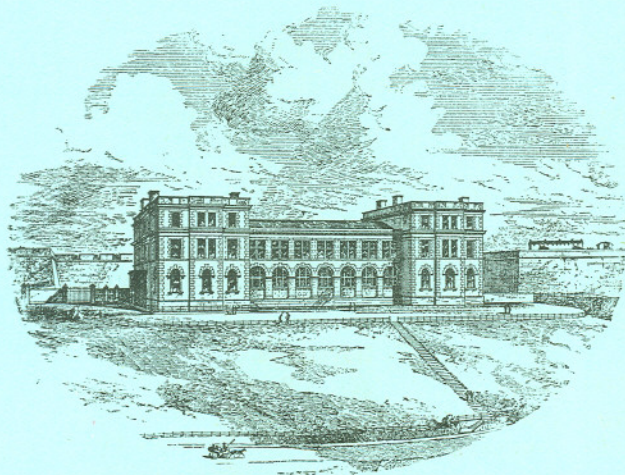


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AN EXAMINATION
OF THE
PRESENT STATE OF THE GRIMSBY
TRAWL FISHERY,
WITH ESPECIAL REFERENCE TO
THE DESTRUCTION OF IMMATURE FISH.

BY
ERNEST W. L. HOLT,
LATE NATURALIST ON THE STAFF OF THE MARINE BIOLOGICAL ASSOCIATION.



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1895.

An Examination of the Present State of the Grimsby Trawl Fishery, with especial reference to the Destruction of Immature Fish.

By

Ernest W. L. Holt.

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INTRODUCTORY.

It will be within the recollection not only of the comparatively small section of the community which is consciously interested in fishery matters, but of all those whom a sense of public duty or a lack of other occupation compels to some acquaintance with the current topics of the day, that the question of the deterioration of our sea fisheries commenced some few years back to assume something approaching to prominence. One of the earlier indications of the importance with which the question was invested, in the minds of those principally concerned, was the formation, in 1882, by a number of fish merchants, smack-owners, and others, of the National Sea Fisheries Protection Association,—a title which may

well be forgiven for its length, in consideration of the happy augury it holds out of the enduring nature of the Association's services to one of our most deserving industries.

The Association endeavoured to ascertain not only the extent of the evil with which it had set itself to battle, but also the best means of holding it in check, by adopting the method of summoning annual conferences, to which were invited fish merchants, smack-owners, and fishermen from all parts of the coast, members of Parliament, and other guardians of the interests of the nation, and even representatives of such scientific bodies as endeavour to cultivate an acquaintance with matters marine. Subjects were selected for discussion and votes taken, which latter would perhaps have been more representative had not the power of voting been confined to members of the Association.

Every student of matters social is well aware that a Conference is usually prolific only to the third generation. It begets a Resolution, the offspring of which, adhering to the strictly discontinuous type of variation, is a Deputation. A deputation has been described as a "noun of multitude, which signifies many but does not signify much;" and the unanimity with which the sufficiency of this definition is accepted by those in office, of whatever shade of politics, is alone sufficient to prove that "great minds think alike."

It is not surprising that the conferences with which we are dealing achieved, for several years, only the usual result, or want of it, since it cannot be expected that any parliament will lightly undertake legislation when the bulk of its members only profess such acquaintance with its subject as for once is actually somewhat akin to that which they possess; while, strange as it may possibly appear to less enlightened nations, the principal kingdom in the Union has no department capable of dealing with the matter by minor methods, though in Scotland there is a Fishery Board, and in Ireland a Fishery Office, entrusted with very considerable powers within the limits of their respective countries.*

The conferences, however, cannot be said to have been wholly without result, since in 1893 a Parliamentary Committee was appointed to hear evidence and furnish a report. On this report the hopes or fears of those interested are at present centred, according to the light in which they regard the recommendations it contains.

So far my remarks have only, and in the briefest possible manner, dealt with the attempts made by the N. S. F. P. Association, as representative of the fish trade, to induce the Government to take

* Somewhat similar powers are possessed by District Fisheries Committees of the County Councils in England, but each Council is independent of the others and, practically, of any central authority.

steps to check the evil of which complaints were made, but other action was being taken in the meanwhile. The Marine Biological Association, although its activity is in the main directed to the prosecution of what would generally be termed strictly scientific pursuits, has always given prominence to the study of those organisms which are of importance to our fisheries. Thus, even before the Laboratory was completed, my colleague, Mr. Cunningham, had commenced his studies of the development and life-histories of the fishes which form the object of the fishing industry of Plymouth and the neighbouring coast—studies which have been continued without intermittence down to the present time. I allude only to those investigations which have a practical bearing such as appeals at once to the intelligence of every one, though it may be claimed with perfect truth that there is no item of marine biology that has not its economic importance directly or indirectly, in that due appreciation of the conditions of marine life without which no rational treatment of fishery questions can ever be attempted.

As may be supposed, the agitation in connection with the alleged deterioration of the fisheries came early under the notice of the Council. Complaints of the scarcity of fish, and of the injury inflicted by certain methods of fishing other than those used by plaintiffs, are matters of immemorial antiquity, but the present agitation was distinctly original in character. It had its origin, as usual, amongst those interested in one particular method of fishing, viz. trawling; but it differed from all other known fishery grievances in that the complaints of the trawlers, and of those who dealt in trawl-fish, were directed, not against some other body of fishermen, but against themselves.

The trawler, of course, has long been the recognised piscatorial scapegoat, reviled by the inshore line-fisherman with an energy which is usually in inverse ratio to that with which he pursues his own calling, and condemned with scant ceremony by the amateur "naturalist" and the public at large. But on this occasion, as I have said, the trawler was his own accuser, and it must be noted that the agitation originated with, and was practically confined to, the ports of Grimsby and Hull, the two greatest trawling centres of the North Sea, which is, of course, by far the most important trawling district. Other trawling communities, if aware that they were doing excessive damage, at all events did not consider that the remedy lay beyond their own powers.

An agitation conducted by one class against another obviously invites the suspicion that it is based chiefly on motives of self-interest, without any particular regard for the welfare of the community at large; but in a case like the present, though self-interest

may reasonably be inferred to be the motive of inception, there would seem to be a much greater chance than usual that the object desired is for the general benefit as well as for that of the agitators.

Still, however strongly the genuine nature of an agitation may appear to be warranted by the probabilities of the case, common prudence demands that it should be supported by the most exact evidence of which the circumstances permit; and especially is this the case in fishery affairs, since experience has taught us that the ignorance of the fisherman of the most elementary features in the natural history of the organisms on which he depends, often leads him to set forth as fact, matter which is by no means capable of that denomination.

Moreover, granted that the complaints prove to be well founded, it will be conceded that remedial measures beneficial to the whole community have their best chance of origin in investigations conducted from a standpoint altogether independent of any trade interest whatsoever.

On these accounts it appeared to the Council of the Marine Biological Association that here was an investigation in which the means at the disposal of the Association could be most usefully employed, and no time was lost in instituting a series of inquiries as to the alleged destruction of immature fish by beam-trawling in the North Sea, and the best means of checking such destruction, if it should be found to exist on a serious scale.

These inquiries the Council was good enough to place in my charge, and for three years, according to my ability and opportunities, I have laboured to collect whatever information seemed to bear on the case. My headquarters were at Grimsby, where the Association, by arrangement with a local Society, secured a small laboratory, fitted with tanks and other conveniences, for my use. From time to time I have communicated the result of my inquiries, either in the form of articles in the Association's Journal, reports to the Council, or evidence before the Parliamentary Committee.

At the end of three years the object of the investigations may be said to have been accomplished, since sufficient evidence has been collected to allow us to form a fairly reliable opinion on the question, and the investigations have accordingly been closed so far as this particular matter is concerned.

Of course an important fishery like that of the North Sea will always afford abundant scope for the activity of the scientific inquirer, but no new question of paramount importance has as yet arisen, nor, indeed, is the old one by any means settled. Still we have at our disposal all the material necessary for dealing with it in a rational way, should such a proceeding ever commend itself to our

legislators. I have indicated the various channels through which my information and views have already been communicated to the public; and, on closing the inquiries, I have been requested by the Council to draw up a brief epitome of the results arrived at, so that they may be presented to the public in a concrete form.

To do this is the object of the present paper, which is designed for a section of the public much more extensive than that which is in the habit of concerning itself with the literature of professional fishery. It is too much to hope that I may be able to invest my remarks with any interest not indissolubly connected with the subject itself, since facts are at best dry reading, and the habits of the scientific writer are not such as to pre-eminently qualify him for the lighter graces of popular penmanship.

A few words are necessary as to the arrangement of my material. The complaints of the trawlers and fish merchants resolved themselves into the following brief statement:—That large numbers of immature fish were destroyed by trawling, and that the supply of trawl-fish in the North Sea was in consequence diminishing. The fish especially referred to were flat-fish, the question of round-fish being considered of secondary importance. It was evident that, as to the diminution of the supply, I could not hope to obtain any absolute evidence of my own. Whatever information was deducible from the Board of Trade statistics was open to every one, and those statistics hardly went far enough back to be of much value, and were, and are, altogether insufficient in detail. I had, therefore, to depend, in forming an opinion, entirely on the reminiscences of fishermen, eked out in a few cases by the books of smack-owners. Any details of information under the last heading I am neither at liberty nor in the position to publish, and I must dismiss this branch of the inquiry with the assertion, whatever it may be worth, that I hold the opinion that there has been a considerable deterioration in the supply of the more valuable kinds of flat-fish. In the case of haddocks I am not convinced that the deterioration has been considerable. Such statistical work as I have carried on since I went to Grimsby will be referred to in due course.

With regard to the alleged destruction of immature fish, the first point to ascertain was the correct definition of the term immature; and then to find out where, and to what extent, the alleged destruction took place. This involved an examination of the different grounds, with the collection of all possible information as to their previous history.

Inseparably related to the whole question is the condition of the

trawl-fishery as a whole, the methods by which it is conducted, and the conditions of the trawlers' life. Not only the deep-sea fisheries, but all minor industries which could in any way affect the question, demanded inquiry, and in the succeeding chapters I shall endeavour to deal with these several matters.

PART I.

CHAP. I.—THE NORTH SEA FISHERIES.

IN addition to trawling, with which we are here almost exclusively concerned, the North Sea furnishes scope to a number of other branches of the fishing industry. Of these, line-fishing and drift-netting are the most important; oyster-dredging is a considerable deep-sea industry, and whelking may almost be included in the same category. The remaining branches, such as crabbing, lobster-potting, shrimping, and seining, are carried on in the more or less immediate neighbourhood of the coast. We are concerned with none of these except in so far as they may be shown to affect, or be affected by, trawling.

The North Sea fishery, if the apparent paradox may be pardoned, is by no means confined to the North Sea itself, since it is impossible to leave out of consideration the fishing operations of vessels belonging to, and regularly landing their fish at, North Sea ports. Many of these, chiefly liners, derive the bulk of their fish from grounds which lie altogether outside the limits of the North Sea. The Orkney, Shetland, and Farøe Islands, Rockall and Iceland, are all extensively worked by North Sea codmen, and the last-named district to some extent by trawlers also; the fish from these grounds pass through the North Sea markets, and are not discriminated in any Government returns from those caught in the North Sea.

A certain number of boats belonging to North Sea ports are engaged in fishing operations on the west coast of England and elsewhere, but, for the time being, they land their fish on the west coast, and so may be considered to cease to belong to the North Sea fishery. Drift-net boats—at least those which are worked the whole year round—may be said to be nomadic, making their headquarters in whatever district the fish may be at the different times of the year.

Fisheries of various kinds are carried on all along the east coast of Scotland, and these must of course be held to belong to the North Sea group. The bulk of the line-fishing, however, is done close to the ports to which the vessels belong; and even the trawlers,

which are by law excluded not only from the territorial waters, but also from some grounds which can hardly be said to lie within the territorial limit at all, take very little part in fishing the grounds frequented by vessels from the east coast of England. An occasional Scotch steam-trawler may be found fishing the southern part of the North Sea, and landing her fish at an English port, but otherwise the industries of the two nations do not seem to commingle much. Consequently I do not think it would be profitable to enter here into a discussion of the Scotch trawl-fishery, even if I possessed any special qualification for the task.

The trawling industry of the east coast of England centres itself at various points along the coast, which are roughly divisible into a northern and southern group. The northern group comprises Grimsby and Hull, and several ports of minor importance, while Lowestoft and Yarmouth are the chief centres of the southern group. At certain seasons of the year, vessels from all ports may be found on the same grounds; but, speaking generally, those of the northern group are occupied on more northerly grounds than the rest.

The relative importance of the different trawling ports may be judged from the subjoined list of the numbers of boats owned and resorting to each. The figures, however, have at best only an approximate value, since of the total number of boats belonging to, say Grimsby, there is nothing to show how many may have been employed away from the North Sea, and for how long, during any one year. Again, in the number of boats resorting to a port, the statisticians of the Board of Trade (from whose returns this column has been taken), if they possess any information as to how often boats belonging to other places visited the port in question in the course of the year, do not take the public into their confidence. It appears to be the peculiar function of the Fisheries Department of the Board of Trade to formulate statistics which shall be just sufficiently complete to bring into strong relief the importance of what is omitted from them.

The preponderance of Grimsby as a fishing port is entirely independent of the drift-net fishery, since it sends not a single vessel to that industry. It rests almost entirely on the deep-sea trawl and line fisheries, although a certain number of its first-class vessels are engaged in deep-sea oyster dredging and whelking. Hull, though owning a less number of vessels than Yarmouth or Lowestoft, is only second to Grimsby in the trawl and line fisheries, since the whole of its fleet is devoted to these industries, and its large fleet of steam trawlers much more than compensates for its inferiority to southern ports in the number of its sailing trawlers.

The conditions under which the deep-sea trawl-fishery is carried

Table showing the number of first-class Trawling Vessels owned (i) and engaged (ii) at the chief ports on the East Coast of England.

	i.			ii.		
	Steam.	Sailing.	Total.	Steam.	Sailing.	Total.
NORTHERN GROUP:						
Grimsby	124*	460*	584	184	546	730
Hull	173	250	423	160	280	440
SOUTHERN GROUP:						
Yarmouth	11	456†	467	11	422	433
Lowestoft	0	300‡	300	0	320	320

Table showing the total number of first-class Fishing Vessels of all sorts owned at different ports on the East Coast of England.

	Steam.	Sailing.	Total.
Grimsby§	143	664	807
Hull	160	280	440
Boston	35	12	47
North Shields	88	0	88
Scarborough	16	71	87
Sunderland	10	0	10
Hartlepool	0	39	39
Yarmouth	11	498	509
Lowestoft	0	447	447
Ramsgate	0	159	159

* Of these vessels, 4 steam "fleeters" and 82 smacks may really be eliminated, as belonging to a company which fleets all the year round, and lands its fish at London by steam cutters.

† Of this number 71 sometimes trawling, at other times drift-netting.

‡ Mr. B. M. Bradbeer (in litt., 19/2/95) remarks that there are between 30 and 40 Rams-gate trawlers which work from Lowestoft. Column ii (from Board of Trade Returns for 1893) is therefore too low for the present year.

§ The number of trawling vessels has already been specified; the balance is made up as follows:

(i) Steam codmen	20
(ii) Cod smacks	76
(iii) Oyster smacks	14
(iv) Whelkers	17

The crews carried by these vessels are—for (i) skipper, mate, four deck-men, three or four apprentices, two engineers, two coal-trimmers, and steward; for (ii) skipper, mate, two or three deck-men (three if there are less than four apprentices), and two to four apprentices; for (iii) six men, including skipper; for (iv) four men including skipper.

out at the different ports differ, so far as I can learn, chiefly in regard to the grounds affected, and in regard to certain market customs and requirements with which we are not here much concerned. My own knowledge of the deep-sea work is derived almost entirely from Grimsby, so that any remarks I have to make must be taken as applying to that port, unless special mention is made of another. I do not know of any particulars in which the Hull fishery differs from that of Grimsby; the boats seem to work precisely the same ground, and are of the same build and average tonnage. Much of the Scarborough trawling fleet is more or less constantly employed at Grimsby, and steamers from the more northern ports are at least frequent visitors.

The fine fleet of steamers owned in Boston appears to be engaged in the same operations as those from Grimsby and Hull. I cannot claim much special knowledge of the boats belonging to southern ports, but I believe that the necessarily scanty nature of the account which I give of them is of little importance, owing to the absolute preponderance of Grimsby and Hull in the North Sea trawl-fishery as a whole.

Besides the deep-sea fisheries, in which we may include trawling, lining, and drift-netting, and, at Grimsby, oyster-dredging and whelking, there are a certain number of men at most of the larger ports engaged in longshore work of one sort or another, such as shrimping, prawning, crabbing, seining, whelking, stake-netting, inshore line-fishing and trawling, &c. &c. With some of these we shall have to deal in a later chapter.

The regular prosecution of the deep-sea fisheries may be said to be confined to such large centres as our remarks have hitherto dealt with. Such centres have, no doubt, attained their present importance in virtue of physical conditions which have lent themselves to the development of the fishery on a large scale, but there exist, of course, a great number of smaller communities.

In fact, wherever the nature of the coast permits of the launching of a boat of any sort, there will be found a race of fishermen engaged in such operations as the harbour or beaching accommodation and the resources of the adjacent grounds permit.

But the conditions of these small communities are altogether different from those of the larger centres. Their importance, in fact, may be said to be purely local, and the share which they bear in the production of the general food-supply of the nation is so insignificant that the extinction of any one of them as a fishing community would hardly be felt outside the limits of the parish. It needs, however, no argument to demonstrate that their welfare is none the less important on this account; and I believe that for many years the

recently constituted District Fisheries Committees will find the most profitable outlet for their legislative energy in safeguarding the true interests of these smaller communities, while they are fitting themselves for the much more difficult task of coping with the problems in connection with the greater fisheries.

Apart from the question of its production, a small fishing community differs essentially from the larger ones in what may be termed the social conditions of the industry. In many cases—in fact, in most—the men are fishermen by heredity, and every member of the family assists in the trade to the best of his or her ability. For generations the men have been fishermen, intermarrying almost entirely amongst families engaged in the same occupation, and it seems quite possible that it will be some time before those twin reformers, the board school and the penny novelette, will succeed in seducing any considerable proportion of the race to pursuits which may appear to offer greater profits at less outlay of work and hardihood. In these small communities there is hardly such a thing as specialisation in fishery; every man is acquainted with, and practises in due season, every mode of fishing which is possible to him, and frequently ekes out his subsistence by farming on a very small scale.

There are among them no fishing companies, not even smack-owners on a large scale, but each man either owns his own boat, or at least stands in a much more familiar relationship to the owner than is the case in the larger communities.

My own acquaintance with the small fishing centres is confined to those on the coast of Yorkshire, and among them we find represented almost all stages in the evolution of a modern fishery. Some appear to have retained unchanged the condition which must have been ancestral to that of nearly all the large stations. Others are perhaps in a state of transition. I include Scarborough among the larger centres, in virtue of the number of first-class vessels which are owned at, if not by any means constantly worked from, that port, but it presents certain peculiarities of interest. The development of the fishery, due to the introduction of trawling, has by no means swamped the inshore fisheries; while the limitations of the accommodation for large vessels, and the competition of other centres possessing better harbours and greater railway facilities, appear to have put a term to much further progress in the deep-sea industry. At the same time the protection afforded to the inshore men by the District Committee's regulations appears to be materially improving their welfare, and may tend to bring about something of a reversion to the more primitive condition.

The important part which the introduction of trawling has played

in the modification of the fishing industry of communities which were originally devoted to longshore and drift-net pursuits, cannot be better illustrated than it is in an account which my friend Mr. T. N. T. Potts has given me of the Sunderland fishery during the period covered by his own memory. It is reproduced at length in a succeeding chapter (p. 367).

In the smaller fishing stations, where no sufficient harbour or beaching accommodation exists, it follows that there are no large fishing vessels. Such may be owned and manned by the men of a small station, but of necessity they frequent some port with a suitable harbour. The work is chiefly carried on in small open boats, cobs and whalers, which can be beached without much difficulty. The nature of the fishing varies with the time of year. In the spring and early summer the manipulation of crab-pots will occupy the bulk of the community; later in the year the herring make their appearance, and promptly receive due attention. For their capture either the small open boats are used, or larger decked boats which spend the rest of the year high and dry on the beach, or, at Whitby, far up the river.

The herring season (or in the south the crabbing season) over, recourse is had to line-fishing, chiefly for cod and haddock, and the question of bait at once becomes of importance. If a productive mussel-bed exists within a reasonable distance, cargoes are brought and re-sown by the larger vessels before the latter are laid up, and from time to time the supply is renewed,—by the cobs, if weather permits; if not, by rail. Where the coast is rocky, “flithers” (limpets) are collected, as required or available. Lugworms are highly prized, but are comparatively little used, as few are obtainable at any place where an inshore line-fishery is carried on, and their perishable nature has so far militated against their dispatch from the Humber estuary, where they swarm unmolested in countless thousands. On the sandy part of the Yorkshire coast south of Flamborough the chief bait supply appears to be whelks, obtained by “potting;” but other bait, such as squid, herring, and mussels, is imported.

It need hardly be remarked that the conditions, social and otherwise, under which the deep-sea fisheries are carried on from large ports, such as Grimsby and Hull, are altogether different from those which obtain among the small inshore communities with which we have just been dealing. Deep-sea fishing, involving prolonged absence from port in every possible kind of weather, can only be carried on in decked vessels of considerable size, and manned by a number of skilled hands; and we find the fisherman, instead of being owner or part owner of the boat in which he fishes, is usually

a hired servant, receiving a regular wage, and interested to no considerable extent in the pecuniary success of his fishing operations. In some cases, which are becoming, I am told, fewer in number every year, the skipper is also the owner of his vessel,—either actually so, or, much more frequently, owner only in name and on sufferance of the mortgagees. By far the greater number of vessels, however, are in the hands of companies or large private owners, and the hands engaged in working them are simply the servants of the owner. The method or rate of payment differs according to the rank of the hand. Thus the master or skipper, and the mate or “second hand,” are paid in shares of “clear money” or the profits, and are held responsible in corresponding shares of the expense if the vessel is worked at a loss. In the case of a steam-trawler the expenses reckoned in estimating the clear money are coal, engine-room expenses, ice, and men’s food, and 5 per cent. on the price obtained for the catch. After these items have been deducted from the gross receipts of the voyage the skipper gets “one share, and one quarter and one half-quarter” of the balance, which is divided into fourteen shares. The mate, or second hand, takes one share and one eighth. Both skipper and mate pay for their food, provided at retail prices from the company’s stores by the steward. The “third hand” and the “deck hands” are paid a fixed salary, are provided with food by the owners, and are also, in common with the apprentices, allowed to make what money they can by the sale of “stocker bait,” a term which formerly included a number of the less valuable kinds of fish. Some years since the owners, finding a decrease in their profits, and noting, no doubt, a rise in the price of fish which had previously been hardly saleable, came to an arrangement with the men by which the latter surrendered their rights to the “stocker” and received an increase of pay, which was supposed to compensate them for the loss. They have, however, retained the right of selling fish-livers for their own profit. The livers are stored in ordinary petroleum casks, and sold to oil refiners at ten shillings per cask. As may be imagined, it takes the livers of a considerable number of fish to fill a cask, even when liberally adulterated with sea-anemones (*Actinoloba dianthus*), so that the profits accruing are not excessive. I have known instances in which the men have been allowed to sell such fish as gurnards and rays for their own profit, but I believe that the owner is strictly within his rights in laying claim to everything that comes on deck. It will hardly be credited, perhaps, that within the memory of living fishermen, haddocks were a perquisite of the apprentices!

In a steam-vessel the engineers receive a fixed wage, and have no interest whatever in the catch. The coal-trimmer is usually an

apprentice ; his duties are by no means confined to trimming coal, and he receives his share of the "stocker," besides many attentions from the superior members of the crew, with which he would probably be glad to dispense. Line-fishermen, besides their regular pay, receive a certain sum per head of fish, but this is not the case with trawlers. In all cases the owner finds everything in connection with the equipment of the vessel, and provides a steward or cook, who is paid a fixed wage. The remainder of the crew are paid weekly wages, and are supplied with food by the owners.

The skipper of a steam codman receives 9 per cent. of the "clear money." The mate gets £1 per week, and 3*d.* in the pound on the clear money ; deck men £1 per week and 2*d.* in the pound on the clear money. The engineers get respectively £2 5*s.* and £1 15*s.* and their food while at sea, but take no share of the catch.

Now the conditions of service, which I have endeavoured to sketch, obviously involve a social atmosphere very different from that which one encounters in the small communities of inshore fishermen.

The duties of the deep-sea man commence when he goes on board his ship ; and when he has landed the fish and cleaned the vessel his interest in her ceases until she starts on her next trip. In consequence his family, if he possess one, takes no sort of share in the fishery. Again, the large size of the vessels and gear employed in the deep-sea fisheries involves a considerable intricacy in the technique of fishing operations, and thus to a great extent the men become specialists either in trawling or lining : some adaptive geniuses of course there are, but as a rule a man is either a trawler or a liner, and not both, and the members of these two branches of the profession appear to have surprisingly little intercourse with each other. But if there is not much intercourse, neither is there much friction, and you shall hear from ten inshore line-fishermen more abuse of trawlers in ten minutes than you shall hear from a hundred deep-sea liners in a year. The fact appears to be that the social conditions of the larger communities, if not very obviously conducive to the higher graces of manners and speech, at any rate tend to evolve an independence and self-reliance which are not always as evident among the inshore men as they might be.

It has often been suggested to me by persons well acquainted with the district that the conversion, for part of the year, of some of the smaller fishing centres into watering-places has had rather a demoralising effect on the fishermen. The prospect of being able to make a good deal of money by pleasure-boating in the season is said to make the men rather careless of the fishing, and it can be well understood that a fisher-lad is not likely to attain to great skill in his profession if he employs a large part of his time in other pursuits. Indiscriminate

charity is also said to have had a bad effect; and, indeed, it can hardly conduce to a man's independence to have benevolent old women advertising for his relief!

The deep-sea fishing is not entirely confined to trawling and lining, though these pursuits occupy by far the largest proportion of the Grimsby fishermen. In addition, a certain number of smacks are engaged in deep-sea oyster dredging, and there is a considerable fleet of "whelkers." Judged by Hull and Grimsby standards, the boats engaged in whelking are comparatively small, but since they remain at sea for prolonged periods they may conveniently be classed among the deep-sea craft; they are all sailing-vessels, as are also the larger boats engaged in oyster-dredging. Lining and trawling are carried on both by smacks and steam-vessels. The former are nearly all first-class vessels, varying from 95 to about 60 tons (displacement measurement), though there are a few liners of small size. The steam-vessels do not differ from each other greatly in dimensions, but they are still undergoing a process of evolution. The present fleet includes a few which are simply smacks into which engines have been put, while the rest have been laid down as steam-vessels, and exhibit various stages of improvement according to their age. The very newest departure is the adaptation of the petroleum engine to fishing purposes, an enterprise which has yet to stand the test of experience, but which seems to have all the elements which should conduce to a successful issue. Steam is not utilised in fishing purposes for motive power alone, since even the sailing trawlers are fitted with a small engine for heaving up the trawl and hoisting the sails. The lining vessels have no use for steam except as motive power, since, as the long-lines are hauled by the ship's boat, no adaptation of steam-power to an "iron man" is practicable. These vessels are of course fitted with a well, while trawlers have an ice-room and fish-hold. At least one steam-vessel, the S.S. 'Aquarius' of Grimsby, has a compartment which can be filled with water as a well for lining purposes, or pumped dry to serve as a fish-hold, and can therefore be utilised for either branch of the industry. In the majority of lining vessels there is no means of closing the apertures by which the water is admitted to the well, an obvious disadvantage when it is necessary to bring the vessel a considerable distance up an estuary or into a harbour, where the low specific gravity and general impurity of the water are prejudicial to the living freight. If the well is fitted with valves, good water can be brought in from the open sea, but there is a disadvantage on this side also, since, if the ship has to lie in dock some hours before unloading, the water stagnates and the fish are asphyxiated. The leading spirits of the fishing community have, however, proved

equal to the emergency by devising an air-circulation. The device has been arrived at, I believe, quite independently, although the principle of an air-circulation has long been familiar to those interested in aquaria, and we have here an instance of a case in which the "practical" man might have saved himself much expenditure of ingenuity by a little attention to what is being done by his scientific brethren. It may be urged, perhaps, with equal truth that the biologist should have perceived the opportunity of an economic improvement, and I have to confess that the idea of adapting an air-circulation to a ship's well did not occur to me until last spring, when I had occasion to fit such a circulation to the Cleethorpes tanks. On communicating my ideas to a smack-owner I found that he was at that time actually engaged in patenting an apparatus essentially similar, but devised entirely by himself and friends.

