. The explanation suggested, and held by many to be sufficient, was that there was a current from west to east which carried floating or buoyant objects towards the German shores, and that, therefore, the buoyant eggs and larvæ of the plaice were carried thither in great numbers. Dr. Fulton* has recently made direct experiments on the course of the drift, by putting floating bottles into the sea in the neighbourhood of the Firth of Forth. In certain cases, out of groups of bottles put overboard at the same spot, some were afterwards found on the English Coast to the south, and others on the coast of Schleswig and the Island of Heligoland. The course thus determined for the general circulation would probably cause more of the plaice spawn, shed in the North Sea, to be conveyed to the German and Danish Coasts than to English. But the difficulty that perplexed me was that the peculiarity of the German grounds seemed to consist not in the greater numbers of plaice generally, but in the exclusive occurrence of small plaice at distances from land at which, on the opposite English Coast, large mature plaice seemed also to occur with the small.

It is not certain that this difficulty exists; if it does exist at all, it is not to be explained by the suggestion that the plaice of the German Bight are a smaller race. The smaller race, similar in the size at which maturity is attained to the Channel plaice studied at Plymouth, exists on the Dutch coast as far as the Texel, and extends to a distance of 50 miles from that coast.

* Thirteenth Annual Report of the Scottish Fishery Board, 1895.

The character of the plaice in the intermediate region from the Texel to Nordeney has not been examined, and the limit of the smaller race cannot be exactly stated. It is more probable that there is a transition from one race to the other than a definite boundary between the two.

It is important, as well as interesting, to notice that other biological features of the English Channel, as well as the small size of its plaice, are found to extend into the North Sea along the Dutch coast, and some of these extend as far as the German Bight, although the plaice there are *not* similar to those of the Channel. I am referring here to the fact that certain southern fishes which are found in the Channel, are also found along the Continental coast as far as the neighbourhood of Heligoland. The first of these to be mentioned is the anchovy. The history and migration of this fish has been repeatedly discussed in previous numbers of the Journal, and it has been often mentioned that there is a regular fishery for anchovies in summer in the great Dutch estuaries, namely, the Schelde and the Zuyder Zee. Dr. Ehrenbaum on one occasion found the eggs of the anchovy in abundance in the open sea farther east, near the Island of Nordeney. On the East Coast of England the anchovy occurs but rarely, and in very small numbers, except in the Straits of Dover. The second case is that of *Trigla hirundo*, called by the east coast fishermen the latchet, by Plymouth men the tub. My records show how constantly this fish is taken in the trawl, both on the Brown Ridges and in the German Bight, as far north as the Horn Reef, while on the English side it is seldom taken. The third case is that of the mackerel. Mackerel fishing takes place off Lowestoft in May and June, and again in September and October. South of the Horn Reef, in May, we took several large mackerel in the trawl, but I believe there is no regular fishery for mackerel in that neighbourhood. Mackerel are usually found in summer in the Moray Firth, but there is no fishery for them between that region and the Wash.

It would be interesting to discuss fully the relation between the biological facts here described, and the physical conditions in different parts of the North Sea. A series of careful physical observations has been carried out recently, according to an international scheme, in which Britain and Denmark, Germany, Sweden, and Norway have co-operated, the initiative in Britain having been due to the Scottish Fishery Board. The investigation of the channels connecting the North Sea with the Norwegian Ocean and Atlantic have been described by Mr. H. N. Dickson, and a paper on the observations in the more southern parts was read before the British Association last year. But these latter observations have not yet been published in full, and therefore their consideration in relation to the present subject must

