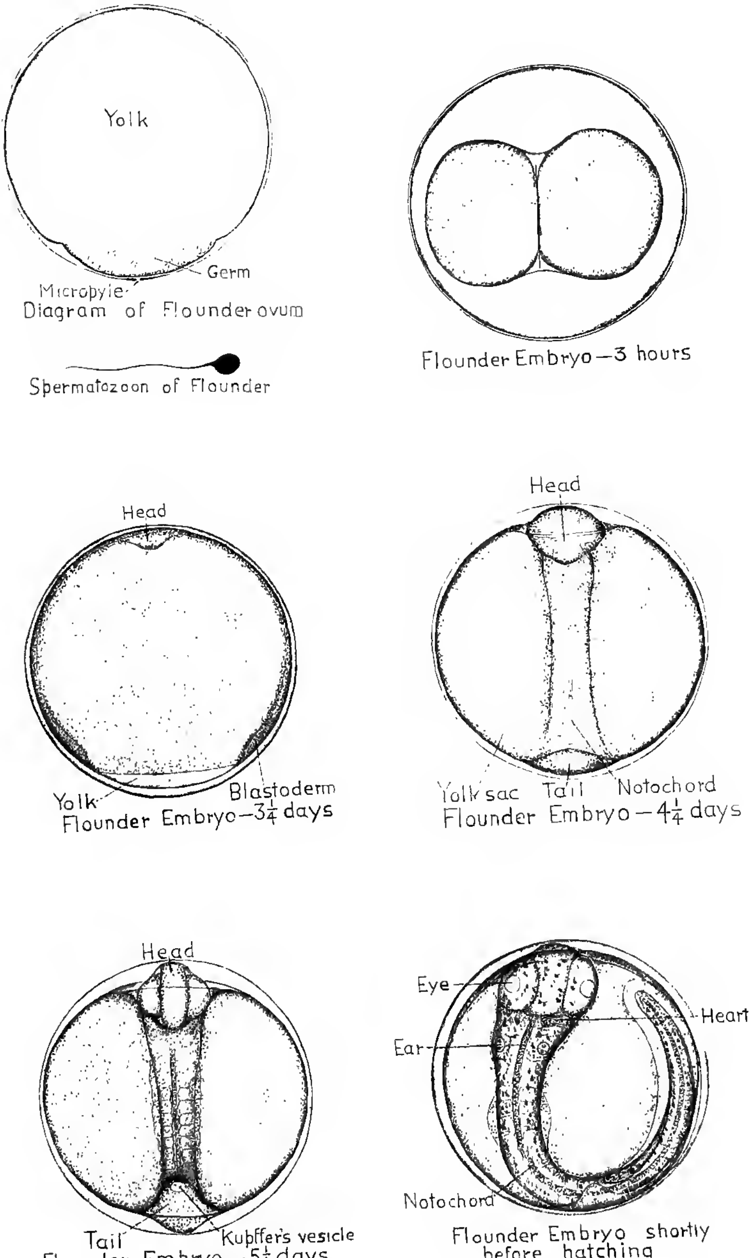
BRITISH FISHERIES

THEIR ADMINISTRATION AND THEIR PROBLEMS



Development of the Ovum of the Flounder. Ova all magnified 40 diameters
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BRITISH FISHERIES

THEIR ADMINISTRATION AND THEIR PROBLEMS

A Short Account of the Origin and Growth of British Sea-Fishery Authorities and Regulations

BY

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PREFACE

In preparing this book I have tried to give such a reasonably short sketch of the present position of sea-fisheries administration and research in the United Kingdom as might be of use to those whose public duties compel them to give some attention to the subject, as well as to the general student of the sea-fisheries of Great Britain and Ireland. It is obvious that, with this aim, certain limitations have had to be kept in mind. Thus, the salmon and fresh-water fisheries and the oyster industry form altogether special subjects, and there is, besides, an extensive literature in existence dealing with the condition of those fisheries. The natural history of the marine economic animals is another subject which is treated very briefly, but there are already several excellent works, such as those of Cunningham and M'Intosh, which give very full accounts of this part of our subject. Finally, much more attention might have been devoted to the consideration of the methods of catching sea-fishes practised in

British seas; but this would require much more space than is consistent with the intention of the work.

In Part I., I have attempted such a summary of the development of modern legislation and fishery authorities as may be verified in any library containing a set of the Parliamentary papers published during the last forty years. Sea-fishery administration, in its modern sense, may be said to have begun in Great Britain in 1863 with the appointment of the Royal Commission of that year, and to go back further than that date would be to enter into a study interesting only to the antiquary. Part II. is a short account of those fundamental facts of marine natural history and oceanography, on the further study of which rational fishery regulation must be based, and of the special problems which at the present time confront modern fishery authorities.

Fishery regulations have three main objects: (1) to ensure that good order may be maintained among fishermen; (2) to secure the greatest possible yield from the fishing grounds at any time that is compatible with the upkeep of the fish supply from year to year; and (3) to give "fair play" to every class of fishermen. This latter aim is not clearly expressed in fishery statutes or by-laws, but it is none the less apparent to anyone who observes the operation of the enactments in force. It is very proper that the poorer classes of our fishermen should be encouraged as much as possible, for in no other section of the population of these islands are the qualities of originality, resourcefulness, and hardihood so highly developed. It is regrettable that present-day tendencies are in the opposite direction. Concentration and specialisation, it has been observed, are the keynotes of modern industrial developments in the fisheries as in everything else. The capitalisation of the industry, the formation of wealthy fishing companies with huge fleets, may, in some ways, be a source of national gratification, and may be the means of providing cheap and abundant food; but the fact should not be overlooked that this end is incompatible, to some extent, with the maintenance of an increasing and comfortable fishing population. At the present time there is a danger that the small fishing village and fishing vessel, and the comfortable and easy-going coast population, characteristic of the immediate past, may by and by disappear, and that their place may be taken by overgrown fishing ports like Grimsby and Aberdeen, inhabited by fishermen whose industrial condition may soon approximate to that of the ordinary seaman and fireman of our merchant service. The skill and pluck of the British littoral population is apparently in danger of being exploited by the capitalist, and sacrificed to the desire for wealth on the one hand, and to the modern craze for cheapness on the other. The protective systems of the beginning of the nineteenth century had for their object the encouragement of the poorer fishermen. Although these were, to a great extent, done away with by the *laissez-faire* policy of the middle of the century, they have never entirely been abandoned, and one is glad to observe that the modern tendency is towards their revival. Many restrictions on methods of fishing, such as the practical exclusion of the steam fishing fleet from the territorial waters and bays of our coasts, have a differential effect, and encourage the small fishing boat at the expense of the larger; and if the maintenance of a numerous and comfortable fishing population is as desirable a thing as the mere supply of cheap food, then restrictive legislation of this nature is to be welcomed.

"Experimental legislation" has been the rule in the past. That this should have failed is due to obvious causes, and one has to admit that for the mass of obsolete, futile, and injurious fishery laws both the fisherman and the administrator are to blame. The growth of our knowledge of the natural laws which govern the abundance of fish in the sea has been a slow process, and the legislators have not been patient enough to wait for a sufficient basis of observation on which to found their restrictions. Fishery authorities have not, as a rule, sought to employ investigators whose sole business it was to study the effect of the stringent regulations proposed by them; and one finds that there are, even at the present day, few fishery restrictions which are based on a rational consideration of natural conditions in the sea. It is perhaps true that the scientific man who advises the administrator is often very much of an amateur, and that his manner of looking at legislative problems is rather academic; but it is no less true that unaided legislative interference with methods of fishing has, not infrequently, been both foolish and, at the least, unnecessary. There is at the present time a very obvious tendency, on the part of those who have to do with the control of the fisheries, to expect "practical results" from the investigator in a very short time—and at a very cheap rate. Attentive study of the application of scientific research to fishery legislation will show anyone who cares to see it that the only way to ensure that the fisheries may by and by be administered in the best interests of the fisherman and the consumer, is to persevere slowly and patiently with the acquirement of scientific facts. No one who takes the trouble to make himself thoroughly acquainted with the results of sea-fishery legislation in the past can doubt that by this method alone can results of lasting value be obtained.

J. JOHNSTONE.

LIVERPOOL, *June* 1905.

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INTRODUCTION

THE SITUATION IN 1903—METHODS AND VALUE OF THE FISHERIES

At the present time there are at least 27,000 vessels, manned by over 90,000 fishermen, engaged in fishing from the ports of the United Kingdom. At any hour of the twenty-four, one-fourth of this enormous number of vessels and men may be on the seas, anywhere and everywhere round the British Isles, from Iceland on the north to the coasts of Portugal on the south. In the course of a twelvemonth they will land over 900,000 tons of fish, worth about £10,000,000. On every week-day throughout the year they will bring ashore some 3000 tons of fish, worth (to them) about £33,000; and during the next two or three days this enormous quantity of fish will have been distributed all over the country, or exported abroad; and the consumers will have paid over £100,000 for it—for the produce of a single day's fishing in the fishing grounds about the British Isles.

These figures are only an approximate statement of the real worth of the British sea-fishing industry; and, though they may be subject to considerable qualification, they represent what is the minimum value of the industry. They are a bald and colourless summary of the value of a great national asset. Looked at in the pages of a Blue Book, they appear dry and repugnant, but the imaginative reader will see in them the evidence of an immense "mine of wealth"; of an incessant struggle to obtain Nature's most grudged possessions; of the existence of a population whose value to the nation it is difficult to over-appreciate.