The preceding remarks will perhaps suffice for our purpose, without entering into a long technical description of the various classes of fishing vessel. Indeed, such is hardly necessary, as Professor M'Intosh has recently published in the Association's Journal a detailed account of Scotch steam-trawling vessels, and the later types of these agree with the Grimsby boats in all essential details. It may be remarked, however, that a deck-house is confined to Aberdeen boats, and no English trawlers that I know of carry an otter-trawl.

Grimsby steam-trawlers are divided into two classes. Those ranging from 35 to 40 tons nett register are spoken of as "inshore" boats, though it must not be supposed they work what are, strictly speaking, inshore grounds. These boats carry a 50-foot beam-trawl and 200 fathoms of warp. The larger steam-trawlers range from 50 to 70 tons, and carry a 56-foot beam and 250 fathoms of warp. The bridles in both cases are 26 feet long.

The smaller trawl-smacks carry a beam of 44 feet, and 140 fathoms of warp. The larger ones have the beam 50 feet long, and 180 fathoms of warp. The warp of a steam-trawler is of wire, smacks using warps of manilla rope.

The sailing trawlers at Grimsby and Hull are fast being superseded by the steamers. The latter increase every year, while the former are gradually disappearing, those which succumb to wreck or old age being seldom replaced by new ones. At Boston the deep-sea trawling industry was started by steamers, and has never been carried on by smacks at all.

At Lowestoft it appears that steam-trawling has been considered unsuitable, and that the smacks are increasing. Moreover, at this port a class of vessel smaller than that generally in use at the Northern ports finds most favour, and the modern type of smack

is only from about 45 to 50 tons. Yarmouth and Ramsgate smacks are, I believe, essentially similar to those of Lowestoft.

It is hard to see why Grimsby men should consider that the large smacks are the best, while Lowestoft men prefer the small ones, since I know of no difference in the conditions under which the fishing operations are carried on from the two ports to account for this. The Grimsby smack has been evolved, chiefly by gradual increase of size, from the much smaller South coast boats, which first opened up the North Sea trawling; and every step in their enlargement seems to have been viewed with apprehensions, which were never justified by the results. The largest I know of exceed 90 tons register, and it is impossible to say that the size would not have been further increased had not the immensely superior catching powers of the steamers practically diverted all piscatorial ingenuity into a new channel.

One branch of trawling remained exclusively in the possession of smacks until quite recently. This was *fleeting*,* the function of steam being confined to the carriage of fish, caught by *fleeting* smacks, to market; but within the last two years there have been launched several steamers designed especially for *fleeting* purposes, and no doubt, if there remain anything to trawl for, the sailing smack will be gradually driven from this, her last vantage-ground.

CHAP. II.—A "VOYAGE" ON A STEAM-TRAWLER.

It may be of interest to give a brief account of a trip on board a trawling vessel, as giving some little insight into the life led by our deep-sea fishermen when engaged in their calling.† For this purpose a voyage in July, 1893, as having covered more grounds in one trip than is usually the case, will best serve. The ship, a steam-trawler, was due to sail with the morning tide, and I found my way on board, at the hospital dock, in good time. The engineers were already on board, and one by one the rest of the crew dropped in, the skipper arriving just as it was time to make for the dock gates. Subject to occasional exceptions, the skipper has absolute discretion

* In "*fleeting*" the trawlers remain on the ground, and transfer their catches to carriers instead of returning to port themselves with the catch.

† I gladly take this opportunity of saying that I have always found both owners and skippers most willing to give me a berth on board their boats, and have received the greatest possible kindness and assistance at sea.

as to what grounds he will fish, and in this instance, as far as I could gather, our skipper had decided to try for a catch of small plaice, and anything else he could come by, south of the Horn Reef, on the Danish coast. However, the plans of skippers are notoriously changeable, and that they should be so is perhaps as good a proof as any of the uncertainty which attends the North Sea trawl-fishery in its present condition. We were hardly clear of the dock gates before we met another trawler of the same firm coming up the river. Professional etiquette, not to speak of other considerations, demanded that both skippers should slow down and have a parley, and the usual query "How's trade?" was, for a wonder, answered with "A good living." Inquiries as to where this "good living" was to be found elicited the information that plaice were plentiful "below" (north of) the Reef, so our skipper determined to give the ground a trial, and laid his course accordingly on clearing the Spurn Lightship. I may here remark that fishermen at sea always appear most willing to give each other information as to the fish to be found on grounds which they have been working. Whether it is correct information or not is another matter.

Having left the river and got a clear course for the Horn Reef Lightship, we have now leisure to have a look at the principal members of the crew. Pretty nearly all the nations of the earth are represented in the North Sea trawling community, from Kroomen to Farøe Islanders, and on this occasion our skipper was a Prussian, and his mate a Dane. The former has the reputation of having landed more undersized plaice than any other man in the world, and it was chiefly this consideration that induced me to seek a berth on his boat. He was fully acquainted with the object of my inquiries, and was, and I believe is still, as anxious as any man that the destruction of small fry should be stopped, but made the perfectly candid reservation that, as long as there was a market for such stuff, he did not see why he should not make use of his experience of the coast, and knowledge of the habits of the fish, to catch more of them than anyone else could. It would be libellous to suggest that a wholesome contempt for the three-mile limit may not have been an unimportant factor in his previous successes. He was excellent company, and certainly did not betray his foreign origin by any ignorance of the intricacies of the English language, as commonly spoken at Grimsby. To his other accomplishments he added that of the violinist, and usually beguiled the tedium of the evening with frequent renderings of the one tune with which he appeared to be acquainted.

The mate, a huge Dane, was known as "Tom," because, I suppose, that was not his name. He was a good-natured soul, and

submitted to any amount of chaff from pretty nearly every member of the crew, but knew perfectly well, nevertheless, how to get the required amount of work out of them. The captain and he were very fond of indulging in elephantine gambols, and gave and received, with perfect unconcern, blows which seemed calculated to stave in the side of a hogshead. The chief engineer, of course, had been brought up in that calling, but his subordinate was an ex-dragoon, whose capabilities did not extend much beyond stoking. The steward had served twenty-one years in the Black Watch, and had lost a thumb, not in the service of his country, but from the sting of a weever (*Trachinus draco*), which he had incautiously handled on one of his earliest voyages. The symptoms, as described by him, appeared to be precisely similar to those which one reads of as resulting from the bite of an adder. The rest of the crew do not call for special remark, but, taking them all round, they were as pleasant and good-natured a set of fellows as one need wish to meet with in any rank of society. They all arrived on board in shore-going costume, looking very unlike the fisherman of romance, and it was not until the evening that they got into their jerseys, oilskins, and sea-boots. The skipper despised the latter altogether, and affected a very ancient pair of "clumpers" (shoes with a thick wooden sole), when the deck was too wet for even him to be comfortable in stockings only. Once the sea-going kit is donned, I have never observed that any change is made until the boat reaches the river on its homeward voyage; and ablutions, if carried on at all, are certainly infrequent. However, any part of the person not covered by oilskins is sure to encounter plenty of water, if no soap.

To resume our narrative, the south-westerly wind had freshened very considerably before we made our land-fall, and the skipper remarked that such weather would have been certain to have spoiled his chances of a catch south of the Reef, since fish will not stay there with heavy weather from that direction, especially so late in the season. The weather had its usual effect on myself, since, though my business takes me a good deal to sea, I am an incurable victim to *mal de mer*, and on this occasion I spent the usual day or so of misery before I was thoroughly right. It did not prevent my noting the duration and locality of hauls with the net, or the fish caught, but tow-netting and microscope work were out of the question. The skipper was exceedingly sympathetic, and prescribed remedies, but to my exceeding good fortune had mislaid the key of his medicine chest, so I escaped with nothing worse than the sea-sickness itself. I should say that the decoction known on North Sea smacks as "tea" had made its appearance not long after we left the Humber.

It consists of a quantity of tea, a tin of condensed milk, and about two pounds of sugar, boiled together for some hours in a huge kettle. Day and night this remarkable beverage is on tap as long as the vessel is at sea, and every man has a mug of it within reach, whatever he may be doing. I can confidently recommend it to anyone who wishes to experience most of the sensations of sea-sickness without the trouble of going to sea. For any other purpose I have nothing to say in its favour, nor, I believe, have those who have medical cognisance of the piscatorial constitution.

Our first haul was made late at night on the Danish coast to the north of the Reef, and for a day and a half we worked along northwards, fairly close inshore, without any luck at all. A heavy sea was running, and we did little but tear our nets, so that all hands were busy mending one net while the other was fishing. The skipper of a steam-trawler appears to have no actual duties beyond that of command, except when the net is being shot or hauled. In the first case he takes the helm, and in the last he has charge of the steam-winch. He takes no share of the watches, nor does he assist in the cleaning and stowing of the fish, but in mending the gear he generally lends a hand. The skipper should be, and generally is, the best hand on the vessel, and with the netting needle certainly no one could come near our particular skipper. All hands, except the engineers, have to turn out when the trawl is shot or hauled, but are otherwise divided into watches. The usual practice on steamers is to make two hauls of six hours at night; and the same, or one of twelve hours, by day. On bad ground, or when fish is very plentiful, shorter hauls are made. Sailing vessels, when "fleeting," usually shoot towards nightfall and haul by daybreak, the daytime being occupied in getting their fish on board the cutter and beating up to windward towards the place where they shot on the previous evening. "Single boating" smacks either follow the same practice or take whatever chance of fishing may be offered by the wind, and of course all sailing vessels are dependent on the vagaries of the weather to an extent from which the "wind-jammers" * are exempt.

The technique of hauling is as follows.† The ship is brought round broadside to the wind, and the main engine stopped. The skipper takes charge of the steam-winch, and the warp is got in until the shackle appears. Then the after-bridle is unshackled and passed to the stem, where the mate makes it fast to a hawser borne

* Steam vessels.

† The mouth of the trawl is formed above by the "beam" terminating in the "heads" or "irons," and below by the heavily weighted "ground-rope." From each "head" runs a "bridle;" the two "bridles" meet at the "shackle," which is connected with the winch of the trawler by the "warp."

on a separate drum of the winch ; the after-head is made fast to the ship's side as soon as it arrives in place, while the fore-head is put on to the tackle and hoisted on board. All hands lay over the beam, which is now along the gunwale, and get in the net by hand, getting the ground-rope on board as soon as possible to prevent any fish escaping. As soon as may be a rope is got round the neck of the cod-end, and the bag of fish is hoisted on the tackle and swung inboard, forward of the steam-winch. If the other net is to be shot at once, the bag is usually left swinging until that operation has been accomplished. Then the cod-end is untied, and the contents come down on deck with a rush. The crew at once set to work to clean the fish, pitching them as they are cleaned into the different pounds, which have been formed on deck by letting boards into slots provided for the purpose. Turbot are most carefully bled, and care is taken that they only lie on the coloured side, as the natural position spoils their appearance for market. In winter, plaice are often brought in "alive," *i. e.* with the viscera intact. After being cleaned, the fish are thoroughly washed, with the aid of the hose, in large tubs, and then stowed away in separate compartments in ice in the fish-hold. The rubbish and viscera are shovelled overboard and the decks washed.

The regular round of duty is broken only by meals, and it may be said that the steamboat men live well, though I believe the same is not always the case on smacks. All meals take place in the saloon, but as it will not comfortably hold all the crew at once, the officers—skipper, second hand, and third hand—and the engineer off duty are first served, and then give place to the rest. Breakfast appears at about 7 a.m. ; it consists of tea, bread and margarine, and fried fish, generally dabs. Dinner arrives at twelve noon, including hot meat, generally two vegetables, and a pudding of some description. Tea is at six, and consists of cold meat, if there is any, bread and margarine, biscuits and cheese, or jam. Excellent bread is baked by the steward several times a week. The only beverage is tea, except that cocoa or chocolate is sometimes served out after the midnight haul, and anyone who wants it gets a biscuit at the same time. I have not seen beer or spirits on any fishing vessel, and I believe teetotalism is the general rule with Grimsby fishermen when at sea, whatever may be their custom when ashore. Personally I have seen nothing of "coopers," but these work chiefly among the sailing fleets, with which I have had little to do. I remember, during the trip of which I am writing, that we were hailed by a Dutch salt-herring boat who offered us a bottle of Schnapps for a dish of fish, an offer which our skipper declined in language which, if not concise, was certainly lucid.

To resume our narrative. The coarse weather continued for

several days, but after passing to the northward of the "Holman" (Hantsholm) our skipper tired of tearing his net in the heavy swell so close inshore, and steamed outwards to shoot inside the "rough" which runs north and south about fifteen miles from the Danish coast. It is, I believe, what is known to geologists as a "moraine," and consists apparently of detached boulders of various sizes. We got very little fish, but venturing too far out we managed to capture a lump of granite (resembling that from Shapfell) about three feet long by two in breadth. It is the custom when a big stone or other impediment to trawling is brought up in the net, to keep it on deck until the Humber is reached. It is then pitched overboard off the New Sand Buoy, where it will be in nobody's way. Tom, however, would not be bothered with this particular geological specimen, and had it lowered overboard as soon as the net was cleared. The skipper remonstrated, remarking that some one else might "get" it. "Let 'em get it," responded the mate, "they'll get nowt else here,"—which seemed likely enough, to judge from our own success.

By this time I had got to work with tow-nets and microscope, and the antics of Copepods and "such small deer" were a source of constant delight to the crew. More astonishing still were the minute pelagic stages of the turbot, which I believe came then for the first time under human ken, though my colleague Mr. Cunningham had already discovered the older pelagic forms at Plymouth. I was able also to introduce my friends to the mystery of artificially fertilising fish eggs, and had hatched out a small family of turbot in a pickle-bottle before we got back to port. Developing eggs of different sorts were of course constantly captured in the tow-nets, and every night the microscope would be requisitioned for the use of the crew, to see how the youngsters were getting on, and to find out how it was possible to tell one from another.

I never lacked assistance in hauling my "trawls," as the skipper elected to call them, and by the end of the voyage that worthy had become comparatively expert in sorting out and pickling the young fish. To subsequent tow-netting operations, carried out by him independently, the world of science is indebted for the completion of the series of the pelagic forms of the turbot and for the discovery of several stages of the mackerel which were previously unknown.

To return to the business of the ship, we moved along inside the "moraine" to a point about thirty-five miles north-north-west of the Reef, and got a few haddock and plaice, with occasional turbot, brill, and hake, but hardly enough to pay expenses. We fell in with a couple of foreign steam-trawlers, but they had had no luck either, so our skipper determined to strike out for fresh ground

altogether. He had rather a hankering after the grounds south of the Reef, as the weather was moderating, but finally determined to try the Great Fisher Bank, so we shaped our course northerly, taking a night-haul by the way on the oozy ground to the east of the Dogger. Going on deck as the trawl came aboard, I was greeted with a sickening odour, apparently of rotten onions, but proceeding in reality from a vast mass of sponge and mud with which the net was choked. There were hardly any fish worth keeping, so we steamed straight on until the leadsman felt the Bank, and then proceeded to hunt about for what the skipper considered the most likely part at that season of the year. The Bank is of great extent, and navigation is not, perhaps, conducted by fishermen in the most exact manner, but in course of time we hit on the "Inner Shoal-water," and got decent, if not large, catches of haddock for some days. The Bank has only been regularly worked by trawlers during the last ten years or thereabouts, and its intricacies are known to comparatively few, of whom our skipper claimed, with apparent reason, to be one. He told me of several parts where the soundings are such as the Admiralty charts (accurate as far as they go) give no hint of, and of one spot in particular, known only to himself and a friend, where splendid bags of fish are always procurable, if you can only find it. On this occasion both coal-bunkers and fish-hold were too empty to allow of any time being spent in what might be a fruitless quest after all, so we remained on much the same ground as long as we could get our fish, chiefly haddocks. Occasionally we got among the dense masses of lemon or scented weed (*Flustra foliacea*), which covers a great part of the Bank, and, especially when using the heavy ground-rope,* we brought cartloads of it aboard. Entangled among it were quantities of tiny cod; and here too we got a few haddock, with the adult conformation, but smaller than any which had previously been immortalised in alcohol. I was surprised to find the anemone *Chondractinia digitata* extremely plentiful; it was almost invariably attached to the shell of a living almond or smooth whelk (*F. antiquus*). The habits of naturalists have hitherto induced them to consider this a rather rare species. I brought many alive to the Cleethorpes aquarium, and was able to verify the correctness, as to colouration and certain other points, of the drawings and description given by Gosse, on the authority of J. Alder, the only actinologist who appears to have been acquainted with living examples. Other equally interesting actinians were met with, and I believe that the obscurity in which several genera are now involved might be

* Some boats have the two trawls fitted with different ground-ropes—one rather light, designed for the capture of haddock; the other weighted, for flat-fish.

cleared up by material collected from the Fisher Bank and adjacent grounds.

After several days on the Bank our skipper began to think of getting nearer home, so a course was steered for the west end of the Dogger, where we had pretty fair catches, and finally we ran home after an absence of twelve days. It was not possible to say anything really complimentary about the weather the whole time, and luck was completely against us at the start, but by sheer perseverance the skipper had managed to get together a very fair "voyage" of fish. Indeed, I am of opinion that what is called "luck" has a less share in determining the fortunes of a fisherman than is generally attributed to it. A man who will have fish, gets them somehow or other. Many men, no doubt, on finding a poor supply after running over to the coast of Denmark, would have simply lamented their ill-fate and fished about on the same ground until the coal ran out, and then come into port without enough to pay wages. Not so our friend, who got his fish, though he had to steam pretty well all round the North Sea to get them, covering about 700 miles, without counting actual fishing operations.

Fishing can hardly be called a lucrative business at the best of times, and the discomforts are greater than can readily be imagined by anyone who has not witnessed, and to some extent taken a share in them. It is astonishing how extremely cold it can be even in the height of summer, with a keen wind blowing and the water splashing all over you as you sit cleaning the fish on deck at one o'clock in the morning. In winter of course the discomforts are intensified. It happened that when I was at sea in March, 1892, we encountered a snowstorm which lasted two or three days. The cold on deck was intense, but of course the work had to be done. When the trawl-beam comes aboard, all hands have to get in the net. The boat is broadside on to the sea, rolling her utmost, as the sails are nearly always left standing to intensify the roll, so as to make it easier to get in the slack of the net as she dips; and laying over the beam under such circumstances of weather, with the sea breaking all over you, is about as unpleasant a job as a man need wish to avoid.

CHAP. III.—AN OUTLINE OF THE RISE OF TRAWLING IN THE NORTH SEA.

Although the North Sea trawling industry has long exceeded in importance that which is carried on along the rest of the sea-board of the United Kingdom, it is probably well known to most people that this method of fishing is not, so to speak, indigenous to the district, but of comparatively late introduction.

No serious attempt at a history of the origin and progress of trawling has yet been made, and it may be feared that by the time it is attempted some attention will also have to be given to its decline. The few remarks which I have to make on the subject here are put forward in all diffidence. They contain only the barest outline of the history, and rest entirely upon information which I have collected from old fishermen, and others who have taken an interest in the trade. I know of no documentary evidence to which reference can be made, but from the general harmony of oral accounts derived from different sources I believe the facts, as far as they go, are approximately correct.

The date of the discovery of the trawl, or of any fishing instrument at all resembling it, is altogether uncertain. On our own coasts the doubtful honour of its introduction seems to have been disputed by the fishermen of Brixham and Barking, but without claim on either side to any very remote antiquity of practice. It seems possible, however, that a fearful engine described as a "Wondyrchoum," against the use of which petitions were presented in the Parliamentary Session of 1376-7, may have more or less resembled a trawl.

Be this as it may, it seems at any rate certain that beam-trawling had been established as a regular industry at Brixham at a period considerably antecedent to the outbreak of the French wars. The boats in use then were quite small, and the trawl-gear could be carried with ease on a man's shoulder. The war naturally interfered greatly with the prosecution of a fishery on the south coast, although in some ways, less reputable than the practice of their legitimate industry, some of our south-coast fishermen seem to have found it not altogether a source of loss.

At the close of the war in 1815 there was a revival of the trawl-fishery, and enterprise began to manifest itself in the search for new grounds. I believe that about this time an attempt was made by the Brixham men to establish themselves at Dublin; but the honour does not seem to have been appreciated by the native fishermen, and the adventure was abandoned. About 1818 we hear that a certain

number of Brixham trawlers migrated eastwards, and established their headquarters at Dover, trawling in Rye Bay and the neighbouring grounds. In or about 1821 the North Sea may said to have been first reached, since at that time the Brixham men began fishing off Ramsgate. The chief ground seems to have been the New or Sandettie Bank, where fine takes of turbot were made for some time, and a more or less regular system of transporting fish to London was now organised.

The tide of migration crept slowly northwards, as new grounds were discovered and in turn exhausted, and about 1828 the system of "fleeting" seems to have been first adopted. Certain boats, instead of returning to port as soon as the catch had been made, banded themselves into fleets, and the catch of the whole fleet would be collected every day by a fast "cutter," and conveyed to market. The system appears to have been organised by fish merchants, who found the cutters and paid contract prices for the fish delivered. It prevailed only during the summer months. Harwich was the port chiefly engaged in these operations, but Barking seems to have had considerable importance as a trawling port either at this time or a little later. The Brixham men, I believe, were in the habit of returning home for the most part in the winter, and, throughout the migration, the most northerly ports reached were always used at first as summer stations only.

About 1830 the discovery of the productive grounds along the Dutch coast gave a great impetus to the trade, and smacks increased both in number and average tonnage. Brixham and Ramsgate seem to have had an aggregate of about fifty-five sail engaged in trawling operations. Local enterprise opened out certain fishing grounds off Yarmouth and Lowestoft; trawlers were hired for this purpose from Ramsgate and Barking, and the fish, chiefly soles, were despatched to London in light waggons, with relays of horses at various posts.

The Dogger was certainly worked by trawlers some time between 1830 and 1840, but it does not appear that it was at first a very remunerative ground. Haddock were of little or no value, and the Dogger plaice are said at first to have been large coarse fish. Boats continued to push northwards, and before 1840 Hull and Scarborough were summer trawling stations, but very little frequented in the winter. The average tonnage was about twenty-five to thirty-five.

One of the most important events in the history of the industry was the discovery, in the winter of 1837, of the now famous sole-ground known as the Great Silver Pit. The master of a Hull trawler, William Sudds by name, being blown out of his reckoning by heavy weather, had the curiosity to shoot his gear in the unusual depth of water which his soundings revealed. The result was

an enormous draught of soles, and the circumstance gave rise to the institution of a regular winter fishery. Boats and capital were attracted from all parts, and Hull became the principal centre of the North Sea trawling industry. The tonnage of smacks also underwent a rapid increase, culminating in that which is now in general use.

What has probably been of more lasting importance to the trade than the transitory productiveness of the Pits, was the introduction of haddock-curing at Hull, which took place about 1840. The haddock is after all the trawlers' best friend, as alone of all the trawl fish it seems able to make headway against the devices of man. Before curing was introduced, there was practically no market for these fish. I am told that only the largest were ever thought worth bringing ashore, and sometimes not even these. Statements have been made that there were no haddock on the Dogger when that ground was first worked, but the balance of the evidence obtainable shows that the fish were exceedingly plentiful there, though of no account, for the reason I have mentioned.

The introduction of ice and the adaptation of steam to fishing purposes occurred, almost simultaneously, about 1850. Steam power, I believe, was first used in the North Sea by Mr. Rushworth, and in connection with line-fishing. The advantages of ice are obvious, since its use permitted the boats to make much longer voyages than had previously been possible. Steam does not appear to have been very extensively used until about 1860.

It will have been noticed from the foregoing remarks that the development of the North Sea trawling has been effected entirely by fishermen from the south coast, and to the present day we find that the bulk of the trawling fraternity are the descendants of south-coast men. Of the rise of the deep-sea line fishing I have little knowledge, but I believe it is also owing, at least in great part, to exotic enterprise. In most of what are now large fishing centres there have existed, in all probability, minor fisheries from a very early period, which have been to some extent masked by the more important modern methods. I do not know that this was the case at Hull; while at Grimsby, which has not yet been mentioned, there was certainly no indigenous fishery of any importance.

Grimsby, in fact, is an altogether modern fishing station. Early references to the port make no mention whatever of any existing fishery, though the adjacent hamlet of Cleethorpes seems to have been always occupied in longshore fishing, whenever its inhabitants had leisure from less reputable pursuits. At Grimsby the existence of a very indifferent natural harbour permitted a certain amount of shipping trade to be carried on from the earliest period of English history, and in 1801 this natural harbour was considerably improved.

The real importance of the port, however, dates from the time at which it began to attract the attention of the Manchester, Sheffield, and Lincolnshire Railway Company. The Company acquired possession of the existing dock, now known as the Old Dock, and proceeded to construct new ones, the first of which was opened in 1852. Additions have subsequently been made, and the dock accommodation at the present day exceeds 100 acres; the population, 3688 in 1841, is now something over 60,000.

The bulk of the dock accommodation is, and has been, devoted to ordinary trading vessels, but the Company seem early to have cast covetous eyes upon the fish trade at Hull, and to have offered every inducement in their power to obtain a share of it for Grimsby. The latter port possesses natural advantages over its older rival, being nearer the mouth of the Humber, and in more direct railway communication with the principal markets,—facts which the fishermen and smack-owners were not slow to appreciate. Special accommodation was provided for fishing vessels, which now have two docks, covering an aggregate of twenty-three acres, and two graving docks, devoted to their sole use. The progress of the trade can in some way be judged from the Railway Company's returns: previous to 1854 there was little or no inland fish traffic; in 1854 the Company despatched 453 tons, in 1860 4537 tons, in 1870 26,234 tons, in 1880 43,415 tons, and in 1893 80,134 tons. An export traffic was also established, and reached about 3000 tons in 1877, but has not materially increased since that year.

It can well be understood that the development of the new fishing port was not viewed with any particular favour by its neighbour on the opposite bank of the Humber, and for many years the rivalry between Hull and Grimsby is said to have been keen and bitter, though nowadays it has no more than a merely formal existence. Hull has been gradually outclassed as a fishing station, not by any intrinsic decay, but simply by the extraordinary development of the Grimsby trade; it has merely had to take the second place in the deep-sea trawl and line-fishery of the nation, and shows no signs of relinquishing it for a lower one.

The Boston trawling industry is the most modern of all, since it was originated within quite recent years under the most modern auspices. There never has been a first-class smack trawl-fishery at Boston, doubtless owing to the intricate navigation of the Wash. This presents but little difficulty to steam-vessels, and the steam-trawlers, devoted to the deep-sea trade, in no way interfere with the pre-existing inshore fisheries.