be deferred. A few general facts may, however, be mentioned. The movement of floating objects, which Dr. Fulton found to occur in his experiments, is in accordance with the fact previously accepted that there is a current to the southward along the east coast of Britain, and another to the north-east from the English Channel along the Continental coast. The meeting of these two currents would necessarily cause a current across the North Sea, from the east coast of England, in a curve towards the Heligoland Bight. This movement, carrying with it the pelagic eggs and larvæ, is probably a very important factor in the explanation of the abundance of young plaice, soles, turbot, and brill in the Eastern Grounds, and generally along the Dutch and German coasts. The northward movement of Channel water along the Continental coast is also probably, in great measure, the cause of the extension of the range of the anchovy, latchet, and mackerel in that direction. But there are details which require further consideration. The anchovy, mackerel, and latchet clearly migrate towards the Dutch and German Coasts only in summer, and we know in a general way that along those coasts the summer temperature of the shallow waters is considerably higher than in the northern and western parts of the North Sea. But in winter the sea temperature along the Continental coast is lower than on the English coast; and although this agrees with the retreat of the migratory fish in winter, we cannot say how it affects the plaice, which appears to migrate very little, except from the shore to deeper water, as it grows larger. Another peculiarity of the water along the Continental coast is its lower salinity, due to the quantity of fresh water poured out by the great Continental rivers, and this may be one of the favourable conditions to which the abundance of plaice, soles, turbot, and brill, especially in their young state, is due.

A brief discussion of the growth and ages of the fish described in the present communication may not be without interest, and is inevitably suggested by the perusal of the memoir on the flat-fish of Denmark, recently published by the Danish investigator, Dr. C. G. Joh. Petersen.* According to the observations described in that memoir, it is possible, by measuring large numbers of plaice of all the sizes in existence at the same time of the year, to distinguish the broods of successive years, or, in other words, the fish of ages differing by one year. At certain lengths there are larger numbers of individuals than at intermediate lengths, these lengths being, of course, those of the *majority* of plaice derived from successive spawning seasons. In

* *Report of the Danish Biological Station*, iv. 1893, published 1894. [An abstract of this Report, prepared by Mr. F. B. Stead, will be found on page 213 of the present number of this Journal.—ED.]

fact, as the production of new plaice is not constant, but confined to a particular part of the year, the spawning season, it naturally follows that if sufficiently numerous measurements are made, the waves of production ought to be perceptible in the greater abundance of plaice at certain sizes, separated by regular intervals, each group thus distinguished representing the progeny of a single year.

It is better, when possible, to consider only the female sex in applying this method, because the sexes of the same age are of different sizes. The length at which the maximum number of specimens is found, in the sample from off Amrum on December 20th, is 13 in., while in the sample from off Nordeney in November, the corresponding length is between 11 and 12 in. Now we have not samples of all the other plaice in the same region at the same time, but we know that there were smaller, younger plaice nearer shore, and larger further seaward, and may reasonably consider the above to be the mid-size of the plaice which were completing their second year, which would be two years old in the following spawning season, about February. This conclusion is supported by the fact that they were all immature.

I am obliged to confess that I cannot altogether follow Petersen's arguments. He gives in his tables two samples taken in the Limfjord in the beginning of December, the mid-size of one being 14 in., of the other 12 in. to 12½ in. He takes 14 in. as the mid-size of what he calls group 2 from these samples, by which he apparently means that they are at the end of their third year. In my judgment, these fish closely resemble those I have examined from the German Bight, their mid-size is clearly about 13 in., and there is no reason to suppose that they are completing their third year. I consider them to be just at the end of their second year.

Petersen places the mid-size of his 2 group in the Limfjord, in July, at 10 in., of his 1 group at 5½ in., meaning by the former, plaice two years and some months old, by the latter those of one year and some months. I cannot see what reason he has for placing the middle of the 2 group at 10 in., as the largest number of specimens in his sample is at 9 in. With regard, then, to the larger northern race of North Sea plaice, there is a very distinct difference of opinion between myself and Dr. Petersen, which is most clearly exhibited in our conclusions concerning the 0 and 1 groups, that is of fish in their first summer and their second. Dr. Petersen criticises my observations in a note on p. 23 of his memoir, and there entirely ignores the fact that though I have not exhibited my data by the graphic method in tables quite similar to his, yet I have used the principle of the mid-size in separating the groups. It is true that I did not attempt to apply this principle to any extent to the 2 and 3 groups, but