Every mile almost of the extensive coast-line of Great Britain and Ireland contributes its share of this fishing population. But the density is not everywhere uniform, and there are remarkable differences in the value of the industry at the various parts. The east coast of England and Scotland, adjoining the important fishing grounds of the North Sea, is, both absolutely and relatively, by far the most important fishing district. Then follow in order the west coasts of England and Scotland, the coasts of Ireland, and the south coast of England.

As I have indicated above, it is impossible to give, with accuracy, the exact number of men and vessels employed on the British coasts; and the exact amount and value of the fish landed is also very imperfectly known. Systems for the collection of these data are in existence in each of the divisions of the United Kingdom, but while the statistical account of the fisheries of Scotland is very complete, that for England and Ireland furnishes only an approximate idea of the extent of the industry, and the figures must be taken as representing minimum values.

I give here a short summary of the principal data relating to the men, *matériel*, and value of the British fisheries. The data are for the year 1903:—[1]

I. Vessels Employed in Fishing

England and Wales

Steam trawlers	1144
Other steam fishing vessels	313
1st class (15 tons and upwards) sailing vessels .	1747
2nd class (under 15 tons) sailing vessels . .	3753
3rd class fishing vessels (navigated by oars only) .	2764
Total number of English fishing vessels .	9721

Scotland

Steam trawlers	280
Other steam fishing vessels	156
Sailing fishing vessels	10,572
Total number of Scottish fishing vessels .	11,008

[1] See—for England—*Annual Report of Proceedings under Sea-Fisheries Acts* for 1903; for Scotland—*Twenty-second Annual Report of the Fishery Board*, Part I.; for Ireland—*Report on the Sea and Inland Fisheries of Ireland* for 1903.

Ireland

Steam trawlers	12
1st class (15 tons and upwards) sailing vessels	364
2nd class (under 15 tons) sailing vessels	2939
3rd class fishing vessels (navigated by oars only)	2920
Total number of Irish fishing vessels	6235

II. Persons Employed in Connection with the Sea-Fisheries

England and Wales

Regular fishermen	34,071
Persons occasionally employed	7,468
Total	41,539

Scotland

Fishermen and boys	36,162
Fishmongers and hawkers	5,835
Curers, coopers, packers	19,981
Manufacturers of boats, nets, etc.	4,174
Other persons employed	18,401
Total persons employed	84,553

Ireland

Fishermen	24,206
Boys	527
Total	24,733

III. Amount and Value of the Fish Landed

England and Wales

	Quantity, cwts.	Value.
Total wet fish . . .	11,198,000	£6,930,000
Shell-fish . . .	...	279,000
Total		£7,209,000

Scotland

	Quantity, cwts.	Value.
Herrings . . .	4,279,485	£1,244,656
Other sea-fish . . .	2,239,323	1,156,631
Shell-fish . . .	...	73,598
Total . . .	6,518,808	£2,474,885

Ireland

	Quantity, cwts.	Value.
Mackerel	448,217	£183,865
Other sea-fish . . .	390,195	192,184
Shell-fish	...	51,751
Total . . .	838,412	£427,800

IV. The Capital Invested

It is difficult or impossible to obtain this information, except in the case of Scotland. No official returns of the value of the vessels and gear are given for England or Ireland.

Scotland

Steam fishing vessels	£1,572,338
Sailing vessels	994,552
Fishing gear, nets (lines, etc.) . . .	881,278
Total value	£3,448,168

These figures give a very bald idea as to the importance of the fisheries in Great Britain, but the reader must be content with them, and his imagination, stimulated by their magnitude, will more easily grasp the importance and the great value of the national asset represented by the sea-fisheries of the country. In comparing the three divisions of the United Kingdom he must, however, bear many things in mind.

The total number of vessels and persons engaged in the fisheries in each country does not give a quite correct idea of the respective values of the fisheries. Thus, the number of vessels and men employed in Scotland, and still more in Ireland, is much greater in proportion to the value of the fish landed than in England. This is because the sea-fisheries of England are pre-eminently trawl fisheries, carried out by large and powerful steam trawlers, which, for the number of men employed and for their own numbers, are much more efficient than sailing boats. In England, too, the fish landed are relatively more valuable than in Scotland ; the flat fishes—soles, plaice, turbot, etc. —which, with cod and haddock, form the great bulk of the fish landed in England, are more valuable than the herring, which is *the* fish in Scotland. A truer idea of the value of the Scottish fisheries is, however, obtained if the value of the fish sold fresh in the neighbourhood where they are landed, and the value of the fish cured for transport, are considered. Thus, the value of such fish in Scotland for the year 1903 was £1,065,040, while the value of all fish cured for transport at home or abroad was £2,341,928; and in addition to the fish represented by these values, a considerable portion is carried away fresh by rail.

The number of persons employed does not bear a similar proportion to the value of the fish landed in each country. This is due to the causes indicated above—the nature and efficiency of the vessels and gear employed by them. But it is also due, in the case of Ireland notably, to the fact that the fisherman there is, in very many cases, a person who combines some other occupation, farming usually, with that of fishing, and to that extent he is to be regarded as a fraction of a fisherman, rather than as a unit, as I have considered him to be in the above tabular statements.

We have now to consider the methods employed by these fishermen for the capture of the fish they bring to the market. There is no industry in which the essentials of the methods employed have changed so little as in sea-fishing. From time immemorial fishermen have employed apparatus which to-day may be seen in use on our coasts. It is easy to trace the causes of the few changes in the nature of the methods, and of the still greater change in the magnitude of the industry. Up to the time of railways, there was no stimulus to change; the difficulty of transport of such a perishable article as fish, and the slow growth of the population, kept the industry within narrow limits. Fish were caught for consumption by the fishing population itself, and for sale or exchange in the narrow strip of coast country within easy access of the sea. Fishing was therefore confined to a somewhat narrow zone of sea round the coast. But railway transport increased the market enormously, and with the increased demand larger boats began to be employed. Finally, steam power was introduced into the fishing vessels themselves, and ice was used to preserve the catches of fish made. These changes increased enormously the area of exploitation, and the quantity of the catch.

I can give here only a very summary account of the various methods employed in sea-fishing, and such an account will not relieve the conscientious reader of the necessity for consulting other sources of information on this part of our subject.[1] One

[1] A complete account of the methods of fishing practised round the coasts of the United Kingdom has yet to be written. The following works should, however, be consulted:—

E. W. H. Holdsworth, *Deep-sea Fishing and Fishing Boats.*

can classify fishermen in various ways; it is convenient at times to divide them into "inshore" or "longshore" men: these are such as work in small boats and mostly within the territorial limits. Opposed to them are the "offshore" or "deep-sea" fishermen, whose area I have already indicated. For our present purpose it is best to consider them as "trawlers," "liners," "seiners," "drift-net fishermen," "shrimpers," and so on, according to the method employed by them, and the kind of fish sought for. Fishermen are now to a great extent specialists; but we may still find places where the residents employ almost every method in turn, according to season and opportunity.

Trawling.—By far the greatest quantity of fish landed at British ports is caught by the method of trawling. This mode of fishing is of great antiquity, and it is difficult to determine where it was first commonly employed. The older form of trawl-net is a triangular flat bag or purse of netting, the mouth of which is from 20 to 50 feet wide, and the length about 40 to 100 feet. This bag is attached by its mouth to a beam of wood, which at either end is fixed to a stirrup-shaped iron frame—

London, Ed. Stanford, 1874. This work is rather old, but is, however, still very valuable.

E. W. L. Holt, *Grimsby Trawl Fishery and Destruction of Immature Fish.* Plymouth, Marine Biological Association, 1895.

J. W. Collins, *The Beam-trawl Industry of Great Britain, with Notes on Beam-trawling in other European Countries, etc.* "Bulletin U.S. Fish Commission" for 1887 (1889), pp. 289–407.

the "head"; and the beam forms the upper margin of the mouth of the trawl. The lower margin is formed by the "foot-rope," which is fastened at each end to the heads, and to which the lower portion of the net is attached. The foot-rope is not stretched tightly between the heads, but curves back in a wide bight behind the beam. When fishing the whole contrivance is dragged along the sea-bottom by two ropes—the "bridles," one attached to either head, which meet at the "shackle." The trawl-rope or "warp" is attached to the shackle; it may be 150 or even 200 fathoms in length; it is made fast on the deck of the vessel in various ways, depending on the size of the latter and on the size of the trawl.

Only such fishes as live on the sea-bottom, or swim about within a foot or two from there, can be caught by the trawl, as the heads keep the beam from two to four feet off the ground. The lower edges of the heads and the foot-rope drag along on the ground, and the scraping action of the latter stirs up any fish resting there or partially buried in the mud or sand, and they are swept into the net by the onward motion of the latter. Anything else lying on the sea-bottom, sea-weed, invertebrate animals, stones and loose débris, even old anchors, may be swept into the net and find their way back to its apex. When the net has been hauled for a variable time—one to six hours—it is brought up on deck—very laboriously if the vessel is without steam power; the beam and foot-rope are made fast to the rail, and the remainder of the net is gathered in by hand; finally the contracted apex or "cod end," into which the whole catch has been gathered, is brought on board and its end untied, and the contents allowed to fall on deck. The trawl is once more "shot," and while it is being dragged the fish are separated out, gutted, packed into boxes, and put away with ice in the fish-hold; the miscellaneous mass of rubbish and unmarketable fishes is then thrown overboard.