The later developments of the North Sea trawl fishery can only be very briefly summarised. Boats found their way along the

Continental coast by gradual stages, opening up the grounds north of the Horn Reef about 1868. The liners, or codmen, seem to have been the pioneers in the exploration of the more central parts of the North Sea, since the Great Fisher Bank had been frequented by them for many years before it became a recognised trawling ground. I believe it was first trawled about twenty years ago, but has only been generally resorted to as a winter ground during the last ten years.

The Iceland grounds were also discovered by liners, and it was not until 1891 that they were first visited by a trawler. They have been worked, though not at great profit, by a certain number of steam-trawlers ever since; whether the fishery will continue is doubtful, but certainly the local authorities have done their best to discourage it. I have given rather a detailed account of the early condition of this fishery in the Association's Journal (vol. iii, 129), but, in view of recent developments, I fear that certain predictions I ventured to make will have only the average value of prophecy.

CHAP. IV.—THE INTRODUCTION OF TRAWLING AT A NORTHERN FISHING STATION, AND ITS INFLUENCE ON THE FISHERY.

In answer to my inquiries on the aspect of fishery matters at Sunderland, and on the past history of the industry at that port, my friend Mr. T. N. T. Potts has kindly drawn up the following sketch, which I make no apology for publishing *in extenso*.

"I am forty-two years of age, and have resided in the locality of Sunderland since childhood. The sea and the sea-shore are the first things I can remember, and as a child I took the greatest interest in its living creatures. My earliest knowledge of the fishing will date from about thirty years ago. At that time fishermen really were fishermen, their forefathers before them had been fishermen, and they brought up their families as fishermen. All did what they could; the girls and younger branches of the family sought bait, while the boys who were old enough went with their fathers to the fishing. In many cases the fishermen made their own lines and nets, during bad weather when they could not get to sea. At that time each family possessed their own 'cobles' (local boats, of which there are two sizes, the large herring cobles about 30 to 40 feet over all, and the small cobles about 20 to 30 feet over all used for line-fishing, crab, lobster, and salmon fishing), nets, lines, and gear sufficient to conduct the various kinds of fishing suitable to the

season. At this time stake-nets were allowed for salmon fishing, and many salmon and sea-trout were taken in this manner.

"At the end of the herring season (then about the end of September) they went to the Tees with their herring cobsles for mussels, which they laid down in sheltered positions to form 'scarps' (a local name for mussel-beds) to last them over the winter; the herring cobsles were then hauled up, and the line-fishing conducted in their small cobsles.

"All bait was locally procured, and such a thing as sending away for bait was quite unknown. In the winter they prosecuted the haddock or small-line fishing, which was conducted comparatively near to the shore; this they did in small cobsles, and it is thus managed:—Three men, or three men and a boy, have a coble amongst them. Each man provides what are termed two half-lines; each half-line is coiled up on a flat-shaped basket, and consists of six or seven pieces of line, each piece being 65 fathoms. The hooks are whiting hooks, and the fishing is for whiting and haddock, though not infrequently cod and ling of large size are taken in consequence of their having swallowed a whiting or haddock already hooked. These lines are baited with mussel, limpets, and sandworms, and, if possible, shot before daybreak, and the principal time for this fishing is from October to March.

"As the season advanced, the same cobsles and crews would commence the long-line fishing, at which cod, ling, turbot, halibut, conger, skate, and other large fish are taken. Twenty years ago, skate were of no value, and were cut adrift as they came to the surface, and they were hooked in enormous quantities, so much so as to be a nuisance to the fisherman; but since steam-trawling has commenced, they have become very scarce, and a moderate-sized skate will sell at the fish-market for from 5*s.* to 7*s.*

"The lines used at the long-line fishing are much stronger, the hooks of course being larger and stronger also, and the fishing conducted at a greater distance from land. In the first place the small lines were shot as in the haddock fishing; the long lines were then got ready for shooting at the after end of the coble, and as the small lines were hauled in, the haddock, whiting, and other small fish would be used as bait for the large lines, which were shot over the stern as the small lines were hauled. The large and dead fish would be cut up into suitable sized baits; the live fish were hooked by the lip, thus forming a very attractive bait. The long lines were then buoyed, and left until the next morning. Of course this cannot now be done, as the lines would be swept away by steam-trawlers. The quantity of fish taken in this manner was immense, considering the amount of line then used, about five

or six baskets being as much as a coble could use, and I can well remember as a boy having often to throw out the ballast to enable the coble to carry the fish, which often amounted to several cart-loads, while now thirty baskets of line may be shot 100 miles off, for not a third the quantity of fish. On one occasion last winter while fishing with the 'Fingal' we shot twenty-four baskets of line 100 miles off the land, amounting to over 3000 hooks, each baited with a whole herring, and only caught eleven fish! Many other steam line-boats can give similar cases. Since the commencement of steam-trawling, this fishing has been abandoned by cobles, owing to the fish having become extinct on the inshore grounds, and to the impossibility of allowing lines to remain at sea overnight.

"At this time there were sailing-trawlers belonging to Hull and Grimsby, fishing on the Dogger Bank, and occasionally landing a catch of fish at Sunderland; and several sailing-trawlers were built and owned in Sunderland, and worked on the same grounds, and in the same manner as the Grimsby trawlers.

"These vessels did no appreciable harm to the inshore fishing-grounds, as they seldom if ever fished within fifty miles of the land.

"About twenty-five years ago, in the summer, owing to that year being exceptionally hot, and prevailing calms preventing them reaching their fishing-grounds, two of them, the 'Henry Fenwick' and the 'Fearnot,' were towed about the inshore grounds by the steam-tug 'Heatherbell,' and I remember having made several trips in them. The mode of working was as follows:

"The 'Heatherbell' would go to sea about noon, and join the two vessels from five to ten miles off the land, take them in tow, when they would shoot their trawls and be towed at an easy speed all night. The trawls would be hauled up at about midnight, and again about 6 a.m.; the 'Heatherbell' would then go to shore with their fish in baskets, and after it was sold, go off again with the empty baskets to repeat the same operation. This might have continued during the months of July and August, and as it was an exceptional occasion, and almost all the line-fishermen were engaged in the herring fishery, no opposition was offered by them at that time to this proceeding, and the practice was never again repeated to my knowledge.

"Many years afterwards, towage being slack owing to the increased development of screw steamers, several of the paddle-tugs, both on the Tyne and Wear, were fitted with trawls, and worked as trawlers on the inshore fishing-grounds.

"At first they caught a prodigious quantity of fish, and their temporary success was so great that every one was induced to embark in the enterprise. Old tug-boats completely played out, unseaworthy,

and unfit for further service as tug-boats, were bought up by persons with no knowledge of the business, and converted into steam trawlers. At first the supply of fish seemed almost inexhaustible, so great was the amount of fish landed, and for a time all went well ; but after a year or two of this wholesale destruction the catches gradually diminished, so much so that many of them could no longer find profitable employment.

“This class of paddle-trawlers has gradually died out, there being few remaining at present owing to the fish within a reasonable distance from the land having been exterminated by continual trawling ; their large coal consumption rendering them unprofitable for long runs. They have therefore been superseded by screw vessels, specially built for the purpose, and fitted with fish-holds and ice rooms to enable them to keep their fish a considerable time ; and as the machinery of a screw vessel is much more compact and more economical in regard to consumption of fuel, they can go a much greater distance from land, and remain much longer at sea.

“These vessels have in their turn almost exterminated the fish on the Dogger and Great Fisher Banks, and several of them this year (1892) have landed their trawl gear, fitted out with lines, and worked at Farøe, &c., at the halibut fishing.

“The extermination of large fish on the inshore grounds has gradually introduced screw steam line-boats. At first paddle-tugs went into the venture, going off from twenty to twenty-five miles from land, and carrying the fish caught on deck ; but as fish became fewer, necessitating their going a greater distance into the sea, they in their turn were superseded by screw vessels built for the service, and fitted with fish-holds, &c.

“This class of vessel is largely on the increase, and on the Tyne there is now a fine fleet of steam line-vessels, many of them going a great distance from land, some of them in the herring season catching their own bait, and at other seasons having herring bait sent to them by rail from Yarmouth or Scotland according to where the herring fishery may be.

“It seems as if the steam line-boat will in time supersede the steam-trawler, as they can be of less size and power, consequently less coal consumption ; their fishing gear is less costly, the cost of a trawl and rope being from £100 to £150, while a set of lines can be had for about £40.

“A very much better price can also be obtained for line fish than for trawled, only healthy and well-conditioned fish being caught on lines, as sick and spawning fish seldom take bait.

“This steam fishing has of course greatly reduced the number of cobbles formerly employed in fishing ; at one time there was a

fleet of herring cobsles at Sunderland, Shields, and Hartlepool, now there will not be more than twenty altogether, the herring fishing being almost entirely done by Penzance, Isle of Man, Scotch, Lowestoft, and Yarmouth vessels, who make the herring fishing a speciality, and follow the herring round the British Isles.

“There are now but very few fishermen in the old sense of the word, that is, where the whole family lived by fishing alone; but there are still a few cobsles fishing with lines in winter, and catching crabs and lobsters in summer.

“Of late years mackerel seem to have entirely deserted this coast; at one time they were taken in large quantities by sweeping on the shore, but now they are seldom seen and only a few taken in herring-nets.

“Stake-nets were at one time allowed for salmon fishing, but now they have to be caught by drift-nets only.”

PART II.

CHAP. I.—THE DEFINITION OF AN IMMATURE FISH.

THE term "immature" as applied to fish is somewhat vague, and it is by no means clear that those who originated the complaints about the destruction of fish included in this category, had any very precise idea as to the meaning which they intended it to convey.

If we take what I suppose may be the most ordinary interpretation of the term, viz. "not full grown," we accomplish nothing. In the case of the higher animals, such as quadrupeds and birds, there is a definite limit of size, and after this limit has been reached, in the youth of the organism, no further increase of bulk takes place; but with fish it is different, since a fish appears to go on growing as long as it lives, a condition which does not admit of the erection of any standard of full growth. The word "undersized" has been frequently used as a synonym of "immature" in connection with fish, but there cannot be said to have been any definite standard of size.

Both words are capable of being used in regard to two very different conceptions, namely, that which has reference to the marketable value of the fish, and that which refers only to its powers of reproduction.

If we regard the terms as referring solely to the maturity of the reproductive organs, we certainly get a definite meaning for them, but at the time when the agitation was commenced there existed absolutely no information as to the size at which fish of various species acquired the power of reproduction. Theories no doubt abounded, and it appeared that many members of the fish trade held the opinion that those fish which were not saleable were immature, in so far as regarded their powers of reproduction. Conversely, it appears to have been generally held that fish large enough to fetch a price were also large enough to breed, or at any rate the affectation of such a belief was not without convenience. Later developments of the agitation have shown that the saleable qualities were really held in paramount importance, very much to the exclusion of any other consideration.

The criterion of market value is of course altogether arbitrary,

and differs in different markets and to some extent with the fluctuations of any one market, so that in dealing with the question from the purely biological point of view this criterion may be left out of consideration altogether; but in endeavouring to arrive at a practical solution one is compelled so far as possible to take a view which shall comprehend at once all aspects of the question. A practical solution may be defined, I suppose, as one in accordance with the dictates of common sense,—a quality, by the way, which is usually most strongly claimed by those who have the greatest need of it.

Deferring for the present any attempt at a harmony between the biological and the market standards of maturity, we will at the moment confine ourselves to consideration of the former.

To Dr. Wemyss Fulton belongs the credit of having been the first to endeavour to ascertain the size at which fish of different kinds begin to breed, and, in consequence, to fix a limit of size which would divide the sexually mature from the immature forms. His paper, which is based on material from the east coast of Scotland, will be found in the Eighth Annual Report of the Scotch Fishery Board.

The next contribution to the subject was from my own pen, as the importance of the results obtained by Dr. Fulton suggested to me the advisability of making use of the records of the Royal Dublin Society's Fishery Survey, to continue the work as far as these afforded opportunity. My paper, contained in the 'Scientific Proceedings of the Royal Dublin Society,' vol. iv, pt. vii, followed pretty closely the lines laid down by Dr. Fulton, but introduced a new consideration. Fulton's limit was based upon the size of the smallest mature specimen, without regard to sex. Now it appeared from the writer's remarks, as well as from my own observation, that there was a difference in the sizes at which fish of opposite sexes arrived at maturity, so that a limit based on the smallest mature example of the species must exclude from its benefits many immature forms of that sex which grows to the largest size before beginning to breed. This is, in nearly all cases examined, the female; it is also more plentiful than the male; and it seemed to me that the limit might most usefully be based on the conditions of the larger and more important sex alone. It was evident that, even in one sex, all fish did not become mature at exactly the same size, but I had not sufficient material for the deduction of a satisfactory average, and accordingly fixed the provisional limit at the size of the smallest mature, or nearly mature, female that came under my notice. I was inclined to suspect that further inquiry would show considerable variation of size in relation to locality, a suspicion which has been amply justified.

On entering the service of the Marine Biological Association in

1892, I found myself in a most favourable position for prosecuting the inquiry, since ample supplies of fish could be obtained from the Grimsby market ; and in almost all cases I was able to ascertain, with sufficient accuracy, where they had been caught. It must not be supposed that all fish exposed for sale in the market are caught in the North Sea, or even landed at Grimsby, since a certain quantity is sent from distant ports (including Milford Haven), while the Grimsby boats themselves may derive their catches from such widely distant localities as the coast of Iceland or the Bay of Biscay. Still, with the ready assistance of all to whom I made application, I found no difficulty in distinguishing the locality of capture, and, so far as the present question is concerned, I confined my attention to fish caught in the North Sea. Flat-fish were of greater apparent importance than round-fish, so my researches dealt chiefly with the former.

The results of my researches are given at some length in the Association's Journal (N. S., vol. ii, p. 363), but I think it will not be out of place to discuss them briefly in this article.

The question is not altogether so simple as it might appear, owing to two considerations. Firstly, as to fish examined during or in the neighbourhood of the spawning season, there can be, so far as I can see, no means of distinguishing, by mere autopsy, whether a ripe fish is spawning for the first time or not. Secondly, in the case of a fish taken, at any time of the year, with the reproductive organs but little developed, there is a certain difficulty in determining whether that fish has not yet become sexually mature or whether it has reproduced its species (during a previous spawning season or during a previous part of the same year) and is now in what may be termed a "resting" condition, so far as its generative functions are concerned.

Personally I hold the view that, especially in the case of flat-fish, owing to their conformation and the topographical relations of the viscera, it is by no means difficult to arrive at a correct conclusion, when dealing with fish taken at a period remote from the spawning season ; while I am not aware of any evidence of the existence of a resting period which covers more than a trivial interval of time. It is within the bounds of possibility that some fish, after becoming ripe, do not develop generative products in every successive season, as hinted by Dr. Fulton ; but I do not know of any facts which can be adduced in favour of this view, and prefer to regard occasional instances of very large but apparently immature fish as explicable by the theory of absolute sterility, or great retardation of sexual development.

The considerable degree of variation which one encounters in the assumption of the mature condition within the limits of one district

seems to me to be explicable by a condition peculiar, so far as I know, to fishes. We have abundant evidence, thanks to Cunningham's researches, of the great variability of the rate of growth in Teleostean fishes, but all our studies of the life-history of the fish, especially of those forms which show a marked difference of distribution at different stages of growth, seem to show that it is size alone and not age which is the determining factor in distribution. That this should be so is not remarkable, if we accept the hypothesis that it is the quest of suitable food which induces the changes, since a dwarfed individual, however old, would not be likely to require more or different food than its younger but more rapidly developed brethren. I believe there is the same relation between size and sexual maturity to this extent,—that a fish which reaches a certain (approximate) size at the season when the roe or milt commences to ripen, develops in due course into a spawning fish at the next spawning season. But if the fish is a little short of the required standard, its maturation is delayed for another year. During this period its growth does not cease, but is probably all the more rapid because there is no drain on its resources from the generative organs, and so the fish, before it spawns for the first time, has reached a size considerably greater than that of the smallest spawning fish of the species. Probably, in some individuals growth is so retarded that even a moderately large size is never reached, and yet we do not find very small ripe fish (at any rate among the female sex), and I do not see how this can be explained except on some such hypothesis as I have put forward.

In considering the method of distinguishing sexually mature and immature fish at a period remote from the spawning season, or in cases where the roe is only slightly developed, we must consider the changes that this organ goes through in becoming mature. In the immature female the ovary, so soon as it is large enough to be easily perceptible, is found to contain a number of minute translucent ova, their size and condition depending neither on the season of the year nor upon the size of the fish. The first approach to maturity is denoted by an enlargement of some of the ova, and by various changes in their internal structure. The most noticeable of these changes is the formation of yolk matter, since, as has been shown by Mr. Cunningham,* it is that which gives to the ova an opaque appearance which they do not previously possess, and for purposes of convenience I have called the minute translucent ova "inactive," applying the term "active" to those which have become opaque.

* Mr. Cunningham's paper ('Journ. Marine Biol. Assoc.,' N. S., iii, p. 154) deserves the closest attention in this connection, the more so since, as will appear later, his views differ slightly from my own.

The presence of active ova appears to be a sure sign that maturity is approaching, and, in most cases, that the fish will spawn at the next spawning season. Mr. Cunningham, however, thinks it possible that the yolk appears rather earlier in the sole than in other flat-fish which he has studied, so that more than a year may elapse between the first appearance of the active ova and the first spawning of the fish. I do not think that this interferes with the value of the distinction for macroscopic purposes, since the first appearance of yolk globules is apparent only under the microscope, and I have only observed active ova, with the naked eye, in young soles which might from their size be reasonably expected to spawn during the same year.

In any case the presence of active ova is an infallible sign of approaching maturity, and the further stages of maturation are so obvious as to call for no remark. But when the fish has become fully ripe and has discharged its spawn, the question arises as to how we are to distinguish the empty shotten roe from one which has never developed eggs at all. As a matter of fact the question can usually be settled, in flat-fish, even at a very considerable interval after spawning has taken place, by the presence of more or fewer ripe eggs which have somehow failed to be excluded. These remain either in the cavity of the ovary or in its duct, and gradually decompose there, but the shells remain recognisable for a long period. But without this certain proof of previous spawning, there are characters which appear to me to be in themselves a sufficient distinction. The really immature roe is short, plump, and very firmly fixed between the body-wall and the spines (hæmal) below the backbone, while in a fish which shows evidence of having spawned I have always found the roe wide and flaccid in front, and nearly always extending further backwards along the spines than in the case of an immature roe. It is also comparatively loosely lodged in the position which it occupies. Indeed, if the specimen is fresh, a groove which can be felt by passing the finger along the skin over the roe is almost a sufficient test of the shotten condition, but in a stale fish the groove is more or less perceptible even if the specimen is quite immature.

A recently shotten ovary usually contains a certain number of small active ova, which, as Cunningham holds, are probably absorbed and do not form part of the next season's crop. Then succeeds, in some species at all events, a condition in which all the living ova are in the inactive condition, but no instance has been recorded in which the shotten condition could not be proved by the presence of dead eggs or by other features associated with this condition. Cunningham makes the pertinent inquiry: "are there cases in which,

these remains* having been expelled, nothing remains to distinguish a fish that has recovered from spawning from one which has never spawned?" Personally I do not think there are, for even though, as Cunningham observes, the ovary of a shotten fish may shrink to a very small size, it does not appear, in my own experience at all events, that it ever regains the appearance of immaturity or the close adhesion to the surrounding parts of the body. I must admit that the question is not absolutely judicially proved; still I think the probabilities of the correctness of my own opinion are at least considerable, and, in putting forward the results of my inquiries, have little fear of their substantial accuracy being challenged by subsequent investigators, if only on the ground that the specimens on which my published results were based were examined either during the spawning season or within so short a period from it that traces of maturity, if they existed, could not fail to be detected.

The variation already alluded to in the size at which fish of a species attain to sexual maturity, makes it imperative that any standard of maturity should be based, not on either of the extremes, but on whatever intermediate size appears to apply to the greater number of species. This point was most justly urged by Cunningham, in criticism of the method adopted in my own definition of immature fish on the West Coast of Ireland; but, as I have already remarked, the paucity of material in that case seemed to render the minimum size the safest standard for provisional purposes. Having no lack of material in the North Sea work, I was able to adopt the better method, and the standards given below accordingly represent the sizes at which I believe most females spawn for the first time.

The standard of sexual maturity in North-Sea fish.

Flat-fish.

Turbot	.	.	.	18 inches
Brill	.	.	.	15 "
Common sole	.	.	.	12 "
Plaice	.	.	.	17 "
Lemon sole	.	.	.	12 "
Common dab	.	.	.	7 "
Halibut (provisional)	.	.	.	36 + "

Round-fish.

Cod	.	.	.	25 inches
Haddock	.	.	.	13 "
Whiting	.	.	.	9 "

* *I.e.* the remains of ripe eggs.

The turbot and the brill appear to be generally regarded as fish of the same size, but though one occasionally sees a brill which has reached a length equal to that of a very large turbot, there is no doubt that the turbot is, speaking generally, considerably the larger species of the two. The difference is emphasised by that which manifests itself in the sizes at which females of the respective species come to maturity, and in fixing the limit for the turbot at 18 inches I have, if anything, placed it rather too low. I have never seen a fully mature female turbot of less than $18\frac{1}{2}$ inches, but there does not seem to be as much variation in this as in most other species in the assumption of the mature condition.

The smallest mature or nearly mature female sole which has come under my notice measured $10\frac{1}{2}$ inches.

Plaice are rather variable, as I have found an apparently mature female to measure only 13 inches; but I am certain that the majority of North Sea plaice only commence to spawn when about 17 inches long. I have added considerably to my inquiries since the figures on which I based the standard of 17 inches were published, but the results have only confirmed my previous conclusion.

From time to time I have heard of the occurrence of very small spawning plaice, but it has always chanced that, for some reason or other, the specimen could not be procured for my inspection, nor have I been able to get any details of the actual measurements. I have found it an invariable rule that fishermen and fish merchants considerably under-estimate the length of a flat-fish, so that a statement about a ripe fish of 12 inches would almost certainly refer to one which actually measured at least 14 inches. Nevertheless I am inclined to think that very small spawning plaice are occasionally taken in the North Sea, but that such belong to a very distinct variety. In the Association's Journal (vol. iii, p. 194) I have described a dwarf variety of the plaice which appears to have its head-quarters in the Baltic. The variety first came under my notice on the Grimsby pontoon, whither several consignments were sent in 1894 by a firm of German fish-merchants. The largest fish of the lot only measured $13\frac{1}{2}$ inches, and all were full of roe or milt, the smallest ripe female being only $9\frac{1}{2}$ inches long. The colouration was unfamiliar to me, and I at once formed the opinion that the fish had not been caught in the North Sea, an opinion supported by the presence, among the plaice, of a number of flounders which were very much more spinous than any I had previously seen. I was subsequently informed by the consignors that the whole lot had been caught in the Baltic, where the plaice-like forms are known as "Goldbutt."

On close examination the small plaice were found to comprise a

number of forms distinguished from the rest by having ciliated scales, though in some cases the cilia were but little developed; in fact every intermediate condition was represented, and, as it proved on inspection, the ciliation was most thoroughly developed in, and almost confined to, the males. The ciliated examples, known to science since the days of Gottsche, had been considered to be a distinct variety, but it became evident that the distinction was only sexual. The females, not as a rule ciliated, are the "Goldbutt" of Gottsche, and of Baltic fishermen of the present day, who recognise them as quite distinct from the larger North Sea fish which enter the Sound at certain seasons of the year. They are not so distinct in outward appearance from small plaice of the North Sea type as to altogether escape a risk of confusion, but from the fortunate peculiarity of the males we get a knowledge of the distribution of the variety as a whole. The males (formerly regarded as *Pl. platessa*, var. *pseudoflesus*) are stated by Continental naturalists to be commonest in the Baltic and in the Sound, but they have been observed also at Håsthalm, and are therefore not altogether unknown in the North Sea. They occur, as I presume, in the eastern fjords of Denmark, and as the Lim Fjord has an opening at either end, there is nothing improbable in their occasional appearance in the North Sea through that channel. Further, Gottsche saw them in the Hamburg market, though that is no proof that they were North Sea specimens, since my own had passed through the Hamburg market before making their appearance at Grimsby.

It will have appeared that there is nothing very improbable in the occasional appearance of a dwarf plaice of the Baltic type in the North Sea, and I believe that any very small spawning fish that have been caught by our boats would have been easily recognised as belonging to the Baltic variety had they come under the notice of a naturalist. At the same time I unhesitatingly assert that the small fish that are caught in such numbers on the Danish and Dutch coasts do not belong to the smaller variety, but are immature members of the North Sea variety. I have examined hundreds of them taken from all parts of the coast, and have never found one of the smaller type amongst them. The possible objection that, the season for the Eastern grounds being later than the spawning season, I may have been deceived in my diagnosis (of maturity or immaturity) by such a reversion to an apparently immature condition as Cunningham appears to think possible, can fortunately be met. Our own boats only fish the Eastern grounds in the late spring and summer, since it is only at that time that there is any certainty of finding a good supply of fish; foreign steam-trawlers, however, sometimes fish there much earlier, and, as they often land their catch at

Grimsby, I have been able in this way to examine the small plaice caught on those grounds during the spawning season, and indeed to compare them with spawning fish consigned at the same time from the Baltic. There can be no possible doubt of the distinctness of the two types, nor of the immaturity of the small fish caught on the Eastern grounds of the North Sea.

The lemon sole or cock sole (*Pl. microcephalus*) agrees with the true sole in that some females are mature at only 10 inches, but I think 12 inches is the length usually attained before the assumption of maturity.

As to the size at which the halibut commences to spawn I have no conclusive information. The fish is not now of much importance in North Sea trawling, on account of its scarcity, and the same reason makes it difficult to procure sufficient material to establish a North Sea standard. Plenty may be had from Iceland or Farøe, but the species reaches a larger size in the higher latitudes, and presumably attains a larger size before spawning than is the case with natives of the North Sea. I think my provisional limit of 36 inches is really considerably below the mark for any district inhabited by this fish.

With regard to cod, the opinion is held by fishermen that there are several distinct varieties within the limits of the North Sea, and in Norway Captain Dannevig holds a similar belief most strongly. I have had neither the leisure nor the inclination to investigate the matter for myself, and consider that, so far as practical purposes are concerned, the existence or non-existence of such varieties is of no moment, as there could be no possibility of discriminating between one and the other unless every fishery official were a trained naturalist. The proposed standard of 25 inches can certainly not be regarded as too high; and, if varieties exist, it is applicable to the smallest. Many cod undoubtedly reach a considerably larger size before spawning.

Before we leave the question of sexual maturity, I must advert briefly to the inquiries on the same subject which were carried on by my colleague Mr. Cunningham, contemporaneously with my own, in the Plymouth district.*

The results are most interesting, since they show conclusively that very great difference may exist in different districts in the size at which sexual maturity is attained by a species. This difference, as Mr. Cunningham justly observes, is a corollary of a difference in the maximum size attained by the species in either district.

Thus the plaice on our South-west Coast are considerably smaller than North Sea forms, and Mr. Cunningham considers the biological

* *Vide* his paper, Journ. Marine Biol. Assoc., vol. iii, p. 64.

limit for the former district to be 15 inches, and has found mature females only 11 inches long.

Lemon soles appear to mature at a very small size on the South-west Coast, as Cunningham records mature females of only 7 inches. These were the smallest he could procure, and none of the fish he examined were immature.

The common sole is usually larger on the South-west Coast than in the North Sea, to judge from consignments which arrive at Grimsby from the district first mentioned, and Cunningham records no mature females of less than 12 inches, while his largest immature specimens measured 13 inches.