I used it in distinguishing the 0 and 1 groups of plaice before Petersen had published anything concerning the growth of this species. Thus, Petersen says that my specimens in January, April, and May are explained by me as the fry of the year, but that they are the smallest specimens of a group reaching to 2, 3, 4, and 5 inches in length. Now a reference to my data on p. 347, Vol. II. of this Journal, will show that the greatest number of my specimens from the Humber at the end of April were 2 in. in length, while those of 3 and 4 inches were in very small numbers. I find it impossible to believe that these large numbers of plaice at 2 in. were over a year old, while the few of 3 and 4 inches were regarded by me as the smallest of the brood of the previous year. Petersen accepts my identification of the specimens mostly $2\frac{1}{2}$ in. long in June as belonging to the 0 group, though he says they were about $1\frac{1}{2}$ in. long, which is not correct. As to the absence of such specimens in May, which Petersen thinks supports his view, it was merely due to the fact that Mr. Holt did not collect any in that month.

With regard to the 1 group, or specimens in their second summer, Petersen considers that the specimens I assigned to this group, 8 to 12 in. long, from Arlberg (which he quotes as Esbjerg, Arlberg being apparently a misnomer) were over 2 years old. In his tables the 1 group in the Cattedgat, in May and June, are only 3 to 5 inches long. The fish in the Cattedgat appear to be considerably smaller than in the North Sea, and I certainly still believe my own estimates to be correct for the sizes at which the greatest number of individuals are found. Thus, in March, at the mouth of the Humber, the majority of plaice taken by the shrimp trawls were 7 to 8 in. long, and as far as the evidence goes the number of specimens between this and 2 in. are comparatively fewer. In May and June the mid-size of the fish brought from Schiermonnikoog and the Danish coast to Grimsby, is 9 or $9\frac{1}{2}$ in. If the fish in their second year were mostly 4 or 5 in. long in summer, these fish would necessarily be more numerous than those of 8 or 9 in. long, a supposition which is against all the evidence we have at present.

Petersen states that he marked 1000 specimens of plaice in the Limfjord, 7 to 10 in. long, in March and April, 1893, and they were from 13 to 14 in. long in October and November. They grew, therefore, 4 to 6 in. in length in 6 to 8 months, and yet he believes that at 7 to 10 in. they were 2 years old. It is certain that fish grow slower as they get older, so that it is almost impossible to believe that a plaice which could grow from, say, 8 to 13 in. in 7 months, should require 2 years to reach the length of 8 in.

I think, then, that we have very strong evidence that the smaller fish,

taken in spring and summer, near the German and Danish shores, and from 7 to 10 in. long are year-old fish, and that if we were to search for specimens less than 7 in. long at that time we should find them to be in smaller numbers.

With regard to the plaice from the Brown Ridges, there is considerable difficulty in forming a judgment concerning the age. We know that some flounders, and, doubtless, some plaice, spawn when they are two years old, but only a small proportion. The mid-size in the first sample is 12 in., and it is improbable that so many immature specimens of this size should be three years old, *i.e.* (the date is October), near the end of their third year. I can only suggest that we have groups 1 and 2 here mixed, that is, plaice nearly 2 and nearly 3 years old, as well as a few which are older.

The plaice from the Leman Shoal, and from off Lowestoft, present the same problem—we have evidently the same stages, only from a larger race of fish. We have the fish nearly 2 years old, those nearly 3 years, and some few older. The mature specimens belong to the last two groups.