I have described such a trawl as was employed previous to about 1893; since then the beam-trawl has entirely disappeared from steam trawling vessels, and has been replaced by the "otter board" trawl. In this apparatus the net and foot-rope are similar to those in the older form, but the beam is replaced by a strong rope—the "head line," which may be over 100 feet in length. It is attached to two heavy wooden boards shod with iron, and nearly the size of ordinary doors, to which the trawl warps are attached in such a way that the board drags on the ground by one of its long edges, and its surface is set at an angle to the direction in which the net is being dragged. This keeps the mouth of the net stretched open in the same way as in the beam-trawl. The otter-trawl is hauled by two warps instead of one, as in the beam-trawl. It is much more efficient than the beam-trawl, but it is only suitable for the larger boats.

Lining.—A considerable proportion of the deep-sea fishes landed is, however, caught by means of "long lines." In some form or other this is, of course, the most ancient method of fishing. A typical long line may be as much as seven miles in length, and is made up of a number of pieces. At intervals of about a fathom, pieces of line two or three feet long—the "snoods," which carry hooks—are attached, and a long line carried by a deep-sea "liner" may carry seven thousand hooks. Ropes and buoys mark the position of the line as it lies on the bottom, one buoy being situated at each end of the line, and one at each intermediate mile. The line is "shot" in the evening and fished at morning. The hooks are baited principally with whelks or mussels.

Drift-netting.—Trawling and lining are carried on at any depth down to about a hundred fathoms, and anywhere and everywhere almost round the British Isles from Iceland to the Bay of Biscay. It will be evident to the reader that only such fish—soles, turbot, plaice, halibut, cod, ling, and haddock, etc.—as lie at the bottom will be taken by either method. There is, however, an abundant class of fishes, living at any depth from the surface to the bottom, for the capture of which neither of the above methods is applicable, and for which "drift-netting" must be employed. Drift-nets are chiefly used for the capture of herring, mackerel, and pilchards. A "train" or "fleet" of herring nets may be as much as two miles long and over ten yards in depth. It is supported on a line carrying cork floats, which is again attached to ropes and buoys which support the net at a variable distance from the surface. The whole contrivance floats or drifts with the tide as a vertical wall of netting which the herring shoal encounters. The fish striking the net penetrates the mesh of the latter, and, if it is a small fish, passes through. But if it is of a suitable size, its head slips through, and the increasing diameter of its body fixes or "meshes" it, in which position it is taken when the net is hauled. The size of the mesh of a drift-net will, of course, vary with the kind of fish it is designed to catch. A herring net has generally about thirty-three to thirty-six meshes to the yard, a pilchard net forty-five or more, and a mackerel net from twenty-five to twenty-eight. Fishing for all these fishes is carried on at a variable distance from shore, or, it may be, in bays or estuaries.

Seining. — By a simple modification the drift-net becomes converted into the "seine" and "draw-net." The seine is an ancient form of fishing implement, and it resembles generally a drift-net, but the manner of using it is very different. At sea it is employed by two boats, which carry the net between them. When the latter is to be "shot," the boats separate and pull away from each other, describing a circle, and putting the net overboard as they go. The latter is thus put into the water in the form of a circular vertical wall of netting, which surrounds the shoal of fish. The ends are united, and the net as it now stands is slowly towed shorewards till the bottom touches ground, and the fish are secure. They are then removed from the larger seine by a special mode of using a small seine. Sometimes the seine is used from the shore; one end is retained there, while a boat, with the other, pulls out to sea and describes a semicircle, "shooting" the net as it goes. The latter, with its enclosed fish, is then hauled on shore.

Inshore Fishing.—This latter method of seine-netting brings us to the consideration of the methods of the inshore or longshore men. Many of these are seiners, working as described above. Then there are comparatively small sailing boats using beam-trawls in the method indicated, but in relatively shallow water and within the three-mile territorial limit. Sea-fish are also largely taken round the British coasts by various kinds of "fixed engines." Such fixed engines, so called in contradistinction to the movable fishing engines — such as trawls — are fishing weirs, stake nets, trammel nets, and various other forms of apparatus. The *trammel* net is a most attractive engine, which is, however, relatively uncommon. Three nets are fastened together at top, bottom, and ends; they are only a little distance apart. This triple net is anchored to the bottom, the foot being weighted, and the top or "back" buoyed, so that it stands upright as a vertical wall of netting. The peculiarity of the trammel is that the middle member of the triple net has a narrow mesh, while the two outer ones have very wide meshes, and are so set that the meshes are exactly opposite each other; the middle narrow-meshed net is longer and wider than the two external ones, so that it is gathered up in slack folds. When a fish strikes the net it easily passes through the mesh of the outer net, but, striking against the restricted mesh of the middle net, it gathers this up and forces it through the opposing mesh of the outside net on the opposite side. The fish is thus in a pocket, in which it is hopelessly "trammelled."

The *stake* net is simply a vertical wall of netting of variable length supported on wooden stakes. It is set on the ground at low water, and so arranged that the tidal stream runs through it at right angles to its length; at next low water after it is set, it is visited and the enmeshed fish removed. It has a number of forms.

Fishing weirs are common on the coast of Wales, and are an easy and safe (albeit destructive to young unmarketable fishes) method of fishing which commends itself to the Welsh maritime population.

Shell-fisheries. — But the shell-fisheries are by far the most prolific of the inshore section of the industry. The oyster, shrimp, and prawn fisheries are carried on from sailing boats. For *shrimps* and *prawns* a small trawl-net is used, in which the meshes are about half an inch square; such a net may also be used in shallow water from a horse and cart worked by a "farmer-fisherman." Such methods of fishing necessarily involve the destruction of an enormous number of small fishes of all kinds, which are nearly always found in association with shrimps.

Oysters are taken by a dredge, which is practically a small trawl, except that the mouth of the net is kept open by an iron frame, and the meshes are made of strong cord or iron rings.

Crabs and *lobsters* are taken in "pots" or "creels" — wicker-work traps baited with fragments of fresh or stinking fish; they are moored at the sea-bottom in suitable places, and "fished" after an interval.

Lastly, *mussels*, *cockles*, and *periwinkles* are mostly collected by hand, though in places the former molluscs are dredged or brought up by means of a large rake. Whelks may be taken by hand or in baited traps. These animals are, however, used almost entirely as bait for long lines.

These are the most common methods of taking sea-fish. To describe fully every variation of these and the other less common modes of fishing would take too much space for a work of this nature. The above account may, however, give the reader such information as will enable him to follow with ease discussions in which the action of the various apparatus is dealt with.

PART I

THE DEVELOPMENT OF MODERN LEGISLATION

"Every legislative restriction means the creation of a new offence. In the case of fishery, it means that a simple man of the people, earning a scanty livelihood by hard toil, shall be liable to fine and imprisonment for doing that which he and his fathers before him have, up to that time, been free to do.

"If the general interest clearly requires that this burden should be put upon the fishermen—well and good. But if it does not—if indeed there is any doubt about the matter, I think that the man who made the unnecessary law deserves a heavier punishment than the man who breaks it." (Huxley, "Inaugural Address," *International Fisheries Exhibition (London) Literature*, 1883.)

CHAPTER I

THE FISHERIES IN 1863

All legislation which professes to regulate the conduct of a trade or occupation must, in order that it should be just and successful, be based on an intimate knowledge of the technical and economic conditions affecting the occupation. But the Legislature is so constituted that few, if any, of its members can acquire this knowledge of the numerous occupations with the regulation of which they may be concerned. It is necessary, then, that, to devise satisfactory laws of this kind, the Legislature should be guided by the knowledge of such persons as have, or are capable of acquiring, this familiarity with the occupation in question, and who are otherwise able to advise them as to the best form of the legislation necessary.

This is particularly true of the fishing industry, where we have an occupation of a very technical nature, and one with which the amateur has peculiar difficulties in becoming conversant. It is always difficult to determine exactly what are the evils for which a remedy is to be sought, and what should be the precise form of the remedial measures. On the one hand there is the fisherman, with an intimate knowledge of the condition of the industry—at least so far as his own branch is concerned, but usually knowing little outside this. He is generally a strongly biassed person, and, like most of us, is naturally prone to regard his own immediate interest as of paramount importance; and he is generally in a position which makes it difficult for his views and wishes to obtain consideration in the proper quarters. On the other hand there is the legislator, who is, as a rule, more ignorant of the fishing industry than of anything else. Between the two, then, there are necessary either the administrative officials with expert knowledge, or the Royal or Parliamentary Commission.

This is the method by which fisheries legislation has usually been elaborated. It has nearly always followed inquiry by some such body. Obviously, its success has depended on the ability and patience displayed by the persons conducting the inquiry and tendering advice to Parliament. That it should often have failed has been due to causes incidental to the nature of the fishing industry, which differs notably in many respects from most other occupations which have been the object of legislation. The success of the sea-fisheries depends almost entirely on the exploitation of great natural resources which are extremely liable to arbitrary fluctuations. It is characteristic of the industry in any locality that it should be subject to periodical depressions, which are due to seasons of bad fishing; and of the causes of these bad seasons we have, even now, very little knowledge. An almost invariable feature of these times of depression has been that they have given rise to agitations for legislative restrictions of some kind or other. Fishermen, as a class, are extremely conservative, and generally resent the introduction of new methods of fishing; although very observant, they have little notion of general causes, and of the wider occurrences in connection with their industry, and they are therefore very apt to attribute a failure in the fishery to any casual event which may have, in any way, provoked their displeasure. We find accordingly that during these bad seasons they have often sought for interference with other forms of fishing than that practised by themselves, or for interference with the same form of fishing practised elsewhere;[1] and if the introduction of a new method happened to coincide with such a bad season, they have connected the two things together as cause and effect.[2]

[1] For instance, in 1836—a season of bad herring fishing—the fishermen of Loch Fyne entreated the Fishery Board to protect their loch from ruin by putting down fishing for herring on the east coast of Scotland. They believed that the Loch Fyne herring went there to spawn and were caught.