As for turbot and brill, there is not sufficient evidence to show that any difference exists as between the two districts, but very few specimens could be obtained for examination at Plymouth.

Having reviewed the evidence as to the definition of sexual immaturity, we must now consider the commercial aspect of the question, and the first definition of the term "immature" of which I am aware was embodied in a resolution by a Conference of those engaged in the East Coast fishing trade, held at Hull in 1890. It was resolved that the term immature fish should be interpreted to mean "a sole which measures less than 10 inches, a turbot or brill which measures less than 12 inches, and a plaice which measures less than 12 inches." This may be taken to represent the North Sea view. It is not wholly a trade interpretation, since plaice and soles of less than 12 inches are saleable; it represents rather a standard of size below which the North Sea trade considered it inexpedient that fish should be destroyed.

However, at the London Conference held under the auspices of the National Sea Fisheries Protection Association in 1892, the trade representation was not confined to the North Sea, but delegates attended from all parts of the United Kingdom, and the standards of size recommended by the East Coast trade by no means recommended themselves to every one. The representatives of the South and South-west Coasts in particular considered the standard a good deal too high, especially in the case of plaice, but with a laudable, though as I think mistaken, desire for harmony, the various parties agreed to a compromise, and the resolution finally adopted by the Conference of 1892 fixed the sizes as follows:

Plaice	.	.	.	10 inches
Soles	.	.	.	10 "
Turbot	.	.	.	12 "
Brill	.	.	.	12 "
Lemon soles.	.	.	.	11 "

I believe that the result was not entirely satisfactory to either the East or South Coast trade. Unfortunately no attention seems to have been paid to a most sensible amendment, moved by Mr. Mallock, M.P., to the effect that the Conference recognised "the fact that the limitation as to the size of fish in different localities must vary." However, in the above-mentioned resolution we have a definition to which the whole English trade, in so far as it was represented, pledged itself.

The sizes were not altered at any subsequent conference, and were more or less generally supported by the trade before the Parliamentary Committee in 1893. That august body did not, however, see fit to adopt them, considering that the size limit "should approximate to that already adopted by foreign countries," with the result that they recommended a limit of 8 inches for soles and plaice, and a limit of 10 inches for turbot and brill.

It may be useful to recapitulate the different standards :

	Biological limit for North Sea.	Biological limit for Ply- mouth area.*	Trade limit. Hull Conference, 1890.	Trade limit. London Conference, N.S.F.P.A., 1892.	Select Committee, House of Commons, 1893.
Turbot	18	18	12	12	10
Brill	15	15	12	12	10
Sole	12	12	10	10	8
Plaice	17	13	12	10	8
Lemon sole	12	7	—	11	—

Reference will be made in the last chapter on Proposed Remedial Measures to the probable results of the imposition of these various size limits.

CHAP. II.—THE EVIDENCE OF DETERIORATION IN THE NORTH SEA TRADE AND ITS ALLEGED CAUSE.

A. *The evidence of Deterioration in the North Sea Trade.*

Since my acquaintance with the North Sea trade only dates from the commencement of 1892, it is obviously impossible for me, of my own knowledge, to say what amount of truth there may be in the statements that have been put forward as to the diminution of the fish supply during the last fifty years or so. Much of the evidence that has been at my disposal has been made public by the Parliamentary

* Mr. Cunningham's figures would appear to yield *averages* approximately as given in this column.

Committee of 1893, and on that evidence, and any other of which I have knowledge, I do not think that one conclusion of the Committee is at all likely to be criticised. It is to the effect that "there seems to be no doubt that a considerable diminution has occurred amongst the more valuable classes of flat-fish, especially among soles and plaice. . . . It is true that there will not be found a great falling off of the bulk of these fish landed on the East Coast. But the appliances for catching them have of recent years been greatly increased in size and efficiency, and the fishing-grounds have been largely extended in area, trawlers going as far as the coast of Iceland to the north, and to the Portuguese coast in the south."

Such evidence as is available consists, therefore, solely of the recollections and impressions of those engaged in the trade, and the last part of the quotation from the 1893 Report illustrates the total inadequacy of the present system of fish statistics. The total quantity of fish landed at any one port may be found in the Board of Trade returns, and, in a good many instances, the different kinds of fish are separately enumerated. But, beyond the fact that the fish were landed at such and such a port, there is no hint as to where they may have been caught. Nor is there any attempt to discriminate between large and small fish. Moreover, several kinds of fish, which, although perhaps of small importance in former years, now represent a considerable item in the profits of a fishery, are not thought worthy of separate enumeration, but are lumped in one column. Thus lemon "soles" and witches, both valuable fish and exclusively products of trawling, are associated with skate, catfish, conger-eels, and a host of others, of which some are largely caught by line-fishing.

Whatever else is neglected, I should say that it was at least essential to distinguish between the products of distinct fisheries at large centres. At the small inshore fishing centres, where everyone takes a hand at whatever kind of fishing is possible, it is of less importance to do so; but the difficulty in any case would hardly arise, since comparatively little inshore trawling is carried on, and drift-net fish are practically confined to two kinds, which are already distinguished in the returns. Fishermen belonging to the large centres are, for the most part, strictly confined to one method of fishing—trawling, line-fishing, drift-netting, or whatever it may be,—and the different branches are so distinct in their interests that no effort should be spared to distinguish them in the returns. I do not know of any difficulty of doing so, provided the staff entrusted with the preparation of the statistics were in any sense adequate to the task; and, except on the theory of want of funds, the existing system courts the criticism of having been devised in some ignorance of the industry with which it is supposed to deal.

The fact is that the fund available for the collection of fishery returns is only £700, and there are 156 collecting stations. I have not the least idea what proportion of the above sum is assigned to each station, but it cannot in the nature of things be otherwise than insignificant in view of the work to be done. The method of collecting the statistics appears to be left entirely to the discretion of the collector. At one port it has been said that the return is merely an estimate of eye. I fancy I am betraying no secrets when I say that at Grimsby the statistician bases his estimate mainly on information furnished by the Railway Company, so that its accuracy depends on the correctness of deductions made for weight of packing materials, additions for difference in condition of fish, home consumption, &c.

Now the fish arrives at the pontoon either whole ("live") or gutted; it may leave the town in almost any condition. It may be sent off *in statu quo*, or may be cleaned, beheaded, boned; only a small part of it may be worth transmission. It may be wet or dried, pickled or smoked; it may come in as a codling, and, or I am much mistaken, go out as a "Finnon" haddock!—be caught as the head of a catfish and the tail of a monk, and go out as the cheek muscles of a skate! The last instance, however, would not affect the correctness of the existing return, as the delicacies in question are assigned to the conglomerate column previously alluded to.

The system will be admitted, I think, to furnish quite adequate opportunities of error, even if the emoluments were sufficient to allow of one man's devoting his whole attention to the production of an accurate return, which I am far from supposing to be the case.

Accuracy in returns, I imagine, can only be ensured by counting the quantity of fish landed on the pontoon, and as the quantity is very large and the time during which the fish are undisturbed is but short, this duty could certainly not be satisfactorily undertaken by one man alone, even were his attention free from any private business of his own. This system would permit of the complete discrimination between line and trawl fish, and between fish from the North Sea and those taken at Iceland, Farøe, &c. According to the experience of the statisticians, a certain amount of discrimination would be possible even between fish from different parts of the North Sea; at all events it would be possible in great measure, from the peculiarities of colouration in the flat-fish, to check the accuracy of answers which might be given to inquiries as to place of capture, and of course there would be no longer any difficulty in discriminating between large and small fish. Statistics dealing merely with weight, without regard to size, are altogether misleading. There is no difference in the weight of a box of fair average-sized plaice and a box of small

ones ; but the former contains only about 100, and the latter may contain about 250, as is commonly the case at Grimsby, or as many as 1036, as in an instance reported from Billingsgate. The hopeless impossibility of obtaining a correct idea of the fishery from statistics which do not distinguish between such boxes requires no argument.

There is a further method of statistical inquiry, which, if it were available, could be utilised by the statisticians as a valuable check on the accuracy of their own numerical observations, and would furnish in addition the most reliable information of value. The auctioneer furnishes to the smack-owner an account of fish sold, in which the separate kinds and the quantities (usually also, I believe, the quality in regard to size) are enumerated, and a copy of this is handed, at least by some owners or companies, to the skipper, who has an interest in the distribution of the profits. There might be an objection to a copy being handed also to the local statistician, but I do not see that there could be any legitimate objection to the information being supplied to the central statistical authority. It is conceivable, nevertheless, that serious opposition, not wholly unconnected with considerations of income-tax, might be offered, in which case it would be better, perhaps, to make each skipper furnish a return only of the quantity of fish landed, in boxes or other local measurements. If this were done, the duties of the statistician would be lightened, and one man would probably suffice to ensure that the skippers' returns were more or less accurate.

The skipper should be required, I think, to state whereabouts he had been fishing, but it would be a hardship to make him give detailed information ; and if he had a good catch from some ground not generally known to be productive at the time, such information as he vouchsafed would probably be worthless. Some check on the value of this latter class of information might be derived from the fishery cruisers, were the latter to keep a diary of fishing-vessels sighted (if they ever do see any), and furnish weekly lists to the ports to which the vessels belonged. Accurate account should be kept of vessels entering and leaving the port, whether belonging to it or not, so that in computing the result of the fishery it would be possible to check the amount of fish caught by the amount (in voyages) of fishing power expended ; and in this, as in other details, it would of course be essential to distinguish between trawlers, cod-men, &c.

The Parliamentary Committee expressed themselves in their report as "strongly of opinion that any steps which may be taken to increase the trustworthy character and fulness of official statistics would amply repay the expenditure which may be necessary to ensure the improvement ;" and it is to be most sincerely hoped

that the authorities may see their way to give effect to this recommendation. I have endeavoured above to formulate suggestions for what appear to be the most urgently required improvements in the existing system of returns. Though based upon the conditions of the Grimsby industry, it is probable that they are equally applicable to all fishing centres, and they may be briefly recapitulated as follows :

1. An absolute separation of the products of different methods of fishing.
2. An exact account of the expenditure of fishing power in each branch.
3. Discrimination as between large and small fish of a species.
4. A more complete separation of species (so that lemon soles, witches, &c., may be separately enumerated).
5. Discrimination, as complete as may be practicable, of the locality of capture.

I have made no mention of meteorological information, since I do not think there is any necessity for the Fisheries Department to go to any expense in collecting statistics of this kind at first hand, but the ample information available to every one from the Meteorological Office should certainly be carefully considered in the preparation of fishery returns. The weather is known to have the most important bearing on fishery operations, not only at the time of incidence, but often in the succeeding season ; and the remarks " As to the weather, &c.," in the " Summary of the Returns made by collectors of Fishery Statistics," if based on the most profound examination of meteorological phenomena, bear no intrinsic evidence of the fact.

It is hardly necessary to say that the preparation of returns so complete as those which I recommend calls for no mean degree of intelligence on the part of the collector ; and intelligence, like any other commodity, has to be paid for. I think it is essential, too, that the official in charge of the whole system of fishery returns should be skilled not only in the commercial, but also in the biological aspect of the fisheries. Such knowledge would enable him to grasp at once the probable importance of any development indicated in the monthly returns of his subordinates, and, if a reserve fund were at his disposal, to institute whatever subsidiary inquiries the case might appear to call for.

Without a system of statistics at least as complete as the above, I do not see that one can acquire even an approximate idea of the state of the fishery for the current year, nor would a long series of incomplete returns yield any reliable ground of conclusion at a future time.

B. *The Alleged Cause of Deterioration in the North Sea Trade.*

The diminution of the fish supply being admitted, it remains to consider what evidence there is as to the means whereby it has been brought about. Such deterioration has been admitted unreservedly only in the case of the North Sea, and there in the case of flat fishes alone.

From the southern fishing centres even of the North Sea there is not an unanimous admission of a decrease in the general supply, but the scarcity of large fish is acknowledged. Having little personal knowledge of the Yarmouth and Lowestoft fishery, in so far as it differs from that of Hull and Grimsby, I must leave my readers to form their own conclusions from the evidence offered to the Parliamentary Committee from those ports.

The alleged cause of the North Sea decrease is over-fishing,—that is to say, over-trawling. Especially is it attributed to the operations of the large deep-sea trawlers. There exists, it is true, or did exist, a subsidiary outcry on the part of longshore line-fishermen, crabbers, &c., against the practices of inshore trawlers, whether of large or small tonnage; but this grievance was of local importance only, and could not be said to affect the industry as a whole to any appreciable extent. Therefore, though inshore matters call for a share of our attention in due season, we may for the present devote ourselves to the deep-sea question.

The decrease in the returns of this branch of the industry were, and are, essentially attributed to the destruction of large quantities of small fish, and the bulk of this destruction is generally known to occur on grounds lying along the Dutch, German, and Danish coasts.

A glance at the chart appended to this paper shows that a line drawn from the Spurn to Hantsholm, in Jutland, forms a rough division between the deeper and the shallower parts of the North Sea. Eastward of the longitude of the Great Silver Pit and south of that line the water never attains a depth of 30 fathoms. North of the line, water of less than 20 fathoms is pretty well confined to a narrow fringe along the British coast, the Dogger Bank, and a stretch of ground that follows the course of the line from the tail of the Dogger to the entrance of the Kattegat. It is also apparent that on the eastern side the shallow soundings run very much further out than on our own coast. The Continental coast forms a large right, of which the estuaries of the Elbe and Weser are the head; while the limbs consist of the coast of Schleswig-Holstein and Denmark to the north, and of Hanover and Holland to the southwest: along both these limbs is seen a series of barrier islands, separating the open sea from large shallow expanses of which a great

part dries at low tide ; the embouchures of numerous streams, large and small, give on to these areas.

At the present day our trawlers cannot afford altogether to despise the territorial rights of the various powers which own this stretch of coast, and the fishing grounds affected by Grimsby vessels are accordingly at a respectful distance outside the chain of islands. The westernmost is off Terschelling light, in about 12 or 15 fathoms, but in an easterly direction boats approach the shore more nearly, fishing along the islands of " Skimliko " (Schiermonnikoog), Borkum, Norderney, &c. Everywhere the ground is smooth, except for a " rough " on Borkum Flat. Trawling is also carried on about the " Island " (Heligoland), and northwards from the island last mentioned to the Horn Reef, this ground being collectively termed " above the Reef," while special parts of it are spoken of according to the name of the nearest island. " Below the Reef " the grounds extend as far north as the Holmen light. A line of rough, boulder-covered ground, supposed to be the moraine of some glacier, follows the general course of the Danish coast approximately in the manner indicated on the chart, and the trawling grounds are anywhere between this and the coast, but, for small fish, as close in as the boats can venture. I do not know that it is necessary to describe the grounds in greater detail here, as this does not profess to be a fisherman's itinerary of the North Sea ; nor, be it remarked, do I recommend the use of the chart for the more exact purposes of navigation. It will serve, however, as I hope, to illustrate the remarks which I have to make on the destruction of fish on various grounds ; but, before proceeding directly to this subject, it may be as well to review what is known of the life-history of some of the fishes on which the trawling industry depends. Some comprehension of this is absolutely essential for a due appreciation of any fishery question, and especially of one into which the destruction of young fish enters largely.

CHAP. III.—THE LIFE-HISTORY OF NORTH SEA FOOD FISHES.

While we remain in ignorance of far too many facts in the life-history of even some of the commonest food fishes, we have been able to form at least a tolerably clear idea of the breeding habits of many of them, of their appearance in the infantile condition, and of their haunts at different periods of existence ; and in the consideration of questions affecting the over-destruction of young fish these facts have to be constantly borne in mind.

There appears to exist, in many persons who express opinions on

fishery matters, a lamentable tendency towards generalisation. The fish form an enormous class, composed of species and families, of which some are so far distinguished from others, not only in conformation but in habit, that it is hardly possible to say that they have much in common beyond that they live in the sea, and breathe by gills. Yet the amateur exponent seems mentally to assign to the most widely distinct kinds a degree of relationship which he would probably be loth to admit as existing between himself and his next-door neighbour.

As a matter of fact, every species of fish requires separate consideration, or at the most, only a few kinds can be grouped together, and that only in relation to a part of their life-history and habit, and not to the whole. It will, perhaps, be no waste of space if, before entering on the question of their destruction, I endeavour to sketch briefly the facts that are known with regard to the life-history of some of the more important kinds.*

Even in dealing with fish of one kind one cannot make sweeping conclusions with regard to locality, since a species often differs considerably in habit, at distances so little remote as are the opposite coasts of this country. There is little or no difference in the temperature in such cases, but there may be a great deal of difference in the coast itself and the soundings at sea. Thus on the west of Ireland we have a very bold coast, rocky in most places, and everywhere with deep water at no great distance from land. One may literally step from land into 40 fathoms of water, and fish in 80 fathoms in sight of some outlying island. For a great part of the coast-line the territorial limit is not far from coincident with the 40-fathom line. When we turn to the North Sea, we find that part of the area with which we have most to do almost entirely devoid of rocks, and everywhere comparatively shallow. Indeed, south of the Fisher Bank the maximum depth is about 60 fathoms, and that is found only in a very limited part.†

Yet much the same kinds of fish occur in the two districts, and, of course, their habits, in adaptation to the available physical conditions, show corresponding modifications. So far as there is constancy of habit in relation to physical conditions, it is found to

* In explanation of the terms used in this chapter, it may be said that some fish deposit their spawn on the bottom; it is then termed "demersal." In the case of other fish, the spawn floats to the top of the water, and is then called "pelagic." When first hatched the little fish or "larvæ" appear to be always "pelagic," *i. e.* swimming at the surface; in the case of flat-fish the pelagic larva undergoes a "metamorphosis" or change of shape into the flattened form, at or near the time when it adopts the habits of adult fish by sinking to the bottom.

† See chart at the end of this paper.

be related to depth of water, and, of course, to nature of bottom. Proximity to land is of comparatively little consequence (though an isolated bank does not correspond, faunistically, with similar soundings not separated from the coast by intervening deep water), yet one is tempted to think that many prefer to obtain their ideas of the sea from a study of the map rather than the chart.

The west coast of Ireland and the North Sea present the greatest contrast which is to be found within the limits of our own seas, but minor physical differences exist between all our districts, such as the Channel and the Irish Sea, involving correspondingly minor divergences in the habit of the fish which are found there. As we are dealing with the North Sea, my remarks must be understood to refer to that area.

With regard to the breeding of fish we may make one tolerably sweeping generalisation—viz. that, with the exception of skates, herring, and cat-fish (or wolf-fish), all our food-fish propagate by means of eggs which float singly at the surface of the water, at least for some considerable part of the time during which the embryo is developing. Of the more valuable* kinds, all the eggs float up to the actual time of hatching, except in the case of the turbot, the eggs of which seem always to sink some days before hatching takes place.

The turbot, though not a very abundant fish, is distributed pretty well all over the North Sea trawling grounds, though scarce in the deeper parts, such as the deep water north of the Dogger, and on the Fisher Bank. Being a predaceous form, feeding largely on herrings, it appears to be somewhat given to migrating in pursuit of these fish, and occurs occasionally in considerable numbers on grounds where it is usually by no means plentiful. It is most abundant probably on the Continental coast, where a good many are always caught in company with the small plaice. Spawning, which is carried on chiefly from the latter part of May to the end of July and later, does not occur, so far as I know, very close to our own coast, but rather on the offshore grounds. On the Continental side, however, spawning fish may be found in comparatively shallow water and fairly close inshore,—in fact, on the small fish grounds. I do not know that the eggs have ever been recognised from tow-net gatherings, but very young specimens, from about one fifth to three fifths of an inch, have been found swimming at the surface of the water a few miles off the coast of Denmark, and on the west end of the Dogger Bank in July and August. I have not found the immediately succeeding stages in the North Sea,

* The egg of the gurnard may, but does not invariably, sink some time before hatching. I do not know any other instance, unless the weever can be called a food-fish.

but young turbot of about an inch and a little larger have been found by Mr. Cunningham, still at the surface, in Plymouth Sound, and I have no doubt that in the North Sea also these fish approach the shore towards the end of their period of pelagic life. I know of no instance of these very young turbot being taken anywhere but at the surface, but shortly after the adult form has been assumed they evidently descend to the bottom.

Exactly where they pass the first winter of their life remains yet to be discovered, but it is almost certainly in comparatively shallow water and at no great distance from land. From the first warm weather of spring throughout the summer young turbot of the previous season's brood, measuring about 3 to 5 inches, are found sparingly among the shrimps and small plaice at the extreme margin of the Humber estuary, and elsewhere along the sandy beaches of our own coast. I have taken them myself at St. Andrews, Filey, and Cromer, and have no doubt they are generally distributed along the east coast. The number taken is nowhere large as compared with the young of other species, but it must be remembered that the turbot, nowadays at any rate, is far from abundant at any stage of existence on our own coasts. I have never heard of such young fish being met with anywhere but at the margin or near it, and do not believe that they range at all into deep water until a larger size has been attained. I have had no opportunity of acquainting myself with the haunts of fish at the corresponding stages on the Continental coast, but have been informed that they are common in the spring and summer and in the large shallow sandy expanses about and within the barrier chain of islands on the Dutch and Danish coasts, and have no doubt of the correctness of the information.*

Larger, but not necessarily older fish, are also found in quite shallow water, close inshore, on both coasts, but much more abundantly on the eastern side of the North Sea. There appears to be a gradual removal from the immediate vicinity of the margin as the size increases, but I do not find many fish under twelve inches in length, outside that area which the moderate degree of respect shown by our trawlers to territorial rights leaves comparatively unmolested. On our own coast similar fish seem to be almost, if not entirely, confined to estuaries or inshore grounds. I have paid but little attention to the probable ages of these small turbot, since, as I have previously remarked, the distribution does vary with the size, and cannot be proved to do so with the age of the fish. The

* Note added in press. Much valuable information as to the life-history of turbot and other flat-fish in the Cattegat, &c., will be found in Dr. Petersen's Report on the Danish Biological Station for 1893 (1894).

former is a matter of fact, the latter one of opinion only, and, in my humble opinion, not a matter of the highest importance in practical fishery problems, except in such cases as the artificial propagation of fish and the temporary closing of defined areas.

Larger turbot, from about 12 inches up to any size which the species attains, are found in great abundance throughout the spring and summer on the whole of the Eastern grounds; opportunities of ascertaining whether they are in the same locality at other seasons of the year are rare, but I have known a considerable number, mostly of the smaller sizes, to be taken very early in the year, before the plaice had appeared in any number, and again in the autumn, after the plaice had mostly departed elsewhere. I have already said that many turbot spawn on these grounds.

The young fish do not appear to betake themselves to the offshore and deeper parts until a length of at least about 14 or 15 inches has been reached, and many certainly stay inshore until later. An examination of the total catch from all parts of the North Sea prior to the opening of the season for small plaice affords a very fair means of judging what proportion of small fish may be present on the offshore grounds.

I have found that the percentage under 17 inches does not exceed 30 per cent.; even this is somewhat unnaturally high, since a good many of the small fish were contributed by a shallow ground on our own coast, but of the whole number of small fish the bulk would be males, sexually mature, since the male may begin to breed at only 12 inches.

In its habits, distribution, and life-history there is little to be said about the *brill* which has not already been said about its more valuable relative, the turbot. The *brill* spawns earlier than the turbot, viz. from the beginning of May, or earlier, until the end of July, but the spawning takes place in the same localities for both species, and, of course, the periods are partly coincident. The smaller free-swimming larvæ, when changing to the adult condition, have not yet been recognised with certainty, but the stages just prior to the assumption of the adult form have been met with by Mr. Cunningham at Plymouth in the same locality as the corresponding stages of the turbot. All the evidence we have shows that the subsequent life-history is identical in the two species. *Brill* seem to be more abundant on our own coast, turbot being in the majority on the Continental coast. In their distribution with regard to size, the two forms seem to agree pretty closely on the Eastern grounds, but as the *brill* matures at a smaller size, it follows that the proportion of sexually immature fish on the trawling grounds is rather lower. Indeed, I have usually found the proportion of im-

mature brill in the catches on Eastern grounds to be a very small one; but it varies considerably, since occasionally a very marked number of sexually immature forms will be taken. Many immature fish are sometimes caught on a shallow ground near Mablethorpe in Lincolnshire. On the offshore grounds in any part of the North Sea comparatively few immature fish seem to occur.

The distribution of the sole in the North Sea is so far capable of more or less exact definition, in that there is a large area in which soles are at all events very scarce. The species is very rare in Scotch waters, but occurs more plentifully southwards along the east coast of England. It is found also on the grounds lying off the coast of Denmark, and southwards along the Continental margin, also in the central parts of the North Sea, south of a line which may be drawn across so as to follow the southern edge of the Dogger Bank. Thus the Dogger and all the central area of the North Sea northwards of this bank may be eliminated as practically devoid of soles. None are found, I believe, on the coast of Norway, and, indeed, the channel of very deep water which follows the Norwegian coast-line seems to act as a boundary impassable to all but the bathybial* flat-fish. That it should be so by the adults is intelligible enough, but it is not so clear why the pelagic ova and larvæ should not cross it. That they do not do so to any appreciable extent is rendered extremely probable by the marked structural differences which one finds to exist between the Norwegian turbot and their brethren of the North Sea.

The sole spawns in the North Sea chiefly in May and June, though the whole period may extend from April to August. Spawning on our own coasts takes place chiefly on the offshore grounds, always in water of some depth, and away from the chief haunts of young flat-fish; but on the Eastern side a great deal of spawning is done on the small-fish grounds. Of the very young stages I know but little from my own observations, having only obtained a few recently hatched larvæ in the tow-nets. The later metamorphosing stages I have never found, either in the North Sea or elsewhere, but specimens of about half an inch long have been found by Mr. Cunningham between tide-marks in Mevagissey Harbour. Soles of about an inch and a half in length begin to appear in the Humber in the summer, though not to my knowledge at the extreme margin, but specimens from about two and a half to four inches are not infrequent at the margin from spring to autumn, and occur also, as I understand, in similar situations further south along the Lincolnshire coast. I do not know that

* The halibut, witch, and megrim are the only North Sea flat-fish of any importance which regularly descend to great depths, and are thus "bathybial" in habit.

there is any record of the occurrence of such small forms anywhere except close inshore, either in shallow sandy grounds or in estuaries ; and for my own part I believe that, while the early stages of metamorphosis are pelagic, the young fish, on the assumption of the adult conformation, adopt an inshore or estuarine habitat, and are in no sense generally distributed over the North Sea. There is no evidence of such general distribution, though it is commonly asserted by fishermen that they catch large numbers of very small soles on the grounds about the Well Bank, and also on the Eastern grounds ; but all the small examples which I have obtained from either locality have proved to be solenettes (*S. lutea*). The solenette is very easily distinguished from a true sole of the same size if the two are compared together, but this the deep-sea fisherman has no chance of doing, as he never catches any very small true soles.

Soles of all sizes, from about five to about twelve inches, are fairly plentiful in the Humber during the spring and summer, especially on certain grounds, mostly with rather deep soundings ; but occasionally examples of larger size than those previously mentioned are taken at the margin also. About the beginning of July larger fish, which have recently spawned, begin to make their appearance in the river, but most of them disappear again by November. In the autumn a considerable number of fish, all of fair or large size, arrive in Scarborough Bay.

Of the haunts of very small soles on the Continental side I know little, but have been told that in the early days of trawling, when the smacks used to tow almost up to the beach, great numbers used to be caught of a size much smaller than those which are now to be found beyond the three-mile limit, and I have no doubt that the shallow sea lakes of Holland, Germany, and Denmark are the nurseries of the species for those coasts.