With regard to turbot and brill, we can scarcely suppose that the former reaches the size of 14 in., and the latter 12 in., in one year. These are the mid-sizes of the immature females taken on the German grounds in June, and are, in all probability, the 2 year old fish. The year old fish, in the case of brill, probably 7 or 8 in., of turbot 9 or 10 in., would be found closer to the shore. Here, again, I differ from Dr. Petersen, who took large numbers of turbot, the mid-size of which was $9\frac{1}{2}$ in., in June and July, at Bornholm, and considers them to be 2 years old. It is true the size of the turbot may be much reduced at this island, which is far within the Baltic, but, on the other hand, Petersen found similar specimens, which he also takes to be 2 years old, in the most northern parts of the Cattegat, and he has no specimens, except one or two at 4 to 6 in., which he can assign to the year-old group. Of brill, Petersen places the 2 year old size at 10 in., the year-old at 5 to 7 in., in the Cattegat.

IV.—PROPOSED RESTRICTIONS ON THE LANDING OF UNDERSIZED PLAICE, IN THE LIGHT OF THE NEW EVIDENCE.

Before the Parliamentary Committee, which conducted an inquiry in 1893, the trawling industry of Lowestoft, as represented by Mr. J. W. Hame, strongly opposed any restrictions being enforced as to the size of fish landed. One of the reasons given was that restriction was unnecessary, because small fish, especially plaice, were not landed at that port. Mr. Hame told the Committee that the day before he gave his

evidence, namely, on May 10th, he turned out two boxes of plaice caught towards the Dutch coast, perhaps from 30 to 40 miles off that coast. He said that one box contained 110 fish, the smallest 12 in. long, and the other contained 90 fish, the smallest 13 in. long. These statements are quite at variance with my observations made at Lowestoft, during September and October this year, and I cannot help thinking that Mr. Hame was mistaken as to the grounds from which the fish came, or else was not sufficiently accurate in his numbers and measurements. The facts show that, on the one hand, a size-limit of 8 in. for plaice, as proposed by the Parliamentary Committee, would make no appreciable difference to the deep-sea trawling industry at Lowestoft, and, on the other hand, that higher limits, such as that which was proposed by Mr. Holt for the protection of the German grounds, would affect that port very seriously.

Mr. Holt's latest proposal was to enforce a limit of 13 in. from March 14th to September 30th, and he supported this proposal by the following contentions: That he had shown the proportion of plaice under 13 in. on the off-shore grounds of the North Sea to be inconsiderable, and that this limit, and no lower limit, would make it unprofitable to trawlers to fish on the Eastern Grounds. Now, it is necessary to see how this limit would work in the southern part of the North Sea, whose conditions I have described, and how it would affect the trawling industry at Lowestoft and Yarmouth. It is clear that the limit would stop the trawling on the Brown Ridges, and all the grounds along the Dutch coast south of the Texel to a distance of about 50 miles from the shore. In the box from the Brown Ridges, examined on October 2nd, no less than 140 out of 176, or over 79 per cent., were less than 13 in. long. In the box from the Dutch coast, received on November 18th, only 18 out of the whole 197, or not quite 8 per cent., were over 13 in. The Yarmouth and Lowestoft trawlers would have to work, therefore, on the English side, from the Outer Dowsing southwards, and, even there, would have to throw overboard a considerable proportion of the plaice now brought to market. In the box from the Leman Shoal, examined on October 4th, 47 out of 115, or 40 per cent. of the plaice, were under 13 in. In the box received on December 23rd, 83 out of 132, or 62 per cent., were under 13 in.

It can easily be inferred from these figures how the establishment of a size-limit of 13 in. for plaice would be received at Lowestoft and Yarmouth. If the regulation were rigidly enforced, it would entail the bankruptcy of probably the greater number of the smack owners, for it is not probable that the increase in the price at which the larger plaice could be sold would be sufficient to compensate for the loss of the smaller.

On the more northern grounds, which are worked by the Grimsby and Hull boats, the proportion of plaice below 13 in. is certainly smaller. Mr. Holt estimated it at 10 per cent., and he was well aware that his proposed limit of 13 in. involved the rejection of this proportion. But the evidence I have collected shows that the proportion is often higher than this. In the sample from the Dogger Bank, of which the measurements are given above, the proportion is 35 per cent., and the samples I described in my paper in the previous number show that a considerable number of plaice of 10, 11, and 12 in. are landed from the Dogger Bank, and, in fact, from all grounds less than 30 fms. in depth in summer.