[2] Thus, the Irish Fishery Commissioners received the most press-

These depressions, due to bad seasons, or the introduction of new methods, or both combined, have in the past given rise to agitations which have led to the appointment of committees or commissions of inquiry; and during such agitation the views of fishermen or of persons interested in the sea-fisheries have been taken uncritically and have been allowed to influence the inquiry and the resulting legislation. It is beyond doubt that sufficient investigation would, in many cases at least, have shown that legislation was not necessary, or would have suggested the proper remedy. It would have been seen that fluctuations in the abundance of fish in any one locality continually occurred without permanent damage to the fishery, and that these fluctuations were, moreover, beyond the control of man. But an essential means for such investigation—an accurate statistical history of the course of the fishery—has not always existed, and indeed is still wanting in many places; and for want of this, and impartial scientific inquiry into the conditions of the depression, incomplete or erroneous conclusions have been arrived at, and have led to unfortunate or, at least, unnecessary legislation. It is necessary to bear these considerations in mind to understand the nature and origin

ing remonstrances from the fishermen of Galway Bay because a single yacht happened to trawl occasionally there. Trawling was first practised during a time of bad fishing, and it was therefore deemed to be an injurious method.

of the legislation of the first half of the nineteenth century. It will be seen, then, that it was for the most part spasmodic in its inception and restrictive in character; that it usually applied to temporary conditions, and when these passed away —as they usually did—the legislation remained, and burdened the statute-book with futile, unnecessary, or injurious enactments.

The chief code of fisheries legislation in England was contained in the Convention Act of 1843.[1] The quarrels of fishermen of different nationalities have always been a fruitful subject for legislation, and it was in consequence of such disputes that a convention was arranged in 1839 between this country and France, and embodied in Acts of the Legislatures of both countries. These Acts gave the fishermen of each country the exclusive rights of fishing in territorial waters, that is, within an imaginary line drawn round the coast three miles distant from low-water mark, and from a straight line joining the headlands of bays and estuaries not more than ten miles apart.

Within these territorial limits each country made its own fishery laws; without them, on the high seas, the Convention Act supplied a code of regulations which applied to the following matters:—

1. Numbering and lettering fishing boats, and the flags and lights carried by these.

[1] 6 and 7 Vict. c. 79 (1843).

2. Forms and dimensions of fishing apparatus; close times for herring fishing.

3. General behaviour of boats and fishermen; supervision.

The Board of Trade, the Customs, and the Admiralty were made fishery authorities under this Act.

There was another Act in force (1 Geo. I. c. 18), of a very stringent nature. This provided that all fish-nets (with the exception of herring, sprat, and pilchard nets) should have meshes of not less than 3½ inches from knot to knot, and that nets of less than this size should be seized and burned. It forbade the landing or selling of unsizeable fish,[1] and provided that such fish, if seized, should be distributed among the poor of the parish. Needless to say, the provisions of this Act, if enforced, would practically have destroyed fishing in the open sea.

Neither this nor the Convention Act was enforced. The latter was an example of legal ambiguity, for opinions differed as to the limits within which it was operative. It was contended that it applied only to the territorial waters as defined and to the English Channel. But it was also held (and this was the better opinion) that it operated all round the British coasts, even on the

[1] The legal minimum sizes were:—Brill and turbot, 16 inches; codling, 12 inches; whiting, 6 inches; mullet, 12 inches; sole, 8 inches; plaice and dab, 8 inches; flounder, 7 inches.

north and west coasts of Scotland. A curious anomaly resulted: so long as a trawler worked in territorial waters (where small fish are relatively abundant), he could use small-meshed nets, and catch unsizeable fish, but on the high seas (where unsizeable fish were relatively scarce) he was compelled to use a wide-meshed net. Also, under the Convention Act he was not allowed to use a mesh of less than $1\frac{3}{4}$ inches square, but under the Act 1 Geo. I. c. 18, he was compelled to use a mesh of not less than $3\frac{1}{2}$ inches square. Both Acts, be it remembered, were in force at the same time. Fortunately, the fishermen were relieved of the necessity of taking legal opinion as to their liabilities, for there was practically no administration and no supervision. There was no public body in England concerned exclusively with the regulation of the fisheries. The Customs people did indeed enforce, to some extent, the law relating to the numbering of fishing boats, and when numbers of French and English boats were fishing together, the Admiralty sent cruisers to preserve order. The regulations as to the prohibition of Sunday herring fishing and fishing in daylight were observed, but only because these regulations agreed with the wishes of the fishermen, and not by reason of compulsion. Apparently the other regulations in force were ignored.

A somewhat similar state of things existed in Ireland. In that country the fisheries were in the charge of the Commissioners of Public Works, who, by Acts of 1842 and 1848,[1] were given almost absolute power to make by-laws for the "government, protection, and improvement" of the sea-fisheries. Numerous by-laws were indeed made by this body, but no actual administration existed. I shall refer to the state of the administration in Ireland later on, and will only note here that the authority there had to deal with economic conditions without parallel in either of the sister countries.

The fisheries in Scotland were regulated in a very different spirit. A fishery board had been formed in that country in 1808, expressly for the purpose of encouraging the fishing industry—chiefly the capture and curing of herring. This authority, later on, took cognisance of other matters than the fostering of the growing herring fishery and curing industry. They had to administer the Convention Act and other enactments of a very special character. Generally, the Scottish authority interpreted its powers in a spirit of great discretion, but about the beginning of the sixties a situation of much gravity arose.[2]

About 1848 a rival method of catching herrings came into use in the Firth of Clyde. The older

[1] 5 and 6 Vict. c. 106 (1842), and 11 and 12 Vict. c. 92.

[2] There is an excellent account of the Scottish Trawling Acts by Fulton in *Eighteenth Annual Report of the Fishery Board of Scotland*, part iii. p. 242.

method was that of the drift-net. The method consisted in the use of a modification of the seine-net, and was known locally as "trawling."[1] The new method was more profitable than the old one, and there is really no reason why it should not be practised wherever desired. But, as it became generally adopted, violent disputes arose between the fishermen using it and those still following the older method, and it was generally the drift-net men who were the aggressors in these quarrels. The latter asserted that the trawlers caught unwholesome fish, destroyed spawn and fry, broke up the shoals and ruined the season, and generally that they were turbulent fellows, wanton in mischief. They agitated for the prohibition of "trawling," and in this they were supported by the fish merchants and curers, who were influenced by motives of self-interest, and who, in the trouble that followed, were responsible for much discontent.

This agitation was successful in so far as the Fishery Board were induced to press for prohibitive legislation. An Act[2] was obtained in 1851 which prohibited the use of the seine-net for catching herrings, and made the use of this apparatus punishable by fine and imprisonment. This Act was put into operation, but for various reasons soon became disregarded, and "trawling"

[1] It had nothing in common with beam-trawling.
[2] 14 and 15 Vict. c. 26.

was again practised. Then a Treasury Committee considered the matter, and found that the only effect of the enactment was "to keep a considerable population in the habitual and successful violation of the law." They recommended its repeal, and, in consequence of this report, the operation of the Act was practically suspended. But disputes again arose, and the Board most sensibly tried to obtain an Act enabling them to restrict or prohibit seining wherever circumstances made this desirable. A Bill was introduced by the Lord Advocate for this purpose; but in consequence of a strong agitation by the fish merchants and curers, the intentions of the Board were totally changed, and the Bill passed into law as an Act[1] containing a much more stringent prohibition of "trawling" than that of 1851. It was put in force, and for a time two gunboats and a strong force of police were stationed in Loch Fyne and the Firth of Clyde.

Even then it was found impossible to put down "trawling," and yet another Act[2] was passed in 1861, which provided not only for fine or imprisonment, but also for confiscation of the boats and nets used, and the catches of fish made, in contravention of the prohibition. Being rigorously enforced, even to the extent that on one occasion a fisherman was shot dead in Loch Fyne, this latter

[1] 23 and 24 Vict. c. 92 (1860).
[2] 24 and 25 Vict. c. 72.

Act was found effective, and "trawling" for herring was at length completely suppressed.

It must be pointed out that the Fishery Board did not seek this additional restrictive legislation. The repressive Trawling Acts were brought about by "ill-will and conflicts engendered among rival classes of fishermen," and by the influence brought to bear on Parliament by drift-netters, curers, and others, "whose immediate interests were deeply concerned in obtaining a repression of trawling, which interfered with the prevalent system of fishing, and lessened its gains."[1] The opposition of the merchants and curers to trawling was due to the fact that, by means of this method of fishing, large quantities of fresh herrings were thrown into the market at low prices, because the trawlers preferred supplying the fresh-fish markets rather than the curers. This helped the competition with the latter, and the prices of cured fish fell. Under the Trawling Acts this competition was minimised, and the price of cured fish again rose, and the consumer suffered. Also, in consequence of this, Norwegian cured herrings were able, in bad years, to compete favourably in British markets.