From any absolute knowledge which we have of the distribution at different sizes it appears that the sole, after the completion of its early metamorphosis, becomes practically an estuarine or, at least, an exclusively littoral species until it has reached a size which closely corresponds with that at which sexual maturity is assumed.

Of the winter habitat of young soles it is hard to speak positively, since very few can be obtained anywhere. To a certain extent they may migrate into deeper water, but I know no proof of this, and I am inclined to share the belief of many fishermen that they hibernate to a great extent by burying themselves in the sand ; their powers of burrowing must be well known to every one who has watched them in captivity.

It is well known that the former abundance of soles in the

Silver Pits was a phenomenon confined to the winter, and, as I am given to understand, soles were always most plentiful there in very hard weather. Within recent years the fish taken from the Pits consist, according to my observations, chiefly of mature fish; at any rate, I have seen no very small ones. I have been told, however, that small soles used to be plentiful there; but the information, based upon recollections of a fact which, at the time of its occurrence, no doubt seemed unimportant, cannot be considered as wholly reliable. The Great Silver Pit is about equidistant from the summer sole grounds of either coast of the North Sea, and its winter supply is recruited, I should imagine, from both coasts. A violent gale sometimes has the effect of driving soles into deeper water; thus after the great gale of November, 1893, there were good takes of these fish in the Yorkshire Hole or Little Silver Pit, where none had previously been obtainable.

Our knowledge of the life-history of the plaice, certainly the most important, if by no means the most valuable, of trawl flat-fish, is fortunately fairly complete. In the adult condition the species is generally distributed all over the North Sea, but is not found very close inshore, or in very shallow water on either coast. It is the earliest spawner among the fish with which we have to deal here, breeding chiefly from the middle of January to the end of March; to some extent a little later, and probably earlier also. There is at the spawning season a distinct congregation of mature fish on different grounds well known to the fishermen, such as various parts of the Dogger, and a ground lying about fifteen miles off Flamborough Head, &c.; but none of these grounds are very close inshore, nor, so far as I have been able to discover, does any spawning at all take place on the shallow sandy grounds on the eastern side of the North Sea. The plaice, in fact, is in the North Sea distinctly an offshore spawner, and, as far as its mature condition is concerned, practically an offshore fish altogether. The eggs are pelagic,—that is to say, they float at the surface; but this fact is not universally appreciated, even by the more enlightened members of the fishing community. There is a substance which some deep-sea fishermen regard as plaice-spawn; what it is I do not know, as I have never been able to inspect any of it, and as the description given of it is only sufficiently exact to render it perfectly certain that the describers' diagnosis is incorrect. It is said to be yellowish in colour, and may possibly be the spawn of the little sucker or gobbler (*Liparis* sp.). Of this I have obtained a good deal on and from grounds which are frequented by spawning plaice, but have not had an opportunity of showing it to any of the exponents of the demersal theory of plaice ova. The inshore

fishermen regard quite a distinct organism as the spawn of plaice, as we shall see later on.

The general set of the tides or currents in the North Sea is well known to be towards the Heligoland Bight, whither most floating wreckage ultimately finds its way, and it seems natural to suppose that the floating eggs of the plaice liberated in the open sea, to a great extent, drift in that direction; the same must be the case with the younger and more helpless of the larvæ. I am far from supposing, however, that the current is by any means the sole determining factor in the distribution of the very young forms, since we do not find on the eastern side the young of several species which must, in their earliest condition, have been exposed to exactly the same tidal influences as the plaice.

In any case the very youngest free stages of the fish do not seem to occur very close inshore on either side of the sea, and most of the phases of the metamorphosis appear to be passed at some little distance from land, or at least in tolerably deep water. The small transparent forms, though capable, like the young turbot, &c., of swimming at the surface, appear to be commoner at the bottom; at least I have found them so, but my fishing operations have very seldom been favoured with that calm, warm weather which appears to have the greatest effect in bringing young flat-fish to the surface.

By the time the young fish has acquired the adult form, a process which is accomplished some time in the late spring or early summer, it will be found, on any coast with which I am acquainted, at the extreme margin, either on the open sandy beach or in an estuary, in company with shrimps and a certain but much smaller number of dabs, sole, turbot, &c. The little plaice is now about an inch long, and from that size up to about three inches the young fish remain very close to the beach throughout the warmer parts of the year. Indeed, it seems probable that those which fail to reach a larger size before the winter remain in the same situation throughout that season. Some at least are obtainable there at the coldest season, and I have found none elsewhere. Possibly they bury themselves to some extent in the sand or mud, but I do not think that they go out to sea, though they may possibly move into rather deeper parts of an estuary than they frequent in summer.

As the size increases there is a gradual withdrawal from the immediate neighbourhood of the margin; thus, in the Humber, there are only a few fish, comparatively speaking, at the margin which exceed a length of about 4 inches, while in the deeper parts there are not very many fish of less than 4 inches. Plaice do not frequent the deepest parts of the Humber to any great extent, but in moderate depths, from two to six fathoms, one meets with all

sizes from about 4 inches up to 12, and in less numbers up to 14 inches. Larger fish are extremely scarce there; indeed, I only know of a solitary instance of the occurrence of a 17-inch plaice in the estuary. The same restriction of size applies to the shallow sandy inshore water of our own coast, whether estuarine or not, and on the vast shallow expanses of the Continental coast the great majority of the plaice do not exceed a length of 13 inches. On the Terschelling fishing ground, where the boats do not go very close inshore, I do not think there are many fish of less than 8 inches, but further north our vessels get a great many from only 4 inches upwards. There is always a certain proportion, not a large one by any means, of fish up to about 15 inches on these Eastern grounds, with occasionally a very much smaller number of large fish; and large fish are found on certain rough patches quite close to the small-fish grounds.

The small fish are plentiful on the grounds from some time in March, if the spring is forward, until the autumn, and a bright calm day in winter is said to bring them out, while heavy weather from the south-west will cause them to disappear. Trawlers imagine, I know not with what reason, that they emerge from and retreat to the "lakes" inside the barrier islands; also that they bury themselves. The former theory, at all events, is very probably in accordance with facts.

So far we have seen the young plaice, after the completion of its larval metamorphosis, confined to an immediately littoral or estuarine habitat. It remains to be seen at what period they pass into the open sea, or into the more central regions thereof. On our own coast there is no obvious migration, but as the fish are never found in the river or bay beyond a certain size, it may be supposed that in the autumn the larger representatives pass out to sea, never to return; and it may be noted that there is a certain correspondence between the size at which they leave the river and that at which the first symptoms of approaching maturity begin to manifest themselves, though some proportion, I imagine, must spend another year on the offshore grounds before their reproductive organs begin to mature.

On the Continental coast, where the numbers of small fish are very much larger than on our own, there is a most definite migration seawards, and every autumn our trawlers are certain of finding a great catch of plaice between the Dogger and the Eastern grounds. The fish are small, but their sizes correspond to those of the *largest* of the fish on the adjacent inshore grounds, none of the very small ones being present. There can be no doubt, I think, that they are the largest of the brood making their first journey to the haunts of

their parents. Once they reach the Dogger, they soon scatter ; but they can be traced through the later months in the considerable proportion of small fish which are found among the large ones on that ground in winter, and when the spawning season arrives no doubt some at least are mature.

We see thus that up to a length of about 12 or 15 inches the North Sea plaice is inshore or estuarine in habitat ; beyond that the species, nowadays at least, is practically confined to offshore grounds.

I spoke just now of a theory held by longshore fishermen of the reproduction of the plaice. These men are, or affect to be, totally unable to appreciate the fact that a fish may differ in its distribution at different ages or sizes, and maintain that the plaice which they get in their bays or estuaries are a distinct race, to which they apply the names of "flat-fish" or "fluke," using them in the specific and not the commoner generic sense. The same contention is held on the Lancashire coast, in the Humber, and, as may be learned from the minutes of evidence before the Parliamentary Committee, further down the Lincolnshire coast. The fishermen's arguments are various, not to say contradictory. The chief argument is that they never get these flat-fish as large as an offshore plaice, which, of course, is not remarkable. A most curious point sometimes urged in favour of the theory is that the "flat-fish" never have a roe in them. How they maintain their numbers without the use of a roe is not explained. It is true that in answer to a question on the subject, a fisherman from Skegness (Minutes of Evidence, 5041) said that ripe spawn was found in them in May and June. I take leave to suppose that this fact was "wrenched from his imagination;" and, indeed, the mental process by which it was arrived at becomes perfectly evident from the rest of his answer, viz. that after these months, in July, August, and September, there are multitudes of "flat-fish" of one, two, and three inches. Threatened with the imposition of a size limit for plaice, it is obviously in the interest of longshore trawlers and shrimpers to maintain the specific distinctness of the "flat-fish."

Though most acknowledge, and all, I suppose, must be aware that spawn is never found in these small fish, there is no lack of information, of a kind, as to their life-history. On the sandy stretches between tide-marks in spring and summer one finds a number of gelatinous greenish or brownish capsules, attached to the sand by the insertion of a long filament. These things, which are well known to naturalists as the spawn of a marine worm, are strenuously asserted by the longshore fishermen to be that of their "flat-fish." No attempt, however, is made to dispose of the interval between the unhatched spawn and the fully metamorphosed

little plaice of an inch long, nor to trace the spawn to the reproductive organs of the parent. How much of this theory is actually believed, and how much is assumed in order to humbug people whom the shrimper believes to be in the almost unattainable position of knowing less about fish than he does himself, it is impossible to say. As long as it can be used as an argument against interfering with his pursuits it will probably flourish.

I have already explained (*supra*, p. 378) that the actual existence of a dwarf variety of plaice in the Baltic, and to some extent on the North Sea coast of Denmark, may have probably given rise to opinions that the small plaice on the Eastern grounds do not grow larger, but that the plaice which are found on these grounds belong to the ordinary North Sea type, and are simply young specimens thereof.

The **lemon sole** is found in most parts of the North Sea, both on deep and shallow grounds, but occurs nowhere in very large numbers, and is certainly far from plentiful on the Eastern side—at least, large numbers are not caught together; but, as the fish has a decided partiality for “roughs,” it may possibly be plentiful on rocky ground quite inaccessible to the trawler. It is not, however, by any means confined to rough ground, being found in fair numbers on the sandy expanse of the Fisher Bank and on perfectly smooth ground elsewhere. The spawning period is protracted, extending from April to September, and spawning does not take place in shallow water. Very little is known of the life-history. Previous to 1893 young fish of less than about 6 inches were hardly known, the only specimens accounted for being a few of 2 and $4\frac{1}{2}$ inches taken on the Smith Bank in the Moray Firth, at 20 fathoms, and two incompletely metamorphosed examples of less than 2 inches which I recorded from 62 to 80 fathoms on the west coast of Ireland. It was obvious that the corresponding stages could not be passed at the same depths in the North Sea—*il n’y en avait pas de quoi*, but I supposed that at least the young fish were confined to considerable depths. I was therefore a good deal surprised to find the species occurring in some numbers in the Humber from a length of 2 to about 4 inches, and, more sparingly, upwards to 11 inches. They were never at the immediate margin, like the very young plaice, but in rather deeper water. A certain number of these very small lemon soles appear to remain in the river throughout the year, and I do not know anywhere else that they occur. I have no knowledge of the occurrence of small lemon soles on the Eastern grounds.

Of the distribution of the **common dab** and its life-history, it is sufficient to say that it is found everywhere and at all stages in

every part of the North Sea, both inshore and offshore, and that, except in estuaries, it seems to spawn anywhere without regard to depth of water or proximity to land. It may be added that it appears to eat anything which it can get into its mouth, a faculty which probably accounts for its universal distribution. Large dabs occur on the eastern grounds in sufficient numbers to be worth bringing to market.

The **megrim** is rare in the North Sea, being almost confined to the deepest grounds. The **witch** is much more plentiful, but confined to the deeper grounds. Immature members of either species are never found on inshore grounds, nor do I know any ground on which they can be obtained.

The **flounder** is chiefly an estuarine fish, and, with the exception of the Eastern grounds, occurs on no ground worked by deep-sea trawlers, except at the spawning season.

Spawning takes place at sea, but the young find their way at a very early age into shallow bays, near the mouths of rivers, and into estuaries, rivers, brooks, and even ditches, the species being quite at home in perfectly fresh water. These localities are not quitted until the fish is ready to spawn, and spawning having been accomplished, the former haunts are at once regained.

The **long rough dab** is almost exclusively an offshore fish, especially in its younger condition. It has no commercial value, and is not considered by Grimsby trawlers to be fit for human food.

The **halibut** is very far from plentiful on North Sea trawling grounds. Practically nothing is known of the early stages of its life-history. A few immature specimens of considerable size are sometimes met with on the Eastern grounds, but are not much commoner there than on offshore grounds.

The **sand sole** and **thickback**, of which the latter is of some importance to south coast trawlers, do not occur, to my knowledge, on any North Sea ground. Thickbacks are obtained on the Bay of Biscay grounds to which North Sea steam-trawlers occasionally resort. The young stages, as far as our meagre information goes, are found in very deep water, and the species is at no stage to be found on inshore grounds in northern latitudes.

Round-fish.—Very young cod approach quite close to the shore, and enter estuaries in very considerable numbers, but the number of those which pass all stages of their existence in the open sea appears to be at least as large. Very young whiting frequent estuaries in enormous numbers, but fish of the same size are plentiful also on offshore grounds, so that the immature members of both these species cannot be said to be restricted to either inshore or offshore grounds. The haddock is more exclusive. It appears to

avoid estuaries altogether,* though both mature and half-grown fish may approach the coast where no considerable fresh-water outlet exists. The very young stages (having the adult conformation) have only been met with on offshore grounds. I am not aware that very small haddock ever occur on the Eastern grounds.

It will be seen from the foregoing remarks that we can generalise but little with regard to the distribution of mature and immature trawl fish. We can say that the plaice is an estuarine or inshore fish in its immature condition, and practically an exclusively offshore fish when mature. Soles, turbot, and brill are inshore fish and estuarine fish when immature, but to some considerable extent are inshore spawners also, *i.e.* on the Eastern grounds, while the plaice is not. Haddock, as far as we are here concerned, may be considered as exclusively offshore fish.

CHAP. IV.—AN EXAMINATION, WITH STATISTICS, OF THE DESTRUCTION OF IMMATURE FISH.

a. By Deep-sea Trawling.

It appeared to me, on undertaking my inquiries as to the amount of immature fish destroyed in the ordinary course of the trawling industry, that this object could best be accomplished by the statistical method. Accordingly, during my stay at Grimsby I have endeavoured to keep as exact an account as possible of the amount of small fish landed there, with as much information as I could obtain about the different grounds from which the fish were caught. Owing to press of work in connection with my researches on the definition of sexual maturity, I was obliged at first to limit the scope of my statistics to the plaice, which I soon found to be by far the most important species; and during the first year I could only afford the time necessary to take the numbers of small fish. During the second year I was able to include all plaice, of whatever size, and also to pay attention to the quantity of small haddock and codling landed by trawlers, but it has never been possible to attend to the total numbers of these two species. The destruction effected by shrimp-trawling and various long-shore fisheries did not lend itself to statistical inquiry, and for the present my remarks must be understood to apply only to beam trawling by large vessels, or, as it is generally termed, "deep-sea trawling."

* Large numbers of haddock about 5 inches long were cast up dead on the shores of the Humber after the gale of November, 1893. No other kinds of fish were noticed by myself on this occasion, the only one on which I have heard of the occurrence of a haddock in the estuary under any circumstances.

With regard to the plaice (putting aside the estuary of the Humber, which is the seat of a small shrimping industry, and which annually contributes an insignificant number of small plaice to the market), it soon became evident that all the takes of plaice which included so many small fish that the latter could be packed in separate boxes, were made on the Eastern grounds—that is to say, on any part of the Continental coast from Terschelling on the south, to the Horn Reef on the north, and even further northwards along the Danish coast to Hantsholm (see chart).

My inquiries were facilitated by the fact that vessels which fished these grounds seldom worked any others during the same voyage, so that there was but little admixture in the cargo of the products of different localities. The most usual admixture was in the case of boats which had been fishing off Borkum Island. On the ground nearest the shore of that island the plaice are all small, but on Borkum "rough," only a few miles off, there are plenty of fine fish. Such matters, however, could usually be ascertained in the course of the collection of the records.

It was, of course, impossible to examine all boxes of fish which came to market, and to determine how many were mature or the reverse, so I was compelled to divide my returns into two headings,—(i) those boxes which contained large fish, and (ii) those which contained only small.

The limit of sexual maturity stands, as we have seen, at about 17 inches for the North Sea, but this is not recognised in commercial circles as the natural limit between large and small fish, and I found it convenient to make use of the ordinary market definitions of these two terms. A box of "small" plaice, in market parlance, is one which contains, except in very rare instances, no fish over 15 inches in length, and very few, often none, which exceed a length of 13 inches. A box of "large" may contain all sizes, as long as there are a few large or fair-sized ones on the top. There is an intermediate standard known as "half-fish," consisting chiefly of sexually immature fish; but half-fish are not invariably packed separately, and it is hard to see what boundary of average size may separate a box of "half" from a box of "large." I have only found it possible to deal with two sizes, viz. "large" (including "half") and "small" as above defined.

Of course, in such a classification a great number of immature fish are left out of the category of "small," viz. a certain number nearly always present in boxes of "large," boxes which barely rise to the dignity of "half," and boxes which, though almost filled with small fish, are decorated with a few largish ones on the top.

It may be remarked that the classification is unsatisfactory from

the biological point of view, but I prefer to use the trade standard, since the "practical" man is thereby debarred from raising the howl with which he usually greets any attempt at what he chooses to suppose to be a "scientific" method. The actual proportions of sexually mature and immature fish are deducible from averages based on the contents of boxes which are here excluded from the "small."

Even among the "small" the fishermen sometimes find it necessary or advisable to introduce distinctions. Usually all fish from about 8 to 15 inches are packed together, but sometimes there are so many exceedingly small specimens that they are divided into two lots, of which the lesser series of boxes will contain fish not exceeding about 12 inches, and mostly much smaller.

The Eastern grounds, in fact, differ somewhat from each other in the size of fish caught. Thus the "Skilling" (Terschelling) ground off the Texel, nominally a sole ground, yields plaice of which the smallest are usually about eight inches long, so that all are marketable. The Borkum and Skimliko (Schiermonikoog) grounds, where the boats go closer in, produce quantities of smaller fish, down to a size of about four inches; although none of less than six, and few of less than eight, are thought worth bringing home. Very small fish are also caught northwards as far as the Horn Reef, but north of that the fish are about the same as at Skilling. This much the grounds have in common, that, except recourse is had to the few rough patches already referred to, hardly any fish are caught which exceed the market standard of "small," and only the most infinitesimal proportion of really mature fish are taken.

When these grounds were first worked, and for many years afterwards, it seems to be an undoubted fact that they abounded with large fish. Some say that there were no small ones then, but the general and much more probable report is that the little ones were always there as well, but were simply shovelled overboard (just as the very small ones are now), and so never made their appearance in this country. It was only when the large fish failed that the small ones began to be heard of. On the grounds "below" (north of) the Horn Reef it is said that originally there were only large fish, and it seems to be held that the fish there now are larger than the rest. Of this I have not been able to convince myself, either by personal inspection or by observing the fish landed from there, but certainly there are no very minute fish on the trawling grounds in that region.

It is certainly a fact that large plaice are to be caught north of the Reef, but this is in the autumn, and on grounds which lie further out than those frequented by the small. The latter are

found in the summer anywhere along the coast, quite close in from the reef to the Holmen, the ground about the mouth of the Limfjord being perhaps one of the most productive grounds. Moderate-sized fish, of which some 24 per cent. may be sexually mature, are to be had at the same season in the offing, but within the moraine previously mentioned. The small fish, I find from my records, were still close in to the Holmen up to the last week of August, 1892, though I could find but few of them there a month earlier, probably on account of bad weather.

On the other hand, about the middle of September a quantity of fine fish always appear in the same locality, but further out, viz. about twelve miles off the light. They stay there for some time, and our boats never neglect to take toll of them, 200 boxes being by no means an unusual "voyage" for a steam trawler. The natural question as to whence they come and whither they go may for once, I think, be answered with some degree of confidence. It has long been known to Baltic naturalists that plaice, larger than the dwarfed native breed, enter the Sound and Baltic in the summer. The Danish fishermen called them "priest's flounders," as being fitter to cope with the sacerdotal appetite than the small natives: naturalists, regarding the Baltic dwarf as the type, considered the immigrants in the light of a variety (*P. platessa* var. *borealis*, Gottsche). They are, in fact, ordinary North Sea plaice, and come, I have little doubt, chiefly from the Great Fisher Bank, whither they appear to return in the autumn, *viâ* the Holmen ground; picking up, most likely, some recruits on the way. There are plenty of large plaice on the Bank in the winter and through the spawning season, but after that, and throughout the summer and early autumn, there are comparatively few there. If the Baltic and Holmen migration theory is correct this is easily accounted for.

The above is rather a digression from the subject of the present chapter—the destruction of immature fish—but it leads us to a point which has a distinct bearing on it. The Horn Reef seems to form a natural boundary between different plaice nurseries, of which the most considerable is of course the vast area of small fish ground south of the reef. I have been inclined to suppose that the grounds north of the reef are the nursery for the Fisher Bank plaice, and that the larger among the little ones find their way thither every autumn; but of this I have no proof.

But, as regards the grounds south of the reef, it is hardly possible to doubt that they furnish every year a contingent to the Dogger and other central grounds. About the end of July our trawlers regularly set out, unless they have better sport in hand, to the White Bank, Clay Deep, Back of the Scruff, Rising Ground,

&c.—grounds which a glance at the chart will show to be exactly on the line from the small-fish grounds to the Dogger,—and there capture a considerable quantity of small plaice. There may be an admixture of larger fish, but the bulk and often the entire catch consists of plaice measuring from 12 to 14 inches. There was no quantity of such small fish on the off-shore grounds before, and they correspond exactly to the largest sizes of the fish on the Eastern grounds, while the time corresponds to that at which the “body” of the small fish disappear from these grounds. The fishermen consider that they are travelling some whither, and not feeding at the locality of capture; and of the nature of their migration I think there can be no manner of doubt. What chiefly concerns us here is the evidence of a large destruction at a certain season of the year of (practically exclusively) immature fish on grounds which lie some fifty or sixty miles from the nearest land.

The following table gives, I believe, a very nearly exact account of the plaice landed from the 1st April, 1893. I cannot speak as to the accuracy of the total amounts previous to that date, as my own statistical inquiries, from January, 1892, to April, 1893, only dealt with the “small” fish. In order to get the other amounts for the earlier period I was obliged to make use of the official returns, whatever they may be worth, arriving at the amounts of “large” by subtracting my own account of the “small,” and in June, July, and August, 1892, deducting an amount estimated as the product of the Iceland fishery. For this purpose I deducted only 800 boxes. The number was probably larger, but as I had not kept an exact account of them I preferred to be on the safer side.

My own returns in this table deal only with fish landed by deep-sea trawlers. The Board of Trade figures presumably include also whatever plaice are landed at or sent to the market by shrimpers and other long-shore fishermen, which I have preferred to deal with separately. I also exclude from this table any fish which have been consigned to the market from abroad, or, to my knowledge, from other British ports, since such can have no possible bearing on the Grimsby fishery; but I do not see how the official returns, being based on quantities despatched from the market by rail, can possibly distinguish between fish landed by fishing vessels, and those which arrive at the market by any other means. Consequently the total amounts previous to April, 1893, being taken from official returns, are rather different in scope, as well as in method of collection, from those from April, 1893, onwards; but the amount so excluded from my own returns is not sufficient to make any considerable difference. I should add that there is one large fleet belonging to Grimsby, which

Table showing the Weight, Bulk, and approximate Number of Plaice fishing power (in voyages of steam-trawlers)

	ALL DEEP-SEA GROUNDS.			NORTH SEA.		
	Total.			Total.		
	Cwt.	Boxes.	Fish.	Cwt.	Boxes.	Fish.
1892.	i	ii	iii	iv	v	vi
April	11,000	9,777	1,253,100	11,000	9,777	1,253,100
May	12,000	10,666	1,191,100	12,000	10,666	1,191,100
June	49,000	34,577	3,895,150	10,400	9,244	820,300
July				17,000	15,111	1,820,050
August				10,600	9,422	1,230,800
September	15,000	13,333	1,510,900	15,000	13,333	1,510,900
October	20,000	17,777	1,821,950	20,000	17,777	1,821,950
November	20,400	18,133	1,813,330	20,400	18,133	1,813,330
December	11,000	9,777	977,700	11,000	9,777	977,700
1893.						
January	10,000	8,888	891,950	10,000	8,888	891,950
February	7,600	6,755	680,150	7,600	6,755	680,150
March	10,000	8,888	888,800	10,000	8,888	888,800
April*	12,256	10,833	1,471,650	12,006	10,633	1,463,650
May	23,727	20,439	2,952,020	17,974	15,756	2,765,700
June	21,792	18,555	2,214,250	12,605	11,205	1,920,250
July	30,590	25,190	2,259,290	16,370	13,814	1,804,250
August	22,890	19,675	1,806,610	14,323	12,821	1,532,450
September	14,078	12,296	1,334,000	13,756	12,046	1,324,000
October	18,214	16,191	1,710,450	18,214	16,191	1,710,450
November	12,621	11,219	1,244,300	12,621	11,219	1,244,300
December	5,140	4,570	470,050	5,140	4,570	470,050
1894.						
January	5,020	4,463	477,650	5,020	4,463	477,650
February	4,132	3,707	377,900	4,132	3,707	377,900
March	9,377	8,341	1,061,150	9,377	8,341	1,061,150
Total for year ending } March 1894	179,837	155,479	17,379,320	227,294	125,766	17,171,800
April	20,177	18,705	971,661	18,820	17,619	928,221
May	17,911	15,577	2,174,230	14,015	12,460	2,049,550
June	17,274	15,939	2,139,720	13,827	13,181	2,029,400
July	17,879	15,559	1,752,160	14,118	12,550	1,631,800
August	19,438	17,206	1,886,590	18,606	16,540	1,859,950
September	19,565	17,303	1,871,300	19,565	17,303	1,871,300
Total for six months	114,244	100,289	10,795,671	98,951	89,653	10,370,221

* Totals previous to this date are taken from official returns.

landed at Grimsby by deep-sea trawlers, and (col. xvi) the diversion of from the North Sea grounds in each month.