It is perfectly true, as Mr. Holt pointed out, that the enforcement of a size limit of 13 in. would prevent English trawlers from fishing on the German coast in summer, and so prevent the great destruction of small plaice which they carry on. But with regard to the fishing on these grounds by German boats, I have received from Herr Düge the following important information, which will be of some assistance in forming an opinion concerning the result of keeping English vessels away, supposing the restriction to be put into operation only in Britain.

Sixty-three steam trawlers fish out of Geestemünde, and 600 to 700 sailing boats go there annually, from harbours on the Elbe. The steamers fish the whole year. The grounds worked in the different months are :

January : east and north-west sides of Dogger Bank.

February and March : Great Fisher Bank.

April : Horn Reef.

May : Horn Reef, and grounds twenty miles from East Frisian coasts.

June and July : Horn Reef and Skager Rack.

August and September : Mud-bank to the north of Heligoland, and the east and north-east sides of the Dogger Bank.

October : Mud-bank, Horn Reef, and Sylt ground.

November and December : Horn Reef, Sylt, and Jutland outer ground.

The German steamers seldom go west of 3° east longitude from Greenwich. The grounds off the Horn Reef, and the bank to the north of Heligoland, are much fished, those directly adjoining the coast less.

The sailing boats, on the other hand, fish from March to October almost exclusively within the distance of 3 to 30 miles from the East Frisian and Schleswig-Holstein coasts, and seldom go west of Terschelling, or north of Fanö. The reason of this is that the steamers fish mostly for haddock and cod, while the sailing boats seek for plaice and soles, and take the former to market alive.

There is nothing in this to show what proportion of the smallest fish on these grounds are taken to market, and it is probably true, as Mr. Holt believed, that there is a better market for the smallest plaice at Grimsby, Hull, and London, than in continental ports. At the same time, there can be no doubt that the German steamers, when they are on the small plaice grounds, must destroy as many small plaice as the English vessels, whether they throw them overboard, or take them to market, and with regard to the sailing boats, although they probably throw overboard the smallest plaice without killing them, I cannot believe that they do not take to market the plaice of 10, 11, and 12 inches, which, under the proposed regulation, English vessels would not be allowed to take. In fact, there can be no doubt that the German sailing boats depend for their maintenance and profit chiefly on the same fish as those which were brought to market by the *John Bull*, in the trip on which I was on board of her, namely, on plaice 10 to 13 inches long, soles, and small turbot and brill.

It may be admitted that it would be desirable, if it were possible, to protect and leave alive in the sea the plaice under 13 in. long. It would be desirable for two reasons—firstly, because the fish so preserved would be able to spawn, and secondly, because they would grow to a larger size, and be, therefore, more valuable in the market. According to the evidence I have given in the German Bight, the plaice below this limit are almost all actually immature, both males and females, and even on the Brown Ridges the majority of the females are immature. But we have to consider whether it would be practicable to carry out a prohibition of the landing and sale of plaice under 13 in. I have shown that such a prohibition would mean the closing of the grounds along the Dutch coast to a distance of nearly 50 miles. It must be borne in mind also that my evidence proves that a large proportion of plaice under 13 in., and still more of sexually immature fish, are taken on all grounds less than 30 fathoms in depth, which means a very large portion of the North Sea.