The Trawling Acts had other effects which illustrate the extreme difficulty inherent in fisheries legislation. By making the seine-net an illegal instrument for catching herrings, a flourishing fishery for sprats in the Firth of Forth (worth

[1] *Report of the Commission on Herring Trawling in Scotland*, 1863.

£7000–£8000 yearly) was, for a time, destroyed. It was only after a winter of much severity and hardship, after an unsuccessful action for interdict in the Court of Session by the sprat fishermen, and after "imminent risk of conflict and bloodshed," that sprat fishing was allowed within a specified boundary. The Act of 1861 also prohibited herring fishing on the whole west coast of Scotland during the first half of the year, and this caused much hardship. In Mull the seine-net had been used for catching such fishes as saithe, mackerel, and flounders, and the Trawling Acts made this illegal. They also made the cod and ling fishery impossible, for to catch these fishes fresh herrings were used as bait, and to catch herrings during the close season was illegal. The Sheriff of Skye, writing on this matter, said:— "Last year, 1861, the herring fishery was a failure, and the crops both of corn and potatoes were lamentably deficient, the former to the extent of nearly one-half, and the latter to the extent of two-thirds. To add to what must have been the sufferings from deficient food, the fuel of the country, peats, had only been partially secured, and was scanty and bad. There was no cry of destitution, no appeal to the public for relief; and though, through that dreary winter, herrings came to the coast, and the people were prevented from taking them, no resistance was made; and four policemen, sent from Argyleshire for the purpose, were sufficient to secure the observance of this close time in a population of 20,000. But there is no doubt that it was submitted to with bitter feelings, and not without a sense, natural enough in the circumstances, however unfounded it may be deemed, of cruel oppression."[1]

I have discussed the operation of the Scottish Herring Trawling Acts at some length, because there is little doubt that it was due largely to the consideration of the effect of these enactments that the Royal Commission of 1863 took up an attitude which was entirely hostile to restrictive fishery legislation of nearly every kind.

All the methods of fishing referred to in the Introduction to this work, with the exception of otter-trawling, were in operation in 1863. Beam-trawling was even then by far the most important means of catching sea-fish. About 1000 sailing trawlers were working regularly from about a dozen English ports. These vessels were manned by at least 5000 souls, and represented a capital of at least one million sterling. They must have landed about 300 tons of fish per day. Other methods of fishing were of course followed, and though it is impossible to obtain statistics, we know that a great number of smaller boats must also have been employed. A few steam trawlers were working regularly, but steam was not generally applied to fishing vessels, and ice was not

[1] *Report of the Commission on Herring Trawling*, p. 18, 1863.

generally used for preserving the catches. The first steam trawlers were tug-boats which, owing to the increased development of steam power in merchant vessels, had insufficient towage to keep them fully employed.

The principal fishery in Scotland was that for the herring. The development of beam and otter trawling, which now bids fair to render Aberdeen the first fishing port in the United Kingdom, had not commenced in 1863. Cod, hake, and ling were caught by means of lines. Herrings, cod, ling, and hake were sold, to a limited extent, in the fresh condition, but the bulk of these fishes caught were cured for export. 13,191 boats, manned by 43,358 men and boys, were fishing from Scottish ports. The capital invested was about £845,724. The total value of fish landed cannot now be obtained, but in 1863, 654,816 barrels of herring were cured, and 407,761 were exported; 129,725 cwts. and 7337 barrels of cod, ling, and hake were cured, and 53,736 cwts. were exported.[1]

Ireland presented a miserable contrast with England and Scotland. Instead of the "progressive increase" which the British fisheries showed, those of Ireland had exhibited on the whole a steady decrease during the thirty years preceding the Report of the Royal Commission of 1863.

[1] *Rept. Comm. of British Fisheries for* 1863.

CHAPTER II

THE ROYAL COMMISSION OF 1863

THE fishery laws in 1863 were in a state of great confusion. I have only mentioned a few of them, but there was really a great number.[1] Most of them were obsolete and were not enforced. Of those that were enforced, some were unnecessary and others were positively injurious in their effects. The Scottish Herring Trawling Acts belonged to this latter category, and it is evident that it was because of the effect of these enactments that the attention of Parliament was directed in 1863 to the general question of the condition of the British sea-fisheries. A Royal Commission[2] was therefore issued in that year, with very wide terms of reference. The Commissioners were directed to inquire: (1) whether or not the value of the fisheries was increasing, stationary, or decreasing; (2) whether

[1] See the second schedule of the Sea-Fisheries Act of 1868.

[2] The members were Professor Huxley, Mr (afterwards Sir) J. Caird, and Mr G. Shaw-Lefevre.

or not the existing methods of fishing did permanent harm to the fishing grounds; and (3) whether or not the existing legislation was necessary. In 1866 this body issued a report, which is really a historical document of great value. It contains, in 1500 pages, an exhaustive summary of the condition of the British fisheries, based on the personal examination of the methods of fishing in use, and on the answers to 61,831 questions put to witnesses. It may be confidently commended to the attention of the reader who is conscientious (and courageous) enough to make a first-hand examination of the literature relating to the national fisheries. No such exhaustive report has since appeared, and in none that I am aware of are the conclusions deduced so courageous or uncompromising.

Even at the present day it is difficult to answer the questions put to the Commissioners of 1863. Accurate statistical information is still unobtainable in most cases, and in 1863 this information hardly existed. It was nevertheless possible to make a rough estimate of the productivity of the British fisheries. In England, the returns of fish carried by the railway companies, and the current market prices of fish, yielded data which, used critically, convinced the Commissioners that the fisheries of England, so far from being on the decline, were increasing in value, and admitted of a still further progressive increase. The state of affairs in 1863 contrasted very favourably with that in 1833.[1] Then, the fisheries had declined steadily since the peace of 1815; capital yielded no return, the numbers of boats and men were decreasing, and the fishermen in many cases were dependent on the poor-rates for support. In 1863 the value of fish landed was on the increase; the capital invested was yielding a satisfactory return; the boats were increasing in size and number each year; the number of fishermen had doubled during the last twenty years, and no other class of the labouring population were in so prosperous circumstances. The Scottish herring statistics showed that in that country the fisheries were in a most satisfactory condition. It is true that in Ireland the industry had declined to an alarming extent, but in that country the cause was a well-ascertained economic one, and was not due to a natural impoverishment of the fishing grounds.

This being the case, the second question submitted to the Commissioners was already answered. For it is very improbable that there could have been a progressive increase in the value of the industry if the methods of fishing in use had been destructive to a wasteful degree. Nevertheless, it was necessary to examine the effect of the prevalent methods of capturing fish, for it was asserted on all sides that these were ruinous to the industry.

[1] A House of Commons Committee reported in this year on the condition of the fisheries.

The complaints that were made of injurious fishing fall into two classes: it was asserted that each class of fishermen interfered with the operations of others; and it was also asserted that certain methods in use had a permanent effect in reducing the value of the fishing grounds. With regard to the first class of complaints, it is evident that almost any one kind of fishing must almost inevitably interfere with some other. I have already given an instance of such a kind in referring to the Scottish herring trawling agitation. If beam-trawlers, drift-netters, and liners are working together on a restricted area, it will frequently happen that the trawler will sail over a train of drift-nets and injure the latter with his trawl warp, or he may drag his trawl across a long line and do a certain amount of damage to this. Nearly every class of fisherman made such complaints against some other, but most of them combined in crediting the trawler with more than his share of this kind of malpractice. The latter was, in fact, a kind of piscatorial Ishmael.

Now, these complaints had no doubt a real basis of fact. But one method of fishing cannot equitably be prohibited or restricted at the expense of another. The Commissioners took up an attitude on this matter which at first sight seems eminently reasonable. The sea, they said, is the property of all, and no one has any vested right or exclusive interest in the exploitation of any particular portion of it, to justify him in so occupying it as to prevent others from fishing in his vicinity. If, for instance, a line fisherman chooses to set a line in a part of the sea where trawlers are working, he has to take the risk of interference by the latter, and he can resort to ordinary legal methods to obtain redress, if he can show that the trawler wilfully or negligently damages it. But he cannot reasonably expect that trawling should be prohibited from the locality in his particular interest, or in the interest of the class of fishermen to which he belongs.

On the other hand, the State (so the Commissioners contended) may reasonably prohibit or restrict one kind of fishing in the interests of others. If one method is greatly superior to others, then the latter may be restricted, for it is in the public interest that the greatest catch of fish may be obtained at the least possible expense of capital and labour (provided that no permanent harm is done to the fishing grounds), for then the public food-supply is increased and cheapened.

The State may also make regulations to secure the preservation of peace among fishermen at sea, and for this end it may prohibit or restrict any particular method of fishing. For instance, seiners and drift-netters worked together in Loch Fyne. There was much to be said in favour of a policy of non-interference in this case, if it had been possible, for the method of fishing with seine-nets was a superior one, and the public benefited in the supply of abundant and cheap food. But disputes arose, and the State had to interfere and prohibit the use of the seine-net in these narrow waters. There were, of course other motives underlying the repressive Trawling Acts, but it was this consideration (the public peace) that had led to the retention of the prohibition of seine-netting in Upper Loch Fyne ; and to this day, and on that account alone, drift-netting is the only method of catching herring which is permitted there.