NORTH SEA.						ICELAND.			
Large.			Small.			Cwt.	Boxes.	Fish.	Voyages.
Cwt.	Boxes.	Fish.	Cwt.	Boxes.	Fish.				
vii	viii	ix	x	xi	xii	xiii	xiv	xv	xvi
8,933	7,941	794,100	2,065	1,836	459,000	...	...	...	...
11,065	9,836	983,600	933	830	207,500	...	...	...	...
6,000	5,774	577,400	3,903	3,470	242,900	}	800	24,000	?
14,683	13,052	1,305,200	2,316	2,059	514,850				
8,435	7,498	749,800	2,164	1,924	481,000				
13,668	12,149	1,214,900	1,332	1,184	296,000	...	...	...	...
19,667	17,482	1,748,200	331	295	73,750	...	...	...	...
20,400	18,133	1,813,330	...	...	...	...	...	...	...
11,000	9,777	977,700	...	...	...	...	...	...	...
9,977	8,867	886,700	23	21	5,250	...	...	...	...
7,566	6,724	672,400	34	31	7,750	...	...	...	...
10,000	8,888	888,800	...	...	...	...	...	...	...
9,004	7,964	796,400	3,002	2,669	667,250	250	200	8,000	2
8,549	7,822	782,200	8,925	7,934	1,983,500	5,753	4,683	186,320	20
6,615	5,880	588,000	5,990	5,325	1,332,250	9,187	7,350	294,000	30
13,199	10,995	1,099,500	3,171	2,819	704,750	14,220	11,376	455,040	36
12,546	11,152	1,115,200	1,877	1,669	417,250	8,567	6,854	274,160	21
12,856	11,250	1,125,000	900	796	199,000	312	250	10,000	1
17,529	15,582	1,558,200	685	609	152,250	...	...	...	...
11,703	10,403	1,040,300	918	816	204,000	...	...	...	...
5,043	4,483	448,300	97	87	21,750	...	...	...	...
4,785	4,254	425,400	235	209	52,250	...	...	...	...
4,054	3,604	360,400	78	70	17,500	...	...	...	...
7,671	6,819	681,900	1,705	1,517	379,250	...	...	...	...
199,310	100,208	10,020,800	27,583	24,520	6,131,000	38,489	30,713	1,227,520	110
9,347	9,198	919,800	9,473	8,421	405,150	1,357	1,086	43,440	7
7,990	7,103	710,300	6,025	5,357	1,339,250	3,896	3,117	124,680	25
9,493	8,439	843,900	4,334	4,742	1,185,500	3,447	2,758	110,320	21
11,292	10,038	1,003,800	2,826	2,512	628,000	3,761	3,009	120,360	19
17,062	15,167	1,516,700	1,544	1,373	343,250	832	666	26,640	5
18,408	16,363	1,636,300	1,057	940	235,000	...	...	...	...
73,552	66,308	6,630,800	25,259	23,345	5,836,150	13,293	10,636	425,440	77

makes a practice of landing its fish in London, but at rare intervals sends a cutter to Grimsby. Fish landed in this way are omitted from my own returns, as I think that to include them might lead to erroneous conclusions as to the abundance of supply.

From various causes it was not possible to keep the records for several days in various months, and, in order to remedy the omission, I have made up the amount by means of averages. The method is not an exact one, perhaps, but is probably sufficiently so for our purpose here. In the Journal, where my statistics have already been published in a simpler form, I have made no attempt to supply the omissions, but have simply made a note of the number of days on which no record was made.

The Board of Trade returns deal with weight, while I prefer to use the box as the unit of calculation. Indeed, no other method is possible in statistics taken on the pontoon. The official weights have therefore been converted into boxes in the earlier period, but as weights are more intelligible to many people, I have retained them also, and in the returns since April, 1893, have computed the boxes from my own record in weights.

I must explain that at Grimsby a "box" of fish means a box packed in such a way that a considerable number of fish are above the level of the top; a box which is only filled up to the top is called a "level." Boxes of North Sea plaice, as I am informed by fish buyers, and as I find by experiment, average a weight of nine stone; but boxes of plaice from Iceland, owing to the larger size of the fish, can be packed much higher, and are so packed with a view to tempt the rather unwilling market, and weigh about ten stone each. Accordingly cols. v and xiv require different treatment for conversion into weights.

When a vessel is "single-boating," the fish are landed in baskets and packed in boxes upon the pontoon, but in "fleeting" large plaice are packed in boxes on board of the vessel which catches them, and placed on board the "cutter" for transport to market. In this case, for convenience of stowage, the boxes are only filled up to the top, consequently fish derived from fleets are sold in "levels." * A certain allowance of large plaice has to be made for home consumption, and this, I believe, has been done with sufficient accuracy in counting "levels" as "boxes," though the allowance ought really to be spread over the whole year instead of appearing, as it does by my method, highest in the chief fleeting season. I do not know that there is any home consumption of small plaice.

The approximate numbers of fish are derived by multiplying the

* Small plaice are always sold in "boxes," whether derived from fleets or single-boaters.

boxes by the average number which a box of each class contains. In the case of "small" I have taken 250 as the average. The usual number is rather greater, and sometimes very much greater, if the fish are unusually small, but I prefer to run no risk of exaggeration in this matter. I may say that I have never seen a box of small fish which would have numbered anything like 1036, but we have it, on the authority of Mr. Tooze, that at least one such box has been sold at Billingsgate.* I should say that 400 would be an extreme number for a Grimsby box. The same authority spoke (*ibid.*) of 40 to 45 being the contents of a good box of plaice, and I have often heard it said that a box of "large" fish contains about 50. The fact is, however, that nowadays a full box of so-called "large" plaice, taking one ground with another, averages about 100 fish; the idea of the smaller number being a tradition which dates from the times when really large fish were plentiful in the North Sea.

Iceland plaice are of course much larger, especially when derived from the open grounds. Thus a ten-stone box contains only about 30 fish. The fish landed from Iceland in 1892 were almost all from the open grounds, and I accordingly used 30 as the average per box, but on account of the considerable number of smaller fish brought in from inshore grounds in subsequent years, I considered 40 to be a safer average.

It will be understood, of course, that the numbers of fish in the preceding table are those which are contained in the boxes sold as "large" (including "half") and "small" respectively, and are not intended to represent the numbers of actually large and small fish landed. To arrive at that fact approximately we must have recourse to a further process of conversion. The boxes containing only "small" fish come, as we have seen, exclusively from the grounds on the Eastern side; and of the remainder, even of those in which the largest are only "half" fish, all but a comparatively insignificant proportion are derived from grounds other than the Eastern.

The sizes of fish taken on these grounds differ considerably according to the ground, and on some grounds according to the time of year, but we shall be safe in saying that a box of "large" contains, on an average, 30 per cent. of fish which fail to reach the biological standard of 17 inches, and 10 per cent. of fish which are less than 13 inches. I do not think it would be an exaggeration to say that there are 30 per cent. of actually immature fish, whether male or female, but it is difficult to make a perfectly reliable average, and that which I have formulated above, being

* N.S.F.P.A., Rep. Conference, 1892, p. 11.

well within the mark, must suffice for our present purpose. A box of "small" contains at least 90 per cent. of less than 13 inches, and 100 per cent. of sexually immature.

I do not know what may be the standard of maturity in Iceland fish, so have restricted my calculations to those derived from the North Sea. The results are given in the following table.

Table showing the numbers and proportion of plaice of different sizes landed at Grimsby by deep-sea trawlers in one year.

	Sexually				13 inches and above.		Below 13 inches.	
	Mature. 17 inches and above.		Immature. Below 17 inches.					
	No.	%	No.	%	No.	%	No.	%
	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.
1893. April . . .	557,480	38	906,170	62	783,485	53	680,165	47
May . . .	547,540	19	2,218,160	81	902,330	32	1,863,370	68
June . . .	411,600	21	1,508,650	79	662,425	36	1,257,825	64
July . . .	769,650	42	1,034,600	58	1,060,025	42	744,225	58
August . . .	780,640	50	751,810	50	1,045,405	68	487,045	32
September . . .	787,500	50	536,500	50	1,032,400	78	291,600	22
October . . .	1,090,740	63	619,710	37	1,417,605	83	292,845	17
November . . .	728,210	58	516,090	42	956,670	76	287,630	24
December . . .	313,810	66	156,240	34	405,645	86	64,405	14
1894. January . . .	297,780	62	179,870	38	388,085	81	89,565	19
February . . .	252,280	66	125,620	34	326,110	68	51,790	14
March . . .	477,330	44	583,820	56	651,635	61	409,515	39
Total for year . . .	7,014,560	43	9,137,040	57	9,641,820	72	6,519,980	28

I think it may be claimed that this table throws more light on the actual destruction of under-sized fish than any evidence that has yet been brought forward on the subject. Of course the numbers of fish given are not exact, but I emphatically assert that the method of computation, so far from exaggerating the proportion of small fish, tends rather to under-estimate it, yet we find that in a whole year's trawling, on all North Sea grounds, 57 per cent., or more than half, of the fish had never had a chance of reproducing their species, and so contributing to the up-keep of the supply.

I do not know that there is any actual necessity to say anything more as to the destruction of immature plaice, since if the above table does not prove to the satisfaction of any reasoning being that it is serious, nothing will do so. I will draw attention, however, to the difference in proportions which manifests itself in different months of the year,—especially, for a reason which will hereafter

appear, in the case of the series of columns dealing with fish of 13 inches and above, and those which fail to reach even that modest standard of size. It will be noticed that if we eliminate the months of March to August inclusive, the proportion of very small fish is not a large one.

I have never made any attempt to collect the numbers of fish under 8 inches, the limit proposed by the Parliamentary Committee, because there is no necessity to do so. No one conversant with the Grimsby market will be disposed to say that the subjoined table of proportions is far from the mark:

Proportion of plaice landed at Grimsby: 8 inches and above, 99.9 per cent. ; less than 8 inches, 0.1 per cent.

Unfortunately the small fish *landed* at Grimsby by no means comprise all those which are destroyed by Grimsby trawlers. Certainly on any but the Eastern grounds very few unmarketable fish are caught; and on the Terschelling ground and those north of the Horn Reef there are no very small fish, but between the reef and Terschelling the trawl often brings up a quantity that are not saleable. I cannot attempt to estimate the quantity annually captured in this manner, but can give an instance which perhaps will serve sufficiently well. In 13 hauls made in the neighbourhood of Borkum and Schiermonnikoog 141 baskets of plaice were caught. Of these 93½ contained saleable fish from about seven to thirteen inches, which were brought to market. The remaining 47½ baskets, consisting of fish of about four to seven inches, were shovelled overboard. In actual numbers probably more fish were thrown away than were brought home.

The question has often been asked, **is a fish killed by being caught in the trawl?** The answer given on all hands is that it depends upon circumstances. It depends also on the kind of fish, since flat-fish as a class are rather hardier than round-fish, and some flat-fish are hardier than others. The plaice, with which we are now dealing, is about as hardy as any, and if the ground is clear, and there is not much weight of fish in the net, a plaice will survive a short haul, and even a moderately long one; but the smaller the fish, the more liable it is to injury.

When there is a big bag of fish, many of them will be mortally injured, even in only a moderately long haul on clear ground, the small ones especially being liable to be crushed or jammed between the meshes of the net; but if the ground is dirty, with quantities of weed, or, still more, if it is soft, with either loose sand or mud, the fish has not much chance of survival.

The length of haul depends a good deal on the nature of the ground. Thus on open grounds I find the average duration of a steam-

trawler's haul is about six hours, but some skippers make even a shorter average haul. On intricate ground the haul must be shorter, and averages about three hours. The hauls made by smacks when single-boating are rather longer, averaging about seven hours on open and five hours on intricate grounds. Fleeting smacks make, I believe, rather longer hauls as a rule. On the Eastern grounds, especially when there is a "body" of small fish, the hauls are generally rather short.

But granted that the small fish comes aboard alive and well, it by no means follows that it regains its native element in the same condition. The chances are that, on a steam-vessel, the bag of fish is left swinging about from the derrick for a quarter of an hour or so while the crew are occupied in shooting the second trawl, so that the whole weight of the catch is on the undermost fish. Then the cod-end is untied, and down comes the whole collection with a crash on to the deck, which cannot be particularly healthy for the small ones. On a smack which only carries one trawl, if the position is favourable for shooting again without a long beat up to windward, all hands set to work to get the trawl cleared, and mended, if necessary, before the fish receive any attention. When there is time to attend to the fish it is done in the manner calculated to take least time. The turbot must be picked out and bled as soon as possible, and all the marketable fish are cleaned, or at least sorted in separate pounds on the deck, before the small stuff and rubbish is shovelled overboard. On a fleeting smack it may be necessary to pack all the big fish for transference to the cutter before anything else can be done; and in any case, though some small plaice are occasionally alive when pitched overboard, and though I have known a more than usually provident skipper pick out and return a few small plaice, and even moderately large turbot, it may be taken that if a fish is caught by a deep-sea trawler, it is done for, whether it comes to market or not.

A few words as to the **share of different vessels in the destruction** may not be amiss. It can be best illustrated, I think, by the records of a single month. I have not kept my returns in sufficient detail to give particulars for the whole period.

In May, 1893, there were landed at Grimsby 7644 boxes of "small" plaice from the Eastern grounds. Of these, 5587 boxes were contributed by steam-trawlers in twenty-nine voyages, viz. twenty-two voyages by British and seven by foreign steam-trawlers. The remaining 1738 boxes were landed by smacks. Some of the smacks were "single-boating," but most of the stuff was derived from three fleets working the Terschelling sole ground and eastwards to Borkum. I have not the exact numbers by me, but certainly

not less than forty sail were engaged, and yet landed only about one fourth of the amount which was brought in by the steam-trawlers. The twenty-nine "voyages" of the latter might have been effected in the time by only eight or ten vessels. It must be added that the prevailing calms or light winds tended to bring the difference of efficiency as between steam and sail power into greater contrast, as the smacks, in addition to difficulty in fishing, were considerably delayed in landing, the particular fleets engaged being dependent on themselves for "cutters," instead of having steam-cutters.

I have little knowledge of the proceedings of vessels which do not land their catches at Grimsby, but I gather that, in proportion to the strength of the fleet, as much small plaice is destroyed by Hull as by Grimsby boats. Indeed, I was given to understand that in 1892 two large Hull fleets paid a visit to the small-fish grounds, though they did not stop there long. Grimsby during that year had only one small fleet on the Eastern side.

At the Conference of 1890, a number of Hull and Grimsby smack-owners voluntarily bound themselves not to send their fleets to fish a defined area, the western limit of which is shown on the chart by a chain line. This engagement, which does not appear to have applied to steam-trawlers or "single-boating" smacks, has, so far as I know, been carried out. It will be observed that the area does not include a large stretch of ground frequented by small fish.

Of Lowestoft proceedings I know even less, but I am bound to say that I have read the evidence given before the Parliamentary Committee from that port with some surprise, if with no less respectful sentiment. The grounds worked by Lowestoft vessels were roughly defined by a witness as lying between the parallels of $51^{\circ}30'$ and $53^{\circ}30'$, and it was stated that boats rarely went to the grounds about Heligoland.

Unless I have been misinformed, there were at the time three fleets of Yarmouth and Lowestoft boats engaged along the coast from Terschelling to Borkum, *i.e.* about the northern limit of the aforesaid rough definition and a little beyond it. There were also one or two Lowestoft boats in a fleet landing at Grimsby.

Evidence was given that soles or plaice of less than 8 inches were hardly ever seen at Lowestoft. I can only say that our vessels seemed to be catching plenty of smaller plaice on the same ground as the Lowestoft men, but perhaps the latter were fortunate enough to avoid them.

Very small plaice or soles are rarely seen in the Grimsby market in winter, and if by chance a few boxes attracted my attention I was

almost always informed that they had been culled out of a consignment from Lowestoft.

I found it impossible to keep statistical account of the mature and immature soles landed, nor have I made any attempt to secure even the total numbers. I may remark that large numbers are consigned from abroad, and some from our own western ports, but I am not aware whether these have been deducted in the preparation of official returns. If they have not, the returns are worse than useless.

With regard to the destruction of immature soles by deep-sea trawlers, I have myself seen one immature specimen caught in the course of my peregrinations on board of Grimsby vessels. I have examined a good many catches brought to market, but have never been able to find any large proportion of undersized; probably the whole amount of sexually immature fish does not exceed 30 per cent., nor is there evidence that many soles too small for market are destroyed at sea by Grimsby vessels. I do not know that any of less than 8 inches are brought in. I often hear of quantities of very small soles being caught, but whenever samples have been submitted to my inspection they have consisted exclusive of solenettes (*Solea lutea*), useless creatures which never grow more than about 5 inches long. Such seem to be common on the Well Bank, and also on the sole and small plaice grounds on the eastern side. The very small stages of the common sole appear to me to live too close inshore for our deep-sea trawlers to get at them.

I have not been able to collect continuous statistics of the proportion of immature turbot landed. Turbot and brill are always laid out in rows for sale, and to collect the total numbers and proportions of large and small would involve counting every fish on the pontoon—a task for which my other occupations left no leisure. However, by counting them for a considerable number of days one probably arrived at a fairly trustworthy estimate, and by this method I found that the proportion of fish under 17 inches does not exceed 30 per cent. except during the time when the Eastern grounds are being worked. The limit of sexual maturity in the female stands at about 18 inches, but I have not made any calculations upon that basis. Of the fish from other than Eastern grounds which failed to reach 17 inches, I always found that a large proportion were mature males, since the male may be fully mature at only 12 inches. Very few fish of less than 12 inches are brought in from any ground, and I do not think many are caught by deep-sea trawlers. I do not know that any of less than 10 inches are caught.

But, as regards sexually immature fish, the number caught on the Eastern grounds is very considerable. Thus in June, 1892, the aggregate of thirty-one "voyages" of steamers and smacks on the

Dutch, German, and Danish coast comprised 4623 turbot, of which 786 or 18 per cent. measured 17 inches or more, and 3837 or 82 per cent. were less than 17 inches. The highest proportion of immature reached in individual voyages was 100 per cent. and the lowest 28 per cent., but in only two instances did it fall short of 50 per cent.

In the following month of the same year eighteen voyages comprised 2435 fish, of which 69 per cent. were less than 17 inches. This slight diminution in the proportion of the immature seemed to be related to a slight movement offshore of the bulk of the small plaice on which the Eastern trawl fishery is mainly dependent. The smallest turbot apparently lived closest inshore.

With regard to **brill** I have not much evidence of any very extensive destruction of immature members; it appears rather variable. As a rule, not very many are brought in from the Eastern grounds, but sometimes the proportion is quite considerable. I cannot attempt to formulate a percentage, but can at least say that it is much less than in the case of turbot. A lot of immature brill are sometimes landed from our own coast near Mablethorpe. Very few brill of less than 10 inches are landed by deep-sea men from any ground, and I think very few are caught. I have hardly ever seen an 8-inch brill in the market.

The proportion of immature **lemon soles** landed from any ground is not very considerable. A good many are sometimes brought in from grounds near our own coast, and a number of very small ones are said to be caught sometimes about the Inner Dowsing, but on the whole I do not think the destruction that takes place is of great moment.

Though a flat fish of the hardier kinds has, under the most favourable circumstances, some small chance of surviving its capture in a deep-sea trawl, it may be taken that a **round fish** has none. This is partly due to structural differences of the gill-cover, which, adapted to the burrowing habit in flat fishes, proves also efficacious in keeping the gills closed, and therefore moist, when out of water; but the chief difficulty with which a round fish has to contend is its air-bladder. All the trawl round-fish usually met with in the North Sea are provided with a closed air-bladder, by the contraction or expansion of which the fish is enabled to maintain itself at any depth which it desires; but it is only able to adapt this apparatus to gradual changes of depth. Consequently, when it is suddenly drawn up from comparatively deep water, the diminution of external pressure is not sufficiently gradual to allow of the muscular apparatus keeping due control of the gases within the bladder. The latter expands, and the fish, though it arrive at the top otherwise uninjured, cannot get down again. Thus when the trawl warp is

straight up and down in hauling, a number of round-fish usually float up to the surface through the mouth of the net or the large meshes of the square, and, engaging the attention of the gulls, perish without ever coming on deck. Moreover I believe that pressure or injury in the trawl may induce what I suppose is a paralysis of the muscles of the bladder, so that the same effect is not invariably due to mere alteration of bathymetrical position, but the result, which would be the same in either case, is more important to us at present. The fish, if its injuries be confined to the expansion of the bladder, is certainly not beyond remedy, but the remedy must be rapidly administered. Liners, who commonly work in deep water, succeed in bringing many of their fish home alive in the well, and these may live in floating boxes for months afterwards. The method adopted is to release the expanded gases by pricking the fish with a needle, and letting the air escape, great care being taken not to puncture the liver in the process. I will leave my readers to conjecture what chance there is of trawl fishermen adopting this practice with regard to unsaleable round-fish. In any case the fish would have to be returned to the water very shortly, and probably most of them would be dead ere the surgical assistance arrived.

I have made no attempt to estimate the proportion of sexually mature and immature cod landed by trawlers. It would be extremely difficult to do so, since the larger immature fish are much mixed up with mature ones. I paid very little attention to the species at all until the winter of 1892, when my attention was attracted to the considerable and, as I was told, unprecedented quantities of codling which were being landed by trawlers from certain grounds.

Local custom divides the individuals of this species into four sizes. Up to about 20 inches they are "codling," thereafter they rank as "sprags," until at about 30 inches the dignity of "half-cod" is attained. Larger fish are simply "cod." A sprag is therefore on the borderland of sexual maturity, a condition of which all codling fall short.

The catches of codling to which I have referred first became noticeable in November, 1892, and were all derived at first from about a ground known as the Yorkshire Hole or Sole Pit. The fish seem to have continued there until February, and were chiefly pursued by several steam-trawlers. The largest "voyage" landed comprised 122 boxes for about a week's fishing. Towards the end of February a good number began to appear from off Flamborough Head, 40 boxes being obtained thence by one vessel, but they did not remain there very long.

As a rule, codling do not form a very important item in a trawler's voyage. They are to be had everywhere, but nowhere in very large numbers,—a few boxes, perhaps only half a box, being a common feature in a voyage. Considering it probable that there might be a regular migration of these fish to the grounds mentioned, I commenced to take account of all trawled codling brought to market, but there has been no recurrence of anything like a similar congregation of the fish, though the total number caught has not diminished, as the following figures show :

	Boxes.		Boxes.
1892. November (last week only) .	180	1893. November, less 1 day .	2491
December .	825	December, less 8 days .	2730
1893. January .	1605	1894. January .	3096
February .	1763	February .	2607
March, less 6 days .	2037	March, less 6 days .	2363
April .	1596	April, less 4 days .	1093
May, less 1 day .	1204	May (record imperfect).	
June, less 1 day .	1490	June, less 1 day .	986
July, less 1 day .	1838	July .	1708
August, less 5 days .	2717	August, less 2 days .	2140
September, less 7 days .	2123	September .	2636
October .	2939		

The chief deduction that can be made from the above figures is that, in the absence of any recurrence of large catches from particular grounds, the congregation noted in the winter of 1892 cannot be regarded as a regular feature in the life history of the species. It was not associated with any unusually severe weather.

About 100 fish, of about 12 to 20 inches, go to a box in the above figures, but as I have no information as to the total number of cod landed by trawlers, we cannot formulate proportions of mature and immature fish. We can say, however, that there is a considerable destruction of immature fish, not specially confined, save in exceptional seasons, to any particular grounds, and certainly not to those on the Eastern side.

The small fish destroyed are not of course confined to those which are landed, as unsaleable fish are simply pitched overboard. On clean grounds most of the very small codling pass through the meshes of the net, but on a part of the Great Fisher Bank where the ground is covered with dense growth of "lemon-weed" (*Flustra foliacea*), I have seen quantities of cod from 2 to 4 inches long brought up and destroyed.

The **haddock** becomes mature at about 14 inches, but is marketable from about 10 inches upwards. Very few of less than 10 inches are brought ashore, but considerable numbers, down to about eight inches or a little less, are caught, and of course are destroyed.

Smaller fish are sometimes, like the small cod, entangled in the net amongst weed or other rubbish.

Small haddock are trawled on pretty well all the grounds of the North Sea, except on very shallow inshore areas. They are packed separately from the larger ones, though boxes of large fish contain a proportion which are actually immature. I have collected the number of boxes of small fish landed since October, 1892, and append the figures for whatever they may be worth, in the absence of statistics showing the total amount of all sizes collected in the same way.

	Boxes.		Boxes.
1892. October . . .	542	1893. October . . .	8457
November . . .	1335	November, less 1 day . . .	6712
December . . .	1440	December, less 8 days . . .	5792
1893. January . . .	1416	1894. January . . .	5248
February . . .	1471	February . . .	3848
March, less 6 days . . .	1107	March, less 6 days . . .	5363
April . . .	2424	April, less 4 days . . .	8502
May, less 1 day . . .	2890	May (record imperfect). . .	
June . . .	3596	June, less 1 day . . .	5570
July, less 1 day . . .	3841	July . . .	6039
August, less 5 days . . .	5761	August, less 2 days . . .	6798
September, less 7 days . . .	4670	September . . .	6587

β. By other Methods of Fishing.

Apart from deep-sea trawling there is no doubt that a certain amount of destruction is effected by various other methods of fishing. Drift-netting may be left out of the question, since, though on the south coast I have seen considerable quantities of under-sized hake brought in by the drift-netters, I do not know that this fishing is injurious in the North Sea to any kinds of fish except those which form its object, and with which we are here in no way concerned.

Line-fishing.—In deep-sea long-lining and hand-lining, and in inshore lining generally, there occurs without doubt a considerable destruction of sexually immature cod, and, in the deep-sea branch of the industry, a very material destruction of immature halibut, but mainly in grounds which lie beyond the boundaries of the North Sea. It is hardly within our province to discuss the latter, and with regard to the cod I am not in a position to give information in sufficient detail to be of much value. It may be remarked that the destruction of small fish caught on the lines is to this extent wanton, that most hooked fish would survive if returned to the water.

With the exception of the halibut, which is of no great account as a North Sea trawl fish, I do not know that any flat-fish are commonly captured by deep-sea liners. It is natural to suppose that turbot

and brill may be occasionally caught, as on other coasts, but I do not know for a fact that they are.

Though the smaller kinds of flat-fish are not generally fished for by inshore liners on that part of the east coast of England with which I am best acquainted, there is at Scarborough a regular line-fishery for soles during a part of the year, but practically no immature soles frequent the ground. In Lough Swilly, on the north coast of Ireland, there is, as I am informed, a considerable destruction of small soles by line-fishers, but I know of nothing of the sort in the North Sea.

Inshore trawling.—Of the proceedings of inshore trawlers in the Wash, and on the coast to the south, I have no special knowledge. North of the Wash to the Humber I do not think there is much trawling within the three-mile limit. From Donna Nook to the Tees estuary the legitimate use of the fish-trawl in inshore waters is restricted to a portion of Bridlington Bay, but I am not acquainted with the results as regards immature fish. There was formerly a good deal of fish-trawling in the Humber, but this is now forbidden by the bye-laws of the local Fisheries Committee, though the practice has not, I believe, been eradicated. With the exception of a small proportion of large soles between July and October, there are no mature trawl-fish, except dabs and flounders, in the river. Whatever destruction now takes place may be best considered in connection with shrimp-trawling.

Shrimp-trawling.—Shrimp-trawling is carried on in the Humber, under the provisions of the Fisheries Committee's bye-law, from the 1st March to the 31st October. About fifteen cutter-rigged boats are engaged. The largest is of 22 tons; about eight are from 8 to 11 tons, and the remainder from 15 to 18 tons. All carry similar gear, viz. a trawl of shrimp mesh, with a beam not exceeding (by enactment) 20 feet in length, and a thick hempen ground-rope. Some of the larger vessels also possess what are called sole-nets, viz. trawls of a larger mesh than that which is used for shrimps, and, in spite of the provisions of the bye-law, did, within quite recent times, use them in the river; but I believe that the Committee's officer, though hampered by the want of anything in the shape of a police-boat, has done a good deal to check this practice. Be this as it may, all fish brought to market by these boats purport to have been caught in the pursuit of their legitimate industry, so may be considered under the present heading.

The fish landed consist of soles, plaice, flounders, and a few common dabs. The quantity of fish landed is never large, and would hardly deserve consideration were the general supply more abundant.

Soles, however caught, are not very numerous, sixty pairs being considered a very fine night's work for one boat, while the quantity is usually very much less. Unfortunately they are nearly all immature. Indeed, up to the end of June hardly a mature fish is to be found in the river. About the beginning of July a certain number of larger, spent fish begin to drop in, presumably from the offshore spawning grounds. They do not remain long, and very few Humber soles of any size appear in the market after September. The smallest fish landed measure about six inches; at the period of the greatest abundance of mature fish I do not think that the latter ever exceed 16 per cent. of the total, while prior to July about 88 per cent. are immature.