It would not be feasible to have one limit at Grimsby, and another at Lowestoft; the fact that fish from the Humber fleets, and from the Yarmouth fleet, which latter fishes the same grounds as the Lowestoft boats, are alike landed in London, shows how absurd the suggestion is. We have, then, the horns of a dilemma: a 13 in. limit cannot be applied to the grounds between Norfolk and Suffolk, and the Dutch coast, and no lower limit will keep the Humber trawlers from the small plaice grounds of the German Bight. We must then consider whether we are to disapprove of a size limit altogether, or to advocate a lower limit. It is clear that the imposition of an 8 in. limit would do little or no good. It is also certain that plaice of 11 in. and 12 in. form

a large proportion of those landed at Lowestoft. A higher limit than 11 in. does not seem practicable, and the question is, would that limit do any good? The difficulty, of course, is that which has so often been mentioned, that the fish would be usually dead when thrown overboard, and a limit to do good must prevent fishing on grounds where the small plaice abound. In the voyage of the s.s. *John Bull*, on the grounds to the north of Heligoland, plaice below 10 in. actually were thrown overboard, and as I saw myself, mostly dead. Nevertheless, vessels are often tempted to go near shore and fill their holds with such small plaice, when there are not enough larger plaice, soles, and other fish to make a profitable cargo. A limit of 11 in. would, I believe, be of distinct benefit in preventing such a practice. Unfortunately, as I mentioned in the account of my cruise on the *John Bull*, on the Eastern Grounds soles are usually more plentiful, where the plaice are smallest, and I do not see how to prevent vessels fishing for the soles and throwing the plaice overboard. Some of the plaice thrown overboard certainly live to grow larger.

The limit of 11 in. would have certain distinct advantages in addition to the above. It would prevent almost entirely the capture of small plaice below this size, which goes on in English territorial waters by small boats, and where it is not advisable to stop shrimp or inshore trawling altogether, plaice below the limit could be returned to the water alive. In my previous paper I suggested a limit of 10 in., and still believe that even that limit would be of some benefit, but after collecting more extensive evidence and further considering the matter, I have come to the conclusion that a limit of 11 in. would be both practicable and beneficial for the North Sea, and could be applied with equal benefit and no greater difficulty to the South Coast. As a limit of 10 in. is already in force in Denmark, it ought to be possible, in time, for all the nations interested to agree to adopt the same limit of 11 or 10 in. for plaice.

There is probably more chance of soles surviving, if thrown overboard, than of plaice.

The evidence shows that there is no such wholesale destruction of small soles in extra-territorial waters, as of plaice on the German grounds, but a considerable number of a length of 8 in. or less are captured and taken to market in territorial waters, as shown above at Lowestoft. The limit of 8 in. is not sufficiently above the limit of saleability to be of much benefit, while a limit of 12 in. would be unduly high. A limit of 10 in. would be beneficial.

There can be no doubt that the capture of such large numbers of undersized turbot and brill on the German grounds is extremely wasteful, and prejudicial to the general supply of larger fish. Such

undersized and immature fish of these kinds were not found on the Brown Ridges or other grounds worked by Lowestoft trawlers, but doubtless occur near the Dutch coast. There is no evidence that they occur on any grounds at a considerable distance from the shore. The reasonable and practicable limit for brill, in my opinion, is 13 in. ; 12 in., as recommended by the Protection Association, would not afford enough protection on the Eastern Grounds, and the 10 in. limit proposed by the Parliamentary Committee would be of very little use.

There can be no doubt that the limit for turbot ought to be higher than that for brill, and the practicable limit, in my opinion, is 15 in. It is certain that there are no mature females below that size, and that limit would not cause any difficulty to the fishermen, except on the Eastern Grounds, or other shallow inshore waters. I have already shown the important contrast in the size of the plaice caught in the two voyages to the Eastern Grounds, described in the previous number. The same contrast presents itself in the size of the turbot and brill. The smallest turbot seen, in the first voyage south of the Horn Reef, was an immature female 13 in. long; the others were seven mature males 14 in. to 22 in., and six mature females 24 in. to 30 in. Of the brill examined three were immature females, 12 in. to 15 in.; the others were eight mature females, 13 in. to 21 in. In the second voyage, on the other hand, when we fished nearer to the land, numbers of brill and turbot under 12 in. were taken.