Then, interference with the conduct of fishermen on the high seas, however undesirable in itself it may be, becomes highly necessary when numbers of vessels and men belonging to different nationalities, and perhaps employing different gear, are fishing in proximity to each other. Accidents in such circumstances are apt to occur, and the consequent disputes and risks of disturbance, and the difficulty and delay in obtaining redress in foreign law-courts, can be minimised by proper regulations and supervision. The series of international conventions to which I shall refer later on have been drawn up with this end in view.

But it was also asserted that some methods of fishing were destructive and wasteful. Every fisherman is inclined to assert this about every other kind of fisherman. In local agitations it is nearly always asserted that some other kind of fishing than that practised in the neighbourhood is to blame for any falling off in the value of the fishery. In 1863 complaints were made that beam-trawling was very destructive, because it killed incredible quantities of spawn, fry, and animals serving as food for fishes. Also, it caught too much and led to "over-fishing," and to the supposed impoverishment of certain grounds. Much less was known then of the natural history of fishes,[1] but still enough was known to convince the Commissioners that these charges were without foundation. Fishermen, though very observant, are apt to form absurd hypotheses as to the nature of the organisms encountered by them. As a matter of fact, it was found that the only kind of spawn that might possibly be destroyed by the trawl was that of the herring, and there was then (and now) no evidence that the destruction of this had any appreciable effect on the abundance of herring. The charge that the trawl destroyed animals serving as fish food was also baseless. The trawl does indeed sweep over the ground at the sea-bottom, and no doubt destroys many of the organisms resting there. It must be remembered, however, that the crushing action of the irons and foot-rope is minimised, because a portion of the weight of the apparatus is lost by immersion in water; and as the trawl

[1] G. O. Sars had just discovered the spawn of the cod, but the Commissioners were apparently unaware of this.

warp passes obliquely upward towards the ship, only so much pressure on the bottom is allowed as will cause the net to sweep up the animals lying there. Anyone who has looked over the contents of a trawl-net, when these are emptied out on deck, will see that the invertebrate animals brought up, many of them extremely delicate in structure, are for the most part uninjured.

But the other charge made, that trawling and the use of fine-meshed nets in bays and estuaries destroyed immature fishes and fry to a wasteful degree, is apparently a very reasonable one. I shall examine this in detail later on, and may therefore dismiss it with little ceremony here. The attitude of the 1863 Commissioners on this question was interesting, and may be briefly stated. It was true, they contended, that enormous destruction was effected in fishing operations. But was this destruction *wasteful?* Enormous as it was, it was insignificant when compared with the destruction which went on *normally* in nature, as the result of agencies over which man had no control. The destruction of immature fish by fishing operations was not, therefore, wasteful in degree, and did no permanent harm to the fisheries. I do not see how this conclusion could reasonably be denied in 1863, however much it may be necessary to modify it at the present time.

When the principles thus laid down by the

Commissioners are borne in mind, it will be easy to surmise what were their views with regard to the utility of the legislation in force. They regarded the whole code of 1863 as either futile, unnecessary, or injurious. The only regulations desirable were such as were necessary to preserve peace and minimise legal disputes. No administration was necessary, except what was required to provide police supervision and machinery for the collection of statistics. Restrictions and regulations might easily prove sources of injury to the fisheries, and hardship to the fishermen, in the hands of "injudicious and meddling administrators." Their attitude with regard to the Scottish Herring Trawling Acts illustrates their general views with regard to fishery regulations. Speaking of these Acts, they said that their practical effects had been :—

"To reduce the population of some of the western islands to misery and starvation, while abundant food was lying in front of their doors, by preventing them from taking herrings.

"To destroy, or greatly impede, an important branch of fishery, by preventing the use of herrings as bait for cod-fish.

"To require the introduction of a special police, and to introduce a habit of smuggling and a spirit of disobedience to the law among an orderly and well-disposed, though very poverty-stricken population.

"To produce all these effects without a shadow of evidence to show that the enforcement of a close time has a beneficial effect upon the supply of fish, or in any way promotes the public interest; though without doubt the close time is exceedingly convenient for the curers, in its twofold effect upon the labour market and the herring market."[1]

It has been said that the Commission of 1863 were influenced by the spirit of the Free Trade movement, and that the doctrines of Cobden and Bright were to a large extent responsible for the liberating and liberalising tone of their report. This is to be traced in the tone of their conclusions and recommendations, and it coloured the questions put to the witnesses. The reader of the fishery literature of the time will easily trace the same opinions in the utterances of many of the administrations of the two decades following the publication of the report of 1863.[2] They were strongly opposed to the bounty system and to the system of branding herrings in Scotland, a system which they considered to be an unnecessary (and uneconomic) fostering of the

[1] *Report, Royal Commission of* 1863, p. 114 (8vo edition). The result of these representations was to secure the passage of an Act (30 and 31 Vict. c. 52, 1867) that abolished the close time for herrings on the west coast of Scotland north of the Clyde.

[2] See a lecture by Sir Spencer Walpole on the "British Fish Trade" in *Literature, International Fisheries Exhibition, London,* 1883. Wm. Clowes.

industry. Their recommended policy of throwing open the ports and the territorial waters of the United Kingdom to foreign fishermen was dictated by the same views, and was in thorough accord with prevailing economic doctrines. Nevertheless, they had a profound conviction of the incalculable resources of nature, and of the insignificance of man's operations in reducing those resources; and however those views may require modification at the present day, they were then thoroughly justified by the development of the fishing industry, and they were just those views which aided (or perhaps made possible) the prodigious after-development of the fishing trade.

The recommendations made by the Commissioners of 1863 were that all laws which professed to regulate fishing in the open sea be repealed, and that all similar laws applying to native waters be also repealed, with the exception of a local Act regulating fishing at St Ives, in Cornwall, and of so much of the Scottish Herring Trawling Acts as prohibited seining in Upper Loch Fyne. They regarded these excepted regulations as objectionable in themselves, but nevertheless necessary in the interest of peace. They also recommended the passage of an Act securing police supervision at sea, so as to prevent disputes among fishermen, and provide easy means of obtaining legal redress.

All this was brought about by the passage into law, in 1868, of the Sea-Fisheries Act.[1] By this enactment over fifty Acts of Parliament, dating back through several centuries, were expunged from the statute-book. The Huxleian ideal of unrestricted fishing was realised, and a fisherman was enabled to pursue his calling, "how, when, and where he pleased." A beginning was made of the delicate task of obtaining a code of international sea-fisheries regulations. With these changes fisheries administration emerged from a phase of restriction without reasonable basis, and took on a more liberal complexion. That a period of restriction has again been entered upon is due to causes which I will try to explain in the next three chapters.

[1] 31 and 32 Vict. c. 45.

CHAPTER III

THE TRAWLING COMMISSION

When we consider the laborious and exhaustive inquiry made by the Commission of 1863, it seems reasonable to suppose that the question of the supposed injurious effects of trawling should have been finally set at rest. This was, however, far from being the case, and the reason is not difficult to find. Beam-trawling was becoming more extensively practised, and as no really satisfactory code of sea-fisheries regulations had been put in force, in spite of the recommendations of 1866, collision between the various classes of fishermen was still frequent, and gave rise to much dispute. The effect of trawling on the spawn and fry of fishes was still misunderstood, and, in spite of the clear and accurate statements made by the Commissioners of 1863, great misapprehension still existed with regard to this point. Finally, there is no doubt that a considerable basis of fact did exist for the statements made, during the period we are now considering, as to the depletion of many inshore fishing grounds as a result of excessive trawling.

Two public inquiries, then, belong to this period. In 1878 all the assertions made in 1863 were again repeated; the trawl-net was said to destroy fish spawn and immature fish to a wasteful extent; the national fish-supply was said to be decreasing, and restrictive legislation was again called for. It is obvious that if a Government department had been in existence, and had kept itself conversant with the condition of the fisheries, and had collected trustworthy statistics of the fish landed, these assertions might have been disposed of as they were made. However, in 1878 the Home Secretary appointed another Commission[1] to examine into the state of the fisheries, and this body made a report in the following year. It is unnecessary to go into its proceedings and report at any length, as it covered much the same ground as did its predecessor, and it came to much the same conclusions. The actual conditions of the fisheries had not, in fact, changed much during the interval between 1866 and 1879. The Commissioners were evidently strongly influenced by the opinions expressed in 1866, and they made few recommendations which need concern us here. The question of international agreement as to matters of sea-fisheries supervision was discussed by them, but while

[1] Frank Buckland and (then) Mr Spencer Walpole.

their inquiry was in progress, negotiations were being dragged out, which resulted in the International Convention of 1882. They recommended that the powers exercised by the Home Office under the Salmon Fishery Act of 1861 [1] in respect of the fresh-water fisheries be also extended to sea-fisheries, and this was done in 1886, and a definite Government department, under the Board of Trade, was constituted in that year,[2] which took some cognisance of the sea-fisheries. One other recommendation was made by them, and this led to an Act which is so good an example of ill-considered and futile legislation that I notice it here at length. Complaints had frequently been made of the almost wanton destruction effected by trawlers working over shell-fish beds, which were fished by the line fishermen in order to obtain bait for their hooks. These complaints were well founded, and the Commissioners recommended that machinery be provided to prevent this destruction. This "machinery" was furnished by the Clam and Bait Beds Act of 1881,[3] which empowered the Board of Trade to issue a Provisional Order prohibiting or restricting trawling on any area within the territorial limits, where damage might be done to clam or bait beds. But, to obtain this Order, application