The plaice brought ashore are sold mixed up in boxes with flounders and dabs. Six hundred of such boxes would probably more than represent the total products of the whole fishery for a season. The plaice measure from 6 inches up to about 11 inches, but some reach a length of 14 inches. I found a box brought on the pontoon, and fairly typical to all appearance, to contain 425 plaice from 6 to 11 inches (averaging 7·71 inches), and 34 flounders from 5 to 13 inches.

I have devoted considerable attention to the question of the destruction of small fish by shrimp-trawling in the Humber, and may briefly summarise my results.

It must first be remarked that "shrimp-trawling" is an expression used to comprise the fishery for two distinct creatures, viz. the common brown shrimp (*Crangon vulgaris*), and the pink shrimp or prawn (*Pandalus annulicornis*), which must not be confused with the true prawn (*Palæmon serratus*) of the South coast, nor with the Norway lobster (*Nephrops norvegicus*), though all the last three species are often spoken of as prawns.

Speaking generally, shrimps and prawns do not consort much together; the shrimps prefer the shallow grounds, in most cases near the margin; while the prawns affect deeper water, on grounds covered with "ross," the accumulations of a tube-forming worm (*Sabellaria*) on which the prawns appear to feed.

Very few flat-fish are found on the prawn-grounds, and consequently when prawning the boats catch very few of them. The eight or nine smallest boats restrict themselves almost entirely to prawning, and so do little harm to the flat-fish. On the shrimp-grounds, however, there are many small plaice, the capture of which is unavoidable. Large numbers of dabs are also caught, and a fair number of soles may likewise be present on the shrimp-grounds.

The bulk of the Humber soles, however, seem to affect rather deep parts of the channel, with a bottom of mud or clay, where no

fisherman would go if he really purposed to get a good bag of either shrimps or prawns.

Great numbers of whiting, mostly very small, and considerable numbers of very small cod, are found in all parts of the river worked in either shrimp- or prawn-trawling, but none of these are ever brought ashore, and only flat-fish of the sizes which I have mentioned reach the market, though many much smaller ones are caught. A certain number of lemon soles are taken, but nearly all of them so very small as not to be worth keeping.

Having thus briefly glanced at the *capture* of small fish by shrimp-trawling, it remains to consider what proportion, apart from the comparatively small number landed, are thereby *destroyed*.*

I have made it clear, I think, that on the prawning-grounds the quantity of flat-fish taken is not of moment, so that prawn-trawling may be dismissed as practically innocuous to those kinds of fish.

The shrimp-ground known as "Paull Middle," which lies considerably higher up the river than the rest, does not furnish a very significant amount of flat-fish, and on the lower grounds, though a considerable number, including very small and delicate forms, are taken, the number is nothing like that of which we have evidence from the Mersey shrimping-grounds on the North-west Coast.

In the ordinary course of the Humber industry, when the trawl comes on board its contents are shot into a box, or on to the deck, and as many as possible of the unsaleable products are picked out by hand and pitched overboard. In this way quantities of hard-heads (*Cottus*), bull-routs (*Agonus*), and gobblers (*Liparis*) find their way back to the water, as also any number of shore-crabs and swimmer-crabs. I think it would be wiser to destroy the hard-heads, the gobblers, and the swimmer-crabs, as all these seem very destructive, and are of no known use. I do not find, from the contents of their stomachs, that the bull-routs do much harm; and the shore-crabs, though destructive, deserve some consideration on account of their function as scavengers.

By the same process the young whiting and cod, being of no value, are returned to the sea,—to be out of the way, if with no more provident intent. The saleable flat-fish are put on one side; the remainder, if large enough to attract attention, being thrown overboard. Unsaleable soles are most carefully returned, their future value being most fully recognised by the shrimpers.

The catch of prawns or shrimps having thus being roughly cleared, is placed in the sieve and riddled over the side of the boat. The bottom of the sieve consists of parallel wires, with occasional

* For a detailed discussion of the Humber shrimp-trawling question *vide* Journal Mar. Biol. Assoc., vol. iii, p. 90.

cross-bars to ensure rigidity. In their own interests many of the fishermen have the wires three pennies' thickness (about $\frac{3}{16}$ inch) apart, and wish that this gauge might be made compulsory, as the use of finer sieves tends to lower the market price of the prawns. Until I had made the experiment I did not suppose that small flat-fish would be likely to pass through such a sieve, but as a fact they do, and thus practically all that are too small to have been picked out in the first sorting by hand find their way back into the river, in company with the smaller prawns or shrimps.

Fortunately it is absolutely essential to the profitable conduct of the fishery that all these operations should take place in so short a time that the shrimps can be got into the pot alive, and that the latter should be as free from rubbish as possible. I have known Thames shrimpers to boil the whole hotch-potch of shrimps and small fish together, and sort them afterwards, but the Humber men always sort them first.

Thus we see that the interests of the shrimp-trawler compel him to return all unsaleable fish to the water as soon as possible. But, as it may occur to the reader, we have seen that the mere fact of being caught in the trawl is frequently fatal to fish in deep-sea operations, and it may be asked—is not this equally the case in shrimp-trawling? My answer, after careful experiment, is in the negative, and for the following reasons.

The shrimp and prawn-grounds are none of them of great extent, they are intricate, and can only be worked with the tide, so that short hauls are an absolute necessity. I do not suppose a haul often much exceeds two hours, and I consider one hour to be about the usual period.* The ground is mostly clean, or the boat is brought up if the net gets among clay banks or much rubbish, and the men are obliged to haul. The shrimp-mesh is very fine, and very stiff, the cotton being heavily tarred, and it is rather a rare thing to find small fish jammed amongst the meshes. A larger mesh, more liable to open and shut, would probably be more injurious. As a fact I find that the fish come on deck alive and vigorous, unless they happen to have been spitted by the prow of a prawn or nipped by a crab.

No doubt the most delicate forms are the whiting and cod, especially the former, and if either are allowed to lie on deck they soon succumb. If pitched overboard at once they swim off apparently none the worse, since the depth of water is not sufficient to cause loss of control over the air-bladder on being brought to the surface. I have made experiments to test the vitality of these fish, and find that even in the unfavourable conditions of a tub of

* If the hauls ever exceed an hour it is in contravention of the Committee's bye-law on the subject.

stagnant water a large percentage will survive for an hour, and that fish which appear sickly at first, for the most part recover after a time.

Of the flat-fish the little plaice were especially hardy, and would survive not only a good deal of exposure on the deck before being placed in water, but also the two miles' jolting in a cart involved in conveying them from the docks to the Cleethorpes Aquarium,—a process which proved too much for most of the cod and whiting.

Soles* and lemon soles are seldom injured by capture in a shrimp-trawl. The latter are especially hardy, and a number of very small ones survived all the vicissitudes of capture and travel, and lived for about a year in the Cleethorpes tanks, where they would probably be still flourishing if they would only have let each other's tails alone. Soles which had been chafed, either in the net or in handling, ultimately died in the tank, as they always appear to do in confinement; but I do not think it follows that they die if returned to the sea, as specimens are trawled which have evidently recovered from serious wounds.

Dabs, especially very small ones, are delicate, and will survive but little exposure on deck, or injury from chafing. This matters the less, as the species, being a keen competitor in the matter of food with more valuable kinds, is not deserving of any special protection.

Flounders are about as hardy as any fish I know.

I consider, therefore, that we may acquit the Humber shrimp-trawlers of any very great destruction of small fish other than those which they bring ashore to sell. I do not pretend that the same judgment can be passed on the industry as conducted on the north-west coast.

Longshore shrimping by shove-nets.—If, however, we acquit the trawlers, we can hardly do the same for the shore-shrimpers. The shove-net used along the Humber sands (and southwards along the whole coast of Lincolnshire, I believe), is a sufficiently formidable engine. The frame is shaped like the letter T, the cross-piece representing the beam, which is nine feet long, with a short iron upright at each end; while the shaft, represented by the body of the letter, is rather shorter, and has a short transverse handle. The lower end of the net is laced to the beam and uprights, the upper end being gathered on to an iron ring, which is drawn up the shaft by means of cords passing through the handle of the latter. In this way the belly of the net is made exceedingly rigid, and its meshes are almost closed, so that shrimps, &c., slide right up into a small bag situated just below the ring.

These nets are shoved along the margin at low tide, either by

* Except on muddy grounds, where shrimpers have no legitimate business.

night or day. Great numbers of small fish are caught, and many undoubtedly destroyed, since the men are not always so careful as they might be to sort them at the margin. Small soles, turbot, and brill are certainly returned at once if observed, but "flat-fish," *i. e.* small plaice, are not held of much account.

The following is, I think, a fair sample of the catch of one net for a single tide. The worth of the shrimps was estimated by the captor at 2s. 6d.

Shrimps	4 quarts.
Sole	4 = $2\frac{3}{8}$ to $3\frac{1}{4}$ inches.
Turbot	1 = $3\frac{1}{2}$ "
Brill	2 = $3\frac{5}{8}$ to $4\frac{3}{4}$ "
Plaice	896 = $1\frac{1}{2}$ to $4\frac{1}{2}$ "
"	12 = $4\frac{3}{4}$ to 9 "
Flounders	6 = $2\frac{1}{2}$ to $4\frac{1}{8}$ "
"	3 = 9 "
Dabs	3 = $1\frac{1}{4}$ to $1\frac{3}{4}$ "
Smelts	5 = $3\frac{1}{2}$ to $3\frac{7}{8}$ "
"	1 = $6\frac{1}{2}$ "
Dragonets	23 = $1\frac{3}{4}$ to $2\frac{3}{4}$ "
Gobies	261
Sticklebacks	29
A few sand-eels, bullrouts, and pipe-fish.	

A lot of crabs are always caught, but got rid of as soon as possible. The shrimper, resting the end of the shaft against his chest, can wade along with his hands free, and so intercept a good many unsaleable items on their way up to the bag. He can also swing the basket he carries in front of him, and occupy himself in lightening it by culling out a good many of the small fish. So many as benefit by this process are in no way injured by being caught, but I think a large proportion always remain to be sorted when the tide is over, and on dark nights very little sorting can be done while the fishing is going on. If at the end of the tide the young fish were culled out at the margin, or somewhere along the course of the numerous pools and runnels of brackish water which cross the sands, I imagine no harm would be done, as most of even the smallest flat-fish will survive a considerable sojourn in the basket; but the favourite sorting-ground is at high-water mark, or the whole catch is simply carried home and sorted there; and I think in very many cases not the slightest effort at culling out anything except crabs is made until the fisherman gets home. Consequently I fear the destruction of small plaice in shove-netting is very large. Even the meagre number of soles, turbot, and brill are important when we consider the present scarcity of these species.

Shrimp-seine or Horse-net.—In addition to the shove-net, there is in use along the south shore of the Humber, and along the Lincolnshire coast generally, a still more abominable engine, variously known as a shrimp-seine or horse-net. This is nothing more or less than a trawl of shrimp-mesh, with a mouth 18 feet wide, kept open by a pole. Two short wooden beams, heavily loaded at the lower end, serve to keep the wings upright, and to separate the head and ground ropes. The whole affair is attached by bridles to the axletree of a small one-horse trolley driven by the fisherman.

The net is worked over the same ground as the shove-net, and only differs from the latter in its greater catching power and destructiveness to small fish. "Jehu" has to attend to his horse, and can spare no attention for sorting purposes. Consequently, when the net is cleared, the whole contents are shot into a fish-box and there remain until the fishing is over. It need hardly be said that capture in this case means destruction.

"Flat-fish nets."—A "flat-fish net" is a piece of net, of a mesh about equal to that used for herrings, twenty yards long by a yard wide, corked at the top, and leaded at the bottom. The ends are kept upright by short beams, and the whole is dragged along the margin by a couple of men, keeping at a regular distance apart from each other. Such a net is occasionally used at Cleethorpes. It is designed for the capture of plaice, flounders, and any soles that may be near the margin, and is hauled by the men walking ashore.

As it is preferably used on a rising tide, only the marketable flat-fish are destroyed, as any smaller ones are left to squatter down into the wet sand, and are soon covered by the tide. Of course all the plaice taken, and most of the soles, are immature.

Seining.—Seining is practised in the Humber for smelts and eels, but a good many flat-fish are of course caught, and those above about 6 inches are taken. As in the case of the last net mentioned, the smaller ones suffer no injury, the tide soon coming to their relief. The mesh is smaller than that of the "flat-fish net," being about $\frac{1}{2}$ inch between each knot.

Stake-nets, of the same mesh as the seines, are erected at Cleethorpes and Humberstone in the winter for the capture of sprats. The fishery is a very uncertain one, so that the length of time the nets remain up is variable. It appears to be found most convenient to empty the whole catch into baskets or barrels, and cart them home before sorting. In this way a few small flat-fish and a great number of small whiting and cod are destroyed, as well as, in the early part of the season at least, a quantity of unsaleable sprats and young herring, locally termed "scad." The owner of the nets

being to some small extent interested in agricultural pursuits, the refuse fish is found useful for manure.

Note added in the press.—In comparing my statistics with those furnished by the Board of Trade a considerable discrepancy is found to exist. The official total (of plaice) for the year ending March 31st, 1894, is 168,000 cwt., *i.e.* 11,837 cwt. less than the amount indicated by my inquiries. Seeing that the latter purport to deal only with plaice landed by deep-sea fishing vessels, and exclude even occasional contributions from a fleet which ordinarily lands at Billingsgate, while the official figures presumably embrace all fish from whatsoever source derived, it is somewhat remarkable that my returns should give the larger total.

I acknowledge the objection that my return is completed by the deduction of averages for a certain number of days on which no actual observations were made, but when we come to compare separate months, in which no such source of possible error exists, we do not arrive any nearer to an agreement, or even to a consistency of disagreement. Thus in April, June, October, 1893, and June, 1894, my figures are 2256, 3792, 214, and 2274 cwt. in excess of those given by the Board of Trade for the same months; whereas in January and February, 1894, the official figures exceed my own by 1980 and 2868 cwt. I will content myself with the incontrovertible statement that *both* series of statistics cannot be accurate.

CHAP. V.—PROPOSED REMEDIAL MEASURES.

Having admitted a grave deterioration in the returns of the North Sea trawling industry, I think the contents of the last chapter furnish us with quite sufficient evidence to allocate the causes in so far as Grimsby vessels and the general fishery of the district are concerned.

To my mind they fall under two distinct headings :

(i) **An immense destruction by deep-sea trawling of immature plaice and turbot on shallow grounds on the Continental coast, frequented only by immature members of the first species, and chiefly by immature members of the last ; visited also by spawning soles, turbot, and brill.**

(ii) **A serious destruction on our own coast by various methods of long-shore shrimping of immature plaice, and of immature soles, turbot, and brill, in proportion to the abundance of these species. A serious destruction (but not necessarily involving destruction of the very young stages) of immature members of these species, especially of soles and plaice, by shrimp-trawling and inshore fish-trawling on our own coast.**

Though I can produce no information on the subject, it is reasonable to suppose that the large shrimping industry in the inshore waters of the Dutch, German, and Danish coasts is not unattended by a destruction of immature flat-fish corresponding to that which I have shown to take place on our own coast.

Whatever other factors may have been at work in the admitted deterioration, there can be no doubt that the above furnish ample cause for at least a great part of the decrease, and if any method can be devised to check these evils alone, we shall be in a fair way to a revival of the supply. It behoves us therefore to consider, as carefully as a limited space will permit, whatever propositions have been brought forward with this view.

These fall chiefly under the following headings :

- (i) Prohibition of sale of fish under certain sizes.
- (ii) Extension of the territorial limits.
- (iii) Close seasons.
- (iv) Restrictions of mesh.
- (v) Artificial propagation.

Other suggestions have been put forward, and will be discussed in turn, but hardly merit separate enumeration.

(i) *Prohibition of sale of fish under certain sizes.*

A brilliant suggestion that the *capture* of undersized fish should be prohibited need not detain us long, since it is obviously impossible to avoid catching some undersized fish if one fishes at all, and what benefit could be expected from a legal prohibition of this sort I am at a loss to conjecture, since the law could not possibly be enforced as long as a fisherman was allowed to go to sea. There are, of course, methods by which the capture of a very large proportion of undersized fish can be prevented, but prohibition of capture, *per se*, is not one of these.

We may pass, therefore, to the question of prohibiting the sale, accompanied or not, as the case may be, by similar restriction as to landing.

This is the remedial measure which has found by far the greatest number of advocates, but there has been a very considerable difference in the sizes advocated. It may seem at first sight that this is of comparatively little importance, so long as the principle of prohibition of sale is agreed to, but in reality the principle involved depends entirely upon the size to which the prohibition refers.

We have seen, in Chapter I, that the standard of size may be arrived at by two entirely different methods, according to whether it is sought to discriminate (*a*) between sexually mature fish and

those which are too small to reproduce their species ; or (b) merely between marketable and unmarketable fish. Of course the former standard is considerably the higher in all flat-fish of any considerable value (excepting the lemon-sole in the North Sea), while both standards are subject to variation according to locality.

Of late years I do not know that the enforcement of the biological limit has been much insisted on, except in cases where it chances to fit in with what may be called the economical opportunities of the situation. Its advocates content themselves rather with the pious opinion that it is desirable that fish should have a chance of reproducing their species at least once before they are destroyed. Moreover, at least one authority of the highest standing, Dr. C. G. J. Petersen, holds that the deterioration of the fishing is, in the case of plaice, certainly not owing to a want of spawn, since, with regard to young plaice, he finds "that it is hard to imagine there could be any more individuals than there are."* Petersen's remarks refer here to the Cattegat, and do not profess to say whether the young fish are actually as numerous now as in former years. He simply suggests that there are enough to furnish a remunerative fishery if they were not destroyed at too small a size. On the North Sea grounds our fishermen are emphatic in their statements that even the small fish are much less numerous than they used to be, and I do not think there is any reason to doubt their accuracy in this particular. If it is so, although the fry may be numerous enough to supply the existing fishery when grown up, there must still be an insufficiency of spawn, since I take it that the ideal condition would be that the grounds should hold the greatest possible head of fish which they can maintain. The fishery is growing, and presumably will grow, and the problem which we have to face is not only to try and provide for immediate wants, but in so far as lies in our power to maintain the grounds at the greatest possible degree of productiveness.

The objection to the biological limit is, of course, that by cutting off a large supply of marketable but immature fish, it bears hardly both on the producer and the consumer, and especially the latter ; while there is no apparent way in which it can be enforced with absolute certainty of benefit to the supply. In this connection it will be remembered that we have seen that the conditions of deep-sea trawling are not favourable to the return of undersized fish in a healthy condition, and therefore if, as we know to be the case, mature and immature fish are caught together on certain grounds, the latter have but little chance of surviving the process.

What we have to strive for is a method which shall combine the

* *On the Decrease of our Flat-fish Fisheries*, Rep. Danish Biol. Stat., 1894, p. 62.

maximum preservation to the species with the minimum hardship to the producer and consumer. Some hardships there must be, at least of a temporary nature, for if the matter could be arranged without inconveniencing anyone, it would naturally arrange itself without legislative assistance.

Turning to the size limits recommended by the trade, we find that such are designed, not to admit of the propagation of the fish before it comes to market, but to prevent, in so far as may be possible, its destruction before it has attained the size at which it has a considerable commercial value. The limits recommended by the representatives of Grimsby and Hull were originally such as to exclude rather a large proportion of fish (excepting turbot and brill) which were actually saleable, even if not commanding much of a price. The same limits, as we have seen, did not commend themselves to our South Coast fishermen, and, with view to presenting an unanimous appeal to the legislature, the matter was compromised by the adoption of the limits approved by the Conference of 1892 (see p. 381). It cannot, however, be said that the whole trade expressed itself in favour of the enforcement of these limits, or, indeed, in favour of any legislation based on the adoption of a size limit. Lowestoft, in fact, in the mouth of the witness chosen to represent the smack-owning interest of that important trawling centre, objected strongly to any limit at all; but as the objection was based on an assertion that unmarketable fish were not taken by Lowestoft trawlers, it is hard to see how the prohibition of the sale of such unmarketable fish could injuriously affect the trade. We are entitled, I think, to say that as far as this port is concerned, the statements put forward as evidence are in themselves enough to dispose of the objections to a size limit; but we must note that the Lowestoft standard of discrimination between large and small fish (plaice) appears to be about 8 inches, instead of the somewhat higher figure advocated by Grimsby and Hull.

It was only to be expected that the longshore fishermen should object to a size limit, since the only fish within their reach, with the exception of an occasional sole, fall for the most part far short of any standard advocated. Personally I am inclined to consider that the interests of the longshore fishermen are, in this matter, not entitled to any consideration. In so far as the shrimpers are concerned, the most injury that could befall them by the imposition of a size limit would be the elimination from their saleable catch of a certain number of small flat-fishes, chiefly plaice. Flounders and dabs, and a few marketable soles, would remain saleable, as before. As for inshore fish-trawling, flat-fish netting, and the like, it cannot be denied that these pursuits, having for their object the capture of immature fish

only, are entirely contrary to the public interest, whether of the consumer or of the trawl-fishery as a whole, and if the enforcement of a standard of size should have the effect of suppressing these methods of fishing, the public would gain thereby considerably.

We may now consider the probable effect of the various standards of size placed before the Parliamentary Committee, other than those based on the consideration of sexual maturity. The Conference of 1892 dealt with five species, and proposed, as we have seen, the following sizes :

Turbot	.	.	.	.	.	12 inches.
Brill	.	.	.	.	.	12 „
Sole	.	.	.	.	.	10 „
Lemon Sole	.	.	.	.	.	11 „
Plaice	.	.	.	.	.	10 „

With regard to the North Sea, I have always failed to understand what beneficial effect could be expected from the limit of 12 inches proposed, as above, for brill and turbot, since the same limit may be said to be in operation already. One hardly ever sees either a turbot or brill of less than 12 inches in the Grimsby market, and I do not think that many of less size are caught on any ground worked by deep-sea trawlers. It must be supposed that the originators of the suggestion had some object in view, and we know that there are well-founded complaints as to the scarcity of these two valuable fish, but the limit proposed would leave the matter precisely in the condition in which it is at present.

The limit of 10 inches proposed for soles would certainly benefit that species as far as concerns our own inshore fisheries, but, for the reasons already urged, soles of less size taken in deep-sea trawling operations would not be likely to receive much benefit from the enforcement of the standard. If any standard is adopted, I think that in the case of a fish so extremely valuable and so scarce as the sole, such standard should not be short of the biological requirements.

The lemon sole, in that it is not largely taken in the immature but saleable condition on the Eastern grounds, stands probably in less need of protection by means of a size limit than the others; and to my mind the value of legislation by size limit stands or falls entirely with the size which is adopted in the case of plaice.

Now, when dealing with the destruction of small fish, I have, as I suppose, given ample evidence that an immense number of plaice of *more than 10 inches*, the size proposed by the Conference of 1892, are captured on the Eastern grounds in company with hosts of smaller ones, and there is an absolute consensus of opinion that

when once the small fish have been caught on these grounds, there is very little likelihood of any of them surviving, if returned to the sea. Consequently, if after eliminating all fish which are of less than 10 inches, there remain enough to be a source of profit to the fisherman, the only effect of prohibiting the sale of the smaller ones would be to ensure the fouling of the grounds with their carcasses, and to cause a great waste of food with no corresponding benefit.

The ordinary catch of a boat working the Eastern grounds consists of a large number, it may be several hundred, of boxes of plaice from 15 down to 8 or even 6 inches; a lot of turbot, nearly all immature; and a number of brill, mostly mature, but still of no great size. If the right grounds have been worked, there may be from half a box to about two boxes of soles. On certain of the grounds the soles are the avowed object of the fishery, but now-a-days they are not nearly plentiful enough to pay the expenses of the voyage, much less to secure a profit. It is the small plaice which pay the expenses, and if we could stop the sale of these we might assure ourselves that no one would go near the grounds; but if we only stop the sale of those of less than 10 inches, we shall leave a quantity quite sufficient to pay the expenses; thus, though the profits of the voyage may be a little less, the fishery will go on as before, and the same quantity of small plaice, turbot, brill, and soles will be destroyed as before, though the consumer will get fewer of them. Where does the advantage come in?

If, on the other hand, we raised the limit for plaice to 13 inches, as I have proposed to do, we shall cut off so large a proportion of the catch that it will not be worth while for boats to go to the Eastern grounds. At the same time we shall ensure that the small plaice which annually migrate from these grounds to the Dogger shall not be intercepted on the way, since there are not enough fish of other sorts on the migration track to attract vessels thither if the small plaice were unsaleable. I have shown that the proportion of plaice under 13 inches on the off-shore grounds of the North Sea is inconsiderable, at any rate in the summer, and consequently whatever waste might be caused by the size limit would be of little account. The limit need only be enforced during the spring and summer, say from March 14th to September 30th, as for the remainder of the year the small fish are not to be found on the Eastern grounds, while those which have migrated in the autumn are mixed up on offshore grounds with larger fish, and could only be sorted with difficulty.

I contend, and I do not see how it can be denied, that by the mere imposition of a size limit of 13 inches on plaice alone from March 14th to September 30th we should leave the Eastern grounds entirely

untouched, to serve as a nursery for the whole North Sea for plaice, turbot, and to a less extent of brill and soles, and as a spawning haven for soles, brill and turbot.

There are certain objections to the plan, to which we must return later, turning our attention for the present to the recommendations of the Parliamentary Committee.

The Committee found themselves unable to recommend either the biological limits (though I am not aware that these limits were recommended for legislative purposes) or those of the Conference of 1892. They considered that "while it might be desirable to forbid the sale of small flat-fish, the adoption of the sizes suggested would involve great hardship to many of the poorer fishermen who fish near the shore in the smaller class of boats." The Committee seems to have been further dominated with a fear of originality, and considered that the size limit adopted should approximate to that already adopted by foreign countries.

Such limits are as follows :

Belgium—

Plaice	.	.	.	7·2 inches total length.
Soles	.	.	.	7·2 " "
Turbot	.	.	.	10 " "
Brill	.	.	.	10 " "

Denmark—

Plaice	.	.	.	8 inches from nose to root of tail.
Turbot	.	.	.	8 " " "

France—

Plaice	.	.	.	5½ inches from eye to root of tail.
Sole	.	.	.	5½ " " "

The limits recommended for the United Kingdom are :

Plaice	.	.	.	8 inches total length.
Sole	.	.	.	8 " "
Turbot	.	.	.	10 " "
Brill	.	.	.	10 " "

So far as the North Sea is concerned, this brilliant proposition cannot be said to make any important difference in the existing condition of the fishery. As a matter of fact the only fishermen whom it will in any way affect are the longshore men, whose interests the Committee were so anxious to safeguard. Inshore fish-trawlers and shrimpers will be deprived of a certain number of marketable plaice and soles; the deep-sea men will be deprived of nothing:—they catch no soles under 8 inches, and few, if any, which are as small,

on the Eastern grounds, while if they have to shovel over a few more plaice than they do at present, the difference will do them no harm,—and the fishery no good. Before one can sell a fish, it is necessary to catch it, and as our deep-sea boats do not catch turbot and brill of less than 10 inches, such part of the recommendation as refers to these species might as well have been omitted.

In fact the Committee's recommendations leave the deep-sea trawl-fishery of the North Sea, the deterioration of which was the primary cause of the inquiry, absolutely untouched; they cut off some little from the catches of inshore fishermen—enough to annoy them, but not enough to do any material good to the supply of the species concerned.

In face of the evidence offered, it is rather difficult to understand by what mental process the above result was arrived at, until we take into consideration the conflicting interests of different parts of the coast. It is quite evident, from the experience of my colleague Mr. Cunningham, that there is very little destruction of immature flatfish by the deep-sea trawl-fishery of the south-west coast, and consequently no need of legislation by size limit as far as that industry is concerned. It appears, however, that such legislation would have a beneficial action on certain inshore fisheries of that district, but we are met by the fact that the plaice of the south-west coast are altogether smaller than those of the North Sea. It follows, therefore, that any limit of size, high enough to be beneficial in the North Sea, would be too high for the south-west coast, since it would render unsaleable a large number of actually mature fish, and seriously and unduly interfere with the operations of offshore trawlers. This, I think, is a sufficient argument against the *universal* imposition of a high limit of size, the more so as I can see no reason why the limit should be universal.

The practical application of different size limits to different districts has been held to be extremely difficult, but the difficulty has certainly been overrated. Fish must be landed somewhere, and from my own experience of the Grimsby market, I am convinced that a fishery officer could without difficulty exercise a sufficient control over the size of fish landed. The Parliamentary Committee, though they mention that the prohibition of *landing* as well as of sale was suggested to them, do not make any recommendation on this head; but to most people it will appear to be only a matter of common sense that, if sale is prohibited, it should be made equally unlawful to land the undersized fish. It has been suggested that if we prohibit the sale of fish under a certain size in one district, and permit it in another, fishermen will evade the law by running their catches to some port where the smaller size limit is in operation. Doubtless this might be the case if we were dealing with fish

of great value. If, for instance, there were a different size limit for soles in different districts, and large quantities of small ones could be caught, it might pay to run them to the district where the size limit was the smallest. But we are dealing with plaice, and plaice of less than 13 inches do not command much of a price anywhere, while the best markets are on the east coast and at London. On this account North Sea boats, by running to ports on the south coast to sell their fish, would lose more in time and expenses than they gained by being able to sell the very small plaice. I should think that the southern shore of the mouth of the Thames would make a practical boundary as between the North Sea on the one hand, and the southern and south-western coasts on the other. Moreover, the prohibition of sale or landing with regard to districts would naturally be accompanied by enactment making it unlawful to evade the operation of the measure in the manner suggested, and no fishery officer worth his salt would find any difficulty in detecting an attempt to land fish from the Eastern grounds of the North Sea on the south coast, in the very improbable event of such an operation being attempted. It is perhaps not too well understood by the general public, as well as by others who have less excuse for their ignorance, that there are certain local characters in flat-fishes which are perfectly well known to every one who has much experience of fish and fisheries; and we may at least credit those in authority with sufficient sense to choose their fishery officers only from amongst those who are qualified for the task.

(ii) *Extension of territorial limits.*

Next to the imposition of size limits, the scheme for restoring the fish supply which finds the greatest number of advocates is the closure of certain areas to trawling. In virtue of international law the boats of one nation are already excluded from the territorial waters of any other; in our own country, the District Committees in England, the Fishery Board in Scotland, and the Fishery Office in Ireland, have power to prohibit trawling in their respective spheres of influence. Of these powers the authorities in question have already very largely availed themselves; whether they have done so with a view to the protection of immature fish, or to keeping Her Majesty's peace as between trawlers and drift-net or line fishermen, does not greatly signify, though one may be permitted to express an abstract regret that the powers of a fishery authority should occasionally be degraded to the level of parochial politics. It is admitted that, in so far as concerns the North Sea trawling industry, the remedy is beyond the utmost territorial jurisdiction of our own

country, since the injury complained of takes place on the Continental coast rather than on our own.

The proposal is that a large part of the ground frequented by small fish should be closed to trawling by international agreement, since the grounds extend far beyond the jurisdiction of any one power. We have already seen that the whole coast from the Horn Reef in Denmark to Terschelling Island in Holland is practically one vast nursery of small plaice, and it is proposed along this area, or part of it, to extend the territorial limit by international agreement to ten or twelve miles, and to prohibit trawling within this limit to the vessels of all nations.

The plan is absolutely the most perfect which could be devised, if only it could be regarded as in any way practicable; but this, unfortunately, is not the case. It is, perhaps, within the bounds of possibility that the nations owning the stretch of coast in question might unite with Great Britain in closing this area, but it would then be closed only to British, Danish, German, and Dutch vessels, and as long as the actual three mile limit were respected, there would be a direct incitement to the enterprise of some other nation. France, I believe, has always expressed herself unconvinced as to the necessity of international action in fishery matters, and it may be imagined that the result of abstention by the other nations would be the establishment of a French trawling industry, fishing along the Continental coast, and selling the small fish, which we wish to protect, in our own markets.

But this contingency is remote, since there is not the slightest reason to suppose that the other Continental powers would consent to the scheme. Their interest in the deep-sea trawl fishery is but small; and, on the other hand, a very large fishing population is engaged in trawling operations in small boats along the coast. Moreover, as they are perfectly entitled to urge, these small boats are destructive only to marketable fish. The inshore plaice fishery, on the Danish and German coasts at any rate, is, as I have pointed out before, and as has been recently confirmed by Dr. Petersen, essentially a "live-fish" trade. The marketable fish are picked out of the net before the latter comes on board, and the smaller fish turned loose without ever coming on board at all, and it is very rarely that any are injured by their temporary sojourn in the net. It is not to be expected that because our large trawls destroy a large quantity of undersized fish, foreign nations will sacrifice their own interests for our benefit; for we, as having the deep-sea trade practically in our own hands, should undoubtedly reap by far the greatest share of the benefits which might accrue from closing these areas. The Continental fishermen would be debarred from working

the only grounds they can reach, for the recuperation of grounds whither their small boats dare never venture.

On this account I think we may be perfectly certain that the international closure scheme is purely visionary. It has the further disadvantage of being impossible to enforce. The stretch of ground is so enormous, and extends so far from the coast, that it would pretty well take the entire navy of Europe to look after it, while the necessarily heterogeneous nature of the police force would not tend, as I imagine, to international amenities.

Leaving international action out of the question, we have still the power of preventing our own boats from fishing these grounds, or rather, of prohibiting their doing so; and as the bulk of the injury is inflicted by our own fishermen, it may be held that, by putting a stop to their operations, we should close the grounds sufficiently to allow of the recuperation of the supply. This is true enough, but if we abstained, assuredly other nations would step in, since our markets, in the absence of a size limit, would still be open to small plaice; and in the end, I suppose, the result would be to place our fishing fleet under a foreign flag, just as the unappreciated attentions of the Board of Trade are said to be alienating our Mercantile Marine at the present day.

(iii) *Close seasons.*

The institution of close seasons for some of the more valuable trawl-fishes has occasionally been suggested, but it needs very little reflection to see that it is in no way practicable, except, possibly, in connection with certain defined areas.

From my remarks in a previous chapter it will have been seen that the spawning of different kinds of fish is by no means simultaneous, but that for at least nine months of the year there are one or more valuable species spawning. To establish a close season for one or more kinds, while permitting the rest to be sold, would be folly of the most inconceivable kind, since we know that, once the fish is caught in the deep-sea trawl, it matters little whether it is thrown back or brought ashore. It is killed in either case—in nine cases out of ten. Therefore, if we wish to establish a close season for any one trawl-fish, without regard to area, we must establish a close season for all trawl-fish at the same time, and thus stop trawling altogether. This, I imagine, is altogether out of the question, as it would ruin the trade.

Even with regard to defined areas there are great difficulties in the way of a close season, but it might be possible to close a piece of ground for a certain time with a view to the protection of one species. The sole seems to offer the best opportunity, while it is

also the species which is perhaps most in need of this form of protection. It would be possible, perhaps, to obtain an international consent to the closure of the Terschelling sole ground for a month during the spawning period, and such a limited area could be watched without great difficulty. The landing and sale of soles might be prohibited at North Sea ports and at the London markets during the same period, since I do not know that soles are to be got anywhere else in the North Sea at that time of the year. This would probably have the effect of checking the Dutch sole fishery, as the market for its products is to a great extent in England, and thus the species would benefit on other grounds besides that specially intended.

I am not prepared to speak very strongly in favour of this proposition, and merely put it forward as the only form of close season which seems in any way practicable in the North Sea.

(iv) *Restriction of mesh.*

Legislation based on the size or pattern of mesh or on the nature of the fishing engine to be employed commends itself, perhaps, rather to the amateur than to any one who has had much experience of fishing operations.

The great difficulty with regard to the mesh is found in the fact that fish of different kinds exhibit widely different characters of conformation as well as of size, so that it is actually impossible to devise a size or pattern of mesh which shall be equally suitable to all sizes and patterns of fish. Moreover, apart from their difference in conformation, some kinds of fish are very much more agile than others, and the comparative agility of the different component items of the catch has to be taken into consideration no less than their proportions.

Without wearying the reader with details of breadth in proportion to length, &c., the applicability of the above remarks may be sufficiently illustrated by a comparison of two such well-known forms as the sole and the plaice. Every one interested in such questions should know that a sole reaches maturity at a width which, in the plaice, is associated, not only with complete immaturity, but with a market value so low as to be hardly estimable. Further, any one who has had any experience of trawling, or has even had the opportunity of examining a sole in the living condition, is well aware that this fish is infinitely more active and sinuous than the plaice, and can, and will, escape from the net if there is any possible means of doing so. A plaice, on the other hand, may be caught in a net, the meshes of which, to the uninitiated observer, seem to offer every facility for its escape.

Now, among flat-fishes it is the plaice which (as constituting, with the haddock, the trawler's "staff of life") stands in the greatest need of protection, yet it will be conceded that we should not be justified in so enlarging the mesh, for the benefit of young plaice, as to deprive the fisherman of actually mature soles. Besides this, no mere enlargement of mesh, associated with the apparent opportunity of escape for the species to be protected, would serve the purpose. A net ashore, dry, and with no strain on its meshes, is a very different affair from the same net in actual use, towed along at the rate of two or three miles an hour, with a hundredweight or so of fish and assorted rubbish in the cod end. It may seem to be the easiest thing in the world to protect a plaice of, say 4 inches in breadth, *i. e.* about 9 inches in circumference, by making the meshes of the cod end of the same circumference. Judging from the appearance of the dry net, the fish should have no difficulty in pushing its way out; but, as a matter of fact, when the strain is on, the sides of the meshes are practically closed.

It has been contended that, as the vessel rises and falls on the swell, there is an alternate strain and relaxation on the mesh; probably this is to some extent true, but to a very small extent only, as, when we take into consideration the length and weight of warp out, it seems reasonable to suppose that by the time the motive power is communicated to the net it is to all intents and purposes continuous. However this may be, the fact remains that though the sole (which never ceases to hunt for a loophole of escape until it either finds one or jams itself inextricably in the "pockets"), may escape, a plaice of the same actual circumference does not. It is certainly true that with every enlargement of the mesh a larger proportion of small flat-fish escape; but it is equally true that, to ensure the escape of any significant number, the enlargement has to be carried to such an extent, that the net becomes absolutely useless for the capture of the narrower and more active species. In fact, the relation of size of mesh to size of fish caught, seems to be nearer, in the case of plaice and dabs, to the greatest possible circumference (*i. e.* as measured lengthways) than to the least circumference of the fish; and we may safely say that a net successfully devised for the escape of undersized plaice would catch no soles at all. Much less, therefore, is it practicable to protect young turbot and brill by this method.

There is, however, no doubt that an increase in the size of the mesh is beneficial to small round fish, though even in this case I do not think it is practicable to carry it to such an extent as to protect, even partially, all immature members of any valuable species except the whiting. Of course, the ingenuity of man in this respect

is always subject to utter frustration by the capture of a quantity of weed, mud, or rubbish of any sort, but that appreciable results may be accomplished by mere regulation of size of mesh has been sufficiently demonstrated by the experiments of Mr. Dawson on behalf of the Lancashire Sea Fisheries Committee, to whose observations I would refer readers for particulars.

So far my remarks must be interpreted as applying only to mesh of the ordinary pattern, viz. braided diamond-wise, so that the knots offer the least possible resistance to the longitudinal closure of the meshes. My own experiments, carried on as opportunities have from time to time permitted, have rather led me to the conclusion that, for purposes of deep-sea trawling, it is impracticable to seriously affect the situation by any mere enlargement which the requirements of the case permit. The mesh in the cod-end of Grimsby trawls varies from $1\frac{1}{2}$ to 3 inches "knot to knot," i. e. $\frac{3}{4}$ to $1\frac{1}{2}$ inches "square," or 3 to 6 inches in circumference. I do not think substantial hardship would ensue from the prohibition of a mesh of less than 8 inches in circumference in the cod end, but at the same time, I am far from sure that the benefit ensuing therefrom would be altogether in proportion to the disturbance of the industry. The 6-inch mesh is, I think, the more popular with the fishermen, and I have heard complaints that the owners gave them needless trouble by supplying a mesh which augmented their catch only by rubbish and mud.

It seemed to me, however, that if little could be done in the way of a profitable and at the same time practicable enlargement of the mesh, there was some opportunity of improvement in its pattern. As we have already seen, the meshes are arranged in such a way that the twine of the knots offers the least possible resistance to their closure. It occurred to me that by braiding the meshes for the cod end in the ordinary way, but arranging this part of the net so that the meshes lay at right angles to their ordinary position, the extra strand of twine would offer some resistance to the closure of the sides of the mesh. My surmise was sufficiently borne out, as long as the net was tolerably new, since a cod end arranged in this way caught considerably less small fish than an ordinary cod end with mesh of the same size; but when the net had been thoroughly stretched the difference became inappreciable. Moreover, the transversely arranged meshes had the disadvantage of being liable to be pulled out of shape by the strain, whereas, in a net arranged in the ordinary way, the greater the strain the tighter the knots are pulled, and the more firmly the meshes are set in their right relationships to each other. On the whole, then, the transverse method of arranging the meshes cannot be recommended.

Every one is aware that a net with square meshes (*i. e.* with the sides of the mesh parallel and transverse to the long axis of the net) cannot close to nearly the same extent as a net braided in the ordinary diagonal fashion, and it requires no experiment to show that such a net will let out more small fish than one of the ordinary pattern. Consequently one often hears that the difficulty of the closure of the meshes can easily be adjusted by having the latter braided square instead of diamond-wise. The advocates of this plan, however, have overlooked one fact of the most vital importance. In the diamond-shaped mesh every strand bears an equal share of the strain, whereas in a square mesh the strain is borne only by the two strands which are parallel to the long axis of the trawl, the transverse strands contributing in no way to the strength of the whole engine. Hence it follows that to bear an equal strain, a square mesh must be braided of twine which is double the thickness of that required for an ordinary diagonal mesh. The net therefore requires to be twice as heavy. The square mesh would, of course, be confined to the cod end of the trawl, and in the case of a steam trawler I do not know that the extra weight would be of very great moment. To a sailing trawler any access of weight would be an intolerable infliction, as in a light wind the trawl is only too liable to "sand," as it is. Hence, as far as smacks are concerned, this method of dealing with the matter does not come within the range of practical politics.

It will be easily understood that the way in which the cod end is closed, must have an important bearing on the closure or non-closure of the meshes. The cod end is, as everyone should know, composed of two oblong pieces of net joined to each other along the sides. The fore-end of the resulting tube is laced on to the fore part of the net, while the after end is left open like the mouth of a sack. By Grimsby trawlers it is invariably closed before the net is shot, by gathering the meshes together and tying a cord round the bunch of net so formed. This method is called "tying" the cod end, and it is obvious that the bunching up of the net affords opportunity for the lodgment of every sort of rubbish which can possibly choke the meshes, besides in itself materially decreasing the possibility of their opening. Of course a cod end so "tied" is not difficult to untie when the net comes aboard. There is another method of closing the net known as "marling." Instead of bunching the mouth together, the "back" and "belly" thereof are simply "marled" or laced together.

It seemed probable that a "marled" cod end would let out more small fish and more rubbish than one which was tied, and some experiments which I made, though I could not carry them far

enough to speak with absolute certainty, tended to the confirmation of this view. With a view to still further preventing the closure of the meshes I tried the expedient of lacing the back and belly of the opening to a pole, so as to stretch the meshes to their utmost transverse extent, but a casual encounter with an anchor brought this experiment to an abrupt conclusion, and I have never had an opportunity of renewing it.

I have been able, however, to make trial of another device, which seems likely to yield much better results than any other. In place of tying the opening of the cod end in any way I procured an oblong wooden frame, across which were stretched square meshes of stout twine. The opening of the cod end was laced to this frame, so that the latter formed, as it were, the terminal wall of the whole net. Tested against cod ends of the same mesh, either marled or tied, this last method gave, as far as my experiments went, most satisfactory results, and everything that could pass through the meshes found its way into a large bag of shrimp mesh, which was fastened outside the lower end of the trawl proper. An objection urged against this arrangement was that the meshes of the frame, being stretched quite taut, would be apt to be broken by a stone or a heavy piece of wreckage, and thus the whole catch would escape. I have, however, safely boarded a stove chimney, an iron bucket, a pit prop, and similar things in the Humber without damaging the net, and there is no reason that the meshes of the frame should not be made of wire hawser, or even cast iron, if necessary. Of course a frame of this kind is rather a nuisance to unfasten, but the devising of a rapid method of opening it should not be difficult to any one with greater inventive ingenuity than I can lay claim to. To my mind the only serious drawback to the affair is that a wooden frame would soon get waterlogged and very heavy in deep sea work. Probably this could be remedied by having a frame of metal tubing (preferably aluminium) which would at the same time have a decidedly beneficial action in lessening the friction of the cod end against the ground.

At the time my frame was in use I first became acquainted with a somewhat similar device, in which the extremities of the back and belly of the cod end are separated by the introduction on each side of a triangular gusset of netting, the base of which is laced on to a rod of wood. The opening of the net is therefore oblong, and is closed by an oblong piece of netting corresponding to my frame. The principle is the same, but I think that my own expedient has a decided advantage in keeping the meshes of the terminal wall absolutely taut and wide open.

We must always return, however, to our original conclusion, that

whatever scheme of beneficial mesh-restriction can be devised, it must be for the flat-fishes* at best only subsidiary to some much more far-reaching measure for their protection.

(v) *Artificial propagation.*

This method of restocking the sea may perhaps be said to be one of which the theoretical advantages are rather over-balanced by the practical difficulties. The public are at last awakening to the fact that the possibility of hatching and rearing a trout in a wash-hand basin does not imply a similar facility in the case of a sole or turbot; but it may be doubted whether even a thousandth part of the difficulties attending the artificial culture of sea fish is generally realised.

There is no doubt that the difficulties are by no means insuperable, given the necessary means, but it is, I imagine, entirely impossible to rear sea fish without a considerable initial expense in the way of rearing ponds. To merely hatch the eggs presents no particular difficulties, and involves only an expense which, compared with the outlay which would be necessary for rearing operations, is comparatively trifling. But the question arises—What is the good of merely hatching the egg and turning the larva adrift to fend for itself at its most helpless stage when exposed to countless enemies? If that is all our artificial propagation aims at accomplishing, I, for my own part, think we might as well leave the matter to the fish themselves, who may be supposed to understand it much better than we do.

There is no doubt whatever in my mind that if we are to accomplish any useful results, we must aim at rearing the young fish until it is reasonably well able to take care of itself. In the case of flat-fish the fry should be reared at least right through the pelagic stages. Granted that the difficulties of our present inexperience are successfully overcome, the prosecution of such operations on a scale sufficient to make any appreciable difference in the fish-supply would be very considerable, though the cost would not exceed that which the profits of the fish trade might reasonably be called upon to contribute.

But there is a further question of the utmost importance. Having reared the fry to the required stage, we should naturally

* Personally I have not studied the possibility of lessening the capture of small flat-fish in shrimp trawls by some alteration in the pattern of the net, but I believe that the officials of the Lancashire Sea Fisheries Committee have been experimenting on this question with some prospect of success. Their operations are based, as I understand, on the fact that a shrimp leaps higher than a flat-fish when the net approaches, and so a ground rope which will catch the former will pass over the latter.

enlarge it on grounds suitable to its habits at that period of existence. In the case of flat-fish such ground would only be found on the sandy margins; and are we to go to all this expense and trouble merely for the pleasure of seeing our precious nurselings scooped up and carted away by the first shore shrimper who passed that way?

I imagine the answer will be universally in the negative, and that it will be conceded that, before embarking on the culture of sea fish, we must take such measures as will materially lessen the probability of the money thus expended being altogether wasted.

My remarks have by no means included all the remedial propositions which have been put forward, but I think we have noticed all which deserve serious attention, and perhaps some which do not. With the minor suggestions we cannot here concern ourselves at any great length, but may notice a scheme put forward by Mr. Douglas, of Grimsby.

Mr. Douglas proposes to capture small plaice on the Eastern side, and transport them in well-vessels to the Dogger and to grounds on our own coast, and estimates that the cost of these operations would be amply covered by the increased catches of our trawlers. It is not at first sight apparent why the mere transference of fish from one part of the North Sea to another should increase the general supply. Putting this aside, and granting that the transference can be successfully accomplished, it is not easy to see how the small fish will benefit. No doubt there are some grounds on our own coasts, which are capable of maintaining a much greater head of fish than they hold at present, and which are practically deserted by our trawlers. But, if we dump down an immense quantity of small fish there, what is to prevent boats coming there at once and catching them if there is no hindrance to their sale? As for the proposal of putting young fish on the Dogger, they are probably better off where they are in the summer (the only time at which they could be caught in anything like the numbers anticipated by Mr. Douglas), and in the autumn they do migrate to the Dogger, as we have seen, of their own accord. The plan of allowing them to do so in peace, by means of a suitable size limit, seems at once simpler and more efficacious than Mr. Douglas's scheme of State-aided emigration. The most that can be said for the scheme is, that if the fish were protected by a size limit and by the closure to trawling of such of our inshore grounds as are plaice nurseries, the large plaice grounds lying in the neighbourhood of our own coast might probably be recuperated rather more quickly than by the protection alone. Without the protection the whole affair would simply be a waste of money.

Conclusions.

A very few words will suffice to summarise the conclusions to which my previous remarks will have pointed. They are to the effect that the only practicable method of checking the depletion of the North Sea grounds and of enabling the fish supply to recover is by legislation based on the principle of the size limit.

Further, that the size limits proposed by the Parliamentary Committee are absolutely useless, and indeed ridiculous. No series of limits can be of appreciable use unless that assigned to the plaice is at least 13 inches. No lower limit will suffice to keep the trawlers off the Eastern grounds, where they will continue to destroy as much as ever, even if, in virtue of some smaller size limit, they land and sell less than at present. I would repeat that these grounds can be absolutely closed to our trawlers, and to all trawlers whose catches are ultimately sold in this country, by a size limit of 13 inches for plaice, even if only enforced during the Spring and Summer. It is not absolutely necessary to apply a size limit to any other species, though a size limit of 12 inches (or even 10 inches) could not fail to be beneficial to the sole, as tending to bring about the return to the sea of many small specimens which are caught in shrimp trawls and by inshore fish trawlers. The size limit of 8 inches for soles is altogether contemptible. It does not materially alter the present North Sea market customs in regard to the sale of this fish, and it has been aptly said of an eight-inch sole that, when you have taken off two inches for the head, and two inches for the tail, you are left with four inches of skin and bone in the middle!

It has been said that any legislation having for its effect the closure of the Eastern grounds would deprive our fishermen of their only chance of catching soles in the summer. Even if this were true, the sole is of such little real importance in comparison with the plaice, that I do not think the matter would be of much moment; but, in any case, it may be supposed that the relief of this spawning ground from our large fleet of trawlers would probably result in the reappearance of the species on other grounds which it has now practically deserted; and any increase in the species, even if confined in the summer to the Eastern side, could not fail to make itself felt in the winter in the Silver Pits.

Returning to the plaice question, it is urged that the foreign vessels would continue to catch them as before; but this is not the case, as the chief market for these fish is in our own country, and therefore our restrictions of sale would react on foreign vessels as

much as on our own. There is no foreign market which would tempt our boats to take cargoes of small plaice thither, and if such should be created in the future, I believe the beauties of free trade are not so thoroughly appreciated on the Continent as to allow of the long duration of a trade of this sort. The drawbacks entailed by the elimination from our markets of the large quantity of small plaice at present landed there are not of great importance, since I understand that the small plaice trade is chiefly of a speculative character, and not much affected by salesmen of repute.

I need hardly repeat that whatever penalty may attach to the sale of undersized fish must attach equally to their landing, and that it is essential that different districts should be treated according to their respective requirements. The remarks which are given above apply to the North Sea; whether any, and, if so, what size limit is required in other districts, I do not pretend to determine, since all the information which I have on the subject is equally available to the general public. This much is certain, that the matter cannot be rationally treated except in relation to the requirements of the locality, and there is absolutely no valid objection to discrimination as between one coast and another.

I cannot accept the Committee's argument that the hardship to inshore fishermen involved by a rational size limit is a valid reason against the employment of the latter. To me it appears that the destruction of immature fish stands on much the same footing as the pollution of rivers and other nuisances formerly associated with manufacturing enterprise. No doubt the measures taken against this pollution involved hardships to the manufacture, from the capitalist down to the factory hand, but the public has none the less approved them. Personally, if one may be permitted to illustrate so dry a controversy by a reference to humorous literature, the relative merits of the inshore and deep-sea fisherman in regard to the destruction of small fish seem to me to stand on much the same footing as the Walrus and the Carpenter in "Alice through the Looking Glass,"—one ate more oysters than the other, but the other ate as many as he could get! However, if the assembled wisdom of Parliament chooses to consider that its business is rather to settle the squabbles of rival classes of fishermen than to take measures to increase the fish supply, one can but regret it.

As to the other remedial propositions noticed, I need only repeat that an extension of the territorial limit, however desirable, is not practicable. A close season without an absolute cessation of trawling is useless, restrictions of mesh are only practicable within limits which would not permit of flat-fish being very materially benefited, though they are desirable in the interests of young round-

fish which cannot be protected by the size-limit method. Artificial propagation must, to be really useful, include not only the hatching of the eggs but the rearing of the fry through the pelagic stages, and must most certainly be preceded by such measures for the protection of the young, as would very probably render it entirely unnecessary to embark on this very costly undertaking.

CHART OF THE NORTH SEA.



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OBJECTS

OF THE

Marine Biological Association of the United Kingdom.

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

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

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

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

The Association has at present received some £20,000, of which £5000 was granted by the Treasury. The annual revenue which can be at present counted on is about £1820, of which £1000 a year is granted by the Treasury, the remainder being principally made up in Subscriptions.

The admirable Marine Biological Laboratory at Naples, founded and directed by Dr. Dohrn, has cost about £20,000, including steam launches, &c., whilst it has an annual budget of £7000.

THE ASSOCIATION IS AT PRESENT UNABLE TO AFFORD THE PURCHASE AND MAINTENANCE OF A SEA-GOING STEAM VESSEL, by means of which fishery investigations can be extended to other parts of the coast than the immediate neighbourhood of Plymouth. Funds are urgently needed in order that this section of the work may be carried out with efficiency. The purpose of the Association is to aid at the same time both science and industry. It is national in character and constitution, and its affairs are conducted by a representative Council, by an Honorary Secretary and an Honorary Treasurer, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the Laboratory and the prosecution of researches by aid of its appliances. The reader is referred to page 4 of the Cover for information as to membership of the Association.

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NOTICE.

The Council of the Marine Biological Association wish it to be understood that they do not accept responsibility for statements published in this Journal, excepting when those statements are contained in an official report of the Council.

TERMS OF MEMBERSHIP.

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Members of the Association have the following rights and privileges: they elect annually the Officers and Council; they receive the Journal of the Association free by post; they are admitted to view the Laboratory at Plymouth, and may introduce friends with them; they have the first claim to rent a place in the Laboratory for research, with use of tanks, boats, &c., and have access to the books in the Library at Plymouth.

All correspondence should be addressed to the Director, The Laboratory, Plymouth.