[1] 24 and 25 Vict. c. 109 (1861).
[2] By the Act 49 and 50 Vict. c. 39 (1886).
[3] 44 Vict. c. 11 (1881).

had to be made to the Board by the representatives of the fishermen, or by certain local authorities. Then, after a local inquiry by an inspector of the Board, an Order might be issued, but this Order required confirmation by an Act of Parliament before it could be enforced. The expenses of these proceedings had to be borne by the applicants, and the fishermen could not, as a rule, afford this; while the local authorities were unwilling to incur expense where a small class only of the population were concerned, and in a matter which lay somewhat apart from their ordinary affairs. The difficulty and expense of obtaining powers under the Act were, therefore, so great that it became practically a dead letter.[1]

The Commission of 1878 had therefore little effect on subsequent legislation; but the other inquiry which I have to mention here was very important, because of the influence it had on fisheries administration and scientific research. Its inception seems to have been due to the usual causes—renewed agitation against trawling on the part of the line and drift-net fishermen, accompanied by positive statements of the declining yield of the fishing grounds since trawling became extensively practised. The whole question was now about to receive settlement, and the inquiry and report of the Trawling Commission marks the transition from the policy of *laissez-faire*,

[1] It was repealed by 51 and 52 Vict. c. 54 (1888).

initiated by the report of the Commission of 1863, and the beginning of modern legislative restriction.

The Commissioners were Lord Dalhousie, Mr Edward Marjoribanks (afterwards Lord Tweedmouth), Professor Huxley, Mr (afterwards Sir) T. F. Brady, and Mr W. S. Caine. Professor Huxley, however, was prevented by illness from taking part in the preparation of the report, and did not sign it. They began their inquiry in 1883, and the report was presented to Parliament in 1885. They made a departure in method by securing the services of Professor W. C. M'Intosh, who made a series of observations on the effects of trawling on board Scottish and English steam trawling vessels, and whose report, published as an appendix to the report of the Commissioners, is still a document of some interest. The inquiry was thus, to a certain extent, scientific in character, and from the frequent allusions made to Professor M'Intosh's report, there seems little doubt that the Commissioners were strongly influenced by his results and opinions.

Much knowledge had been gained, during the interval between 1866 and 1885, of the nature of fish spawn and of the spawning habits of fishes. The Commissioners of 1863 had, indeed, come to a perfectly sound conclusion as to the effect of trawling on fish spawn; but, though it was easy to show that the organisms brought up by the trawl-net, supposed by fishermen to be of this nature, had really nothing whatever to do with fishes, the evidence that the trawl did not destroy the spawn of fishes was inconclusive, so long as the true nature of the latter was unknown. In 1864, Professor G. O. Sars of Christiania discovered certain small, round, transparent bodies floating on the surface of the sea in the areas where cod-fishing was extensively carried on, and he proved that these bodies were the eggs of that fish, and that if they were observed for a certain time the hatching out of the little fish could be easily seen. This discovery was confirmed by Professor Malm of Gothenburg, who also found that the spawn of the plaice and haddock was of the same character, and by and by the same was found to be the case with many other fishes, and it was shown that, though normally residing near the sea-bottom, they emitted spawn which rose to the surface and floated, and underwent its further development there. By the time the Trawling Commission had reported, these discoveries had been applied to many other fishes, and it was known that, with the exception of the herring, the eggs of all the economic fishes were *pelagic* in character, that is, they floated about freely near the surface of the sea. It was obvious, then, that the trawl-net could do no damage to them, since it worked at the sea-bottom. The eggs of the herring had long been known to be *demersal*, that is, they were heavier than sea-water, and underwent development lying on the sea-bottom. In this case there was no doubt that the trawl might, if it were worked on a herring spawning ground, pass over masses of these eggs, and at least seriously disturb them. Herring spawning banks may, however, be situated on stony ground, over which it is difficult to trawl, and it appeared from Professor M'Intosh's observations that, even if a trawl did pass over such masses of herring spawn, much damage need not necessarily result. Besides, the herring, from its migratory habit and its enormous abundance, is less susceptible to injury from this source than most other fishes.

The assertion that the trawl-net was injurious to fish spawn was thus finally disproved, and the same result was obtained with regard to the other commonly stated effect of trawling—that it destroyed the bottom-living animals serving as food for fishes. The Commission concluded also that there was no proof of the wasteful or unnecessary destruction of immature food-fishes by this method of fishing. There remained, then, the last charge brought against trawling—that it was a method of fishing which led to the impoverishment of the fishing grounds.

So far the conclusions of the Trawling Commissioners were practically identical with those arrived at by their predecessors ; but with regard to this latter charge a remarkable change of opinion is now, for the first time, apparent. Whatever effect the great development of trawling, and especially of steam trawling, had, would be most likely to show itself first on the inshore fishing grounds, and, as a matter of fact, they received several complaints of a falling off in the number of fishes frequenting those grounds, and they came to the conclusion that these complaints had a basis of fact. "We are of opinion," they said,[1] "that on many fishing grounds" (on the inshore waters), "from the Moray Firth to Grimsby, there has been a falling off in the takes of flat fish, both as regards quantity and quality. There has also been a decrease in the takes of haddock in certain places, chiefly in bays and estuaries." With the exception of soles, no decrease in the takes of sea-fish has been demonstrated to have taken place on the offshore fishing grounds of the North Sea. The position thus taken up, in asserting the impoverishment of the fishing grounds, was a new one for a modern commission of inquiry, but it was supported by much evidence. The observations undertaken by Professor M'Intosh led to the same conclusions, and that investigator was of opinion that there had been a diminution in the number of round fishes and in the size of flat fishes in the areas specially observed by him, viz. the inshore waters of Aberdeen Bay, St Andrews

[1] *Report of the Trawling Commission*, p. xxvii.

Bay, the Firth of Forth, and the fishing grounds off Scarborough.

Though the Commissioners seem to have been satisfied that the inshore fishing grounds had undergone some deterioration, they were not so certain as to the exact cause. There was no doubt, from the evidence laid before them and from the observations made by Professor M'Intosh, that trawling had not produced this effect by damaging the food or spawn of fishes; and they were convinced that the destruction of immature fish had no injurious effect on the fish-supply. There remained, therefore, the hypothesis that trawling might exhaust or impoverish a fishing ground simply because of its great effectiveness as a method of fishing: that a ground might become "over-fished," and consequently less profitable. It is notable that they were reluctant to come to this conclusion, and they suggested that other causes might, at least, co-operate in producing this effect. Bad seasons of fishing might result from natural fluctuations in the abundance of fish; the evidence itself was not sufficiently exact; too much reliance could not be placed on the impressions and recollections of fishermen. They could not conclude, therefore, that trawling was the sole cause of the impoverishment. "In so far as it may contribute to that decrease," they say,[1] "we think it can only be as part of a system of over-fishing, and not

[1] *Report of the Trawling Commission*, p. xxxvi.

because of any wasteful destruction of spawn, fish food, or immature fish." Professor M'Intosh was, however, more confident of the connection between trawling and depleted fishing grounds. "On the whole," he says,[1] "trawling seems to have had a considerable effect on the inshore fishes at Aberdeen as elsewhere"; and again, "Marine fisheries, hitherto, have been conducted as if practically inexhaustible, both liners and trawlers taking as much from the sea as possible, while no margin has ever been afforded the breeding fishes. Fishermen and fishing boats have increased in number at many places, and trawling has likewise been extending, so that it is not a matter for surprise that some changes in the fishes have occurred." And he comes to this conclusion: "The results of successive hauls of the trawl over the same ground appear to point to a reduction in the number of the round fishes, but especially in the size of the flat fishes."

It is evident, then, that the Trawling Commission had come to the conclusion that some kind of restriction on trawling would probably be required in the interests of the sea-fisheries; and further, that there was urgent need of renewed investigation of the effect of trawling on the stability of a fishing ground. Hitherto the only observations made with this end in view were those conducted by Professor M'Intosh, and these they could not

[1] *Report of the Trawling Commission*, p. xvi.

regard as being conclusive from a scientific point of view. In shaping their recommendations they seem to have kept sight of both these objects, for they advised that statutory powers be given the Scottish Fishery Board (then the only effective fishery authority in existence in Great Britain), to enable them to regulate or suspend trawling, or any other method of fishing, within territorial waters; and also that sufficient Treasury support be given them to admit of the purchase of a steam vessel and the prosecution of scientific investigations at sea. The manner in which trawling could be dealt with had previously been suggested by the Fishery Board.[1] Two courses were open, they said: trawling should either be prohibited entirely, except to vessels holding the licence of the Board, or the sea should remain free to all, except such areas as might be barred by by-law. Of these two courses, they preferred the latter. "We are against," they said, "making the sea a *mare clausum*. A public licence to exercise an honest calling is opposed to the spirit of our institutions. The true spirit is freedom, qualified by such regulations as in the common interest may be found to be just and necessary."

The latter course was the one recommended by the Trawling Commission, and speedy effect was given to it by Parliament. In the same year the Sea-Fisheries (Scotland) Amendment

[1] *Report of the Fishery Board for Scotland for* 1884, pt. i., p. xlv.

Act[1] was passed. Whatever may have been the exact view of the Commissioners, there is no doubt that this Act contemplated the restriction or prohibition of trawling in the interests of other forms of sea-fishing. It empowered the Fishery Board to make by-laws[2] restricting or prohibiting any form of fishing in any defined area of the Scottish territorial waters. This might be done if the Board were satisfied that the given method of fishing was injurious to other forms of fishing, or if it interfered with operations relating to fish-culture, or with observations or experiments made with the view of ascertaining whether any particular mode of fishing was injurious. The Board speedily took advantage of these increased powers, and in 1886 they initiated their policy of closing the waters under their control against any form of trawling.

The first by-laws closed certain areas off the east coast—part of the Moray Firth, Aberdeen Bay, St Andrews Bay, and the Firth of Forth; and the object was that the prosecution of scientific trawling observations by the Board's steamer might not be interfered with. The object of these observations was to ascertain whether certain areas might become plentifully stocked with fish on the cessation of trawling by commercial fishing vessels. This was done by making periodical monthly trawls by an experimental trawling

[1] 48 and 49 Vict. c. 70 (1885).

[2] With the sanction of the Secretary of State for Scotland

steamer, and by comparing the results of these experiments; and the observations thus commenced were continued faithfully up to the year 1902. As time went on, however, the policy of the Board changed to a certain extent; in 1889 a further extension of the closed area took place, and the reason given was that the Board were satisfied that, within the area to which the by-law applied, "beam-trawling as a mode of fishing [was] injurious to the sea-fisheries." By this time all the territorial waters off the east coast of Scotland, from Tantallon Castle, on the south side of the Forth, to the Ord of Caithness, on the north side of the Dornoch Firth, were closed against trawling vessels.

"This action gave great satisfaction to the line and drift-net fishermen specially interested in the areas so closed"; but those fishermen prosecuting their calling in other territorial waters wished to have the latter dealt with in like manner. The Board were, however, as yet imperfectly equipped with statutory powers to effect this, and it required the passage of another Act[1] to enable them to complete the carrying out of their policy of restriction of trawling. By this Act the whole of the territorial waters off the coasts of Scotland, with the exceptions of the Solway and Pentland Firths, were closed against trawling, and, in addi-

[1] The Herring Fishery (Scotland) Act, 52 and 53 Vict. c. 23 (1889).

tion, a number of other areas,[1] lying outside the true territorial waters, were also closed. The same enactment also gave them power to close the whole of the area lying within a straight line drawn from Duncansby Head in Caithness to Rattray Head in Aberdeenshire, that is, the whole of the Moray Firth; and in 1890 a large portion of this area was closed. Finally, in 1891, the Board took full advantage of the powers enjoyed by them, and included the whole of the Moray Firth in their list of closed waters. Their policy had again changed somewhat, and the further reason assigned for the closure of these offshore grounds was that it was necessary to secure the protection of the immature fish spawned there and inhabiting the banks in the area. The capture and destruction of these immature fishes, they held—and this opinion had come to be commonly believed in—was the chief cause of the diminution in the fish-supply; and this measure was adopted in the interests of the preservation of the latter.

These by-laws naturally gave rise to much dissatisfaction on the part of the trawling population. It is to be remembered that they operated very unequally on different nationalities. Thus the foreign trawler was at perfect liberty to fish in the offshore waters of the Moray Firth and the Firth of Clyde, which, though still outside the territorial limits, were closed to British fishermen.

[1] Defined in the Schedule to the Act.

But the foreign boat could not legally land and sell the fish so caught at a Scottish port, though she might do so at an English port. Thus there arose this anomaly in fisheries legislation: a foreign trawler might make (say) Fleetwood her port of landing, and fish steadily in the closed offshore waters of the Firth of Clyde, returning with her catch to that port.[1] At the same time the Fleetwood trawler was prohibited from fishing in the same area. The anomaly might have been prevented by making the sale of trawl fish caught within Scottish closed waters illegal in British ports, but this was not done, and to that extent the restrictive legislation failed in its object.

I have now traced the origin of the restrictive trawling legislation so far as Scotland is concerned. The same policy was initiated later on in England, but at the initiative of fisheries authorities which were not created till a later period.

[1] This has actually been the practice. See *Rept. Superintendent Lancashire Sea-Fisheries District* for June 1903.

CHAPTER IV

THE INTERNATIONAL CONVENTIONS

APART altogether from the questions of the regulation of times and methods of fishing, there is the matter of the police supervision of fishermen and fishing boats at sea, and this has been a fruitful subject of legislation. If good order had to be maintained among, and disputes settled between, fishermen of the same nationality, this would still be a task of great difficulty; but when these things relate to the fishermen of several countries working on the same area, it becomes much more difficult. The exclusive jurisdiction of a country over the sea adjacent to its coasts extends only to a distance of three miles from low-water tide-marks. Within these territorial limits its subjects possess the sole right of fishing, and foreign fishing boats, though they enter under stress of weather and other circumstances, may not exercise any method of fishing. The theory of the "three-mile limit" was that a country had control over the sea only as far as a shot from a cannon could carry. This theory has, of course, become upset by the advance made by modern artillery, but the old limit has become fixed in law. Curiously enough, the old Scottish law seems to have held that the territorial limits extended so far seawards as a man could see from the shore, or to that distance at sea from which the ordinary land contour could be observed.[1] In the older days of fishing the three-mile limit was probably sufficient, as sea-fishing would not be practised much beyond that distance from the shore. For a very long time, however, the area over which fishing boats have worked has continually extended, and it was soon found that some jurisdiction was necessary over fishermen working outside territorial waters. It seems clear that the Government of this country, at least, has the power of regulating the conduct of its own fishermen, wherever they may be working, whether within the territorial waters or on the high seas, and the closure of the offshore portion of the Moray Firth is a case which illustrates this. This control over foreign fishermen also, and easy

[1] Wider views were held at one time, however. "In the time of K. James the 5th, the Hollanders having only a verbal licence to fish at 28 miles distance cam neere the shore into the mouth of the Furth of Edenborough, and ther fished in despight of the Kings comand. Then the King sent out men of warre and took so manie of them that he sent a barilful of their heads into Holland w^th their names fixed to their forheads uppon cards." The King had a grim sense of humour. (MS. in Public Records Office. *State Papers*, vol. clii., No. 63; quoted in Mackenzie's *History of the Outer Hebrides*, p. 304, Paisley, 1903).

methods of obtaining redress from them in case of injuries committed on subjects of this country, became very necessary when fishing had extended to the great offshore grounds. In other words, international regulation and an international sea-police became very desirable.

I have already referred to the earliest efforts made to acquire this control. It will be remembered that a convention was arranged between Great Britain and France in 1839, and that Acts of Legislature giving effect to this arrangement were passed in both countries. The Convention Act of 1843 was, however, a very defective piece of legislation; its provisions were generally not beneficial to the sea-fisheries, and the limits within which it operated were exceedingly obscure. The Royal Commission of 1863 did its best to suggest a workable and useful code of regulations, and the only piece of constructive legislation effected by it was the portion of the Sea-Fisheries Act of 1868 which dealt with matters of police and with the better regulation of the oyster fisheries. This Act gave effect, in Great Britain, to a convention between that country and France, and it repealed the Convention Act of 1843. Before it could become operative on French fishermen, however, reciprocal legislation was necessary, and this was not adopted in France. The Act of 1868, therefore, became a dead letter so far as French fishermen were concerned; and by the repeal of the Act of 1843, no means existed whereby a British fisherman could obtain redress for an injury committed by a native of France.

This was a state of matters which could not continue, and it was found necessary to re-enact the provisions of the Convention of 1839. This was done in 1877,[1] and for a time an anomalous system of jurisdiction existed. The Conventions applied only to the English Channel, and the great and fruitful area of the North Sea was left entirely unprovided for. Therefore, if a French fisherman injured a British fisherman in the Channel, he could be proceeded against; but if he committed the injury in the North Sea, redress was impossible to obtain. Again, a British fisherman proceeding for compensation against another British fisherman took advantage of the Act of 1868, but if he proceeded against a Frenchman, he had to be content with the Act of 1843.

The state of the law, then, as regards the regulation of the fishing boats on the offshore fishing grounds was extremely unsatisfactory, and the Commissioners of 1878 drew attention to the need for reform. Several inquiries were also held with the object of determining the nature and scope of the legislation demanded. The facts brought out by these inquiries are fairly represented by the evidence published in the report

[1] By the Fisheries (Oysters, Crabs, and Lobsters) Act, 40 and 41 Vict. c. 42 (1877).

of an extensive investigation made in 1881 by Mr W. H. Higgin into the question,[1] from which it appeared that injuries of various kinds were frequent in occurrence. Many of these were perhaps unavoidable, but there was evidence of wanton destruction of fishing gear. Foreign trawlers, for instance, in many cases, made use of apparatus designed to cut through drift-nets encountered by them, so as to save them the trouble of hauling their nets to avoid fouling.[2] Then there was no uniform and recognised method of lighting and marking foreign boats, and identification of the offender was usually impossible. There were no regulations for the purpose of preventing collisions between boats using different gears and working in proximity to each other. There was no international system of supervision, and no convenient method of legal proceedings with respect to a foreign country. Finally, a most objectionable traffic in spirituous liquors had grown up, and had been attended with particularly unfortunate effects.

The necessity for international regulation of the North Sea fisheries was therefore most urgent, and a conference of the Powers was held at the Hague, the result of which was the International North Sea Convention of 1882, entered into by Great

[1] *Report on the Outrages committed by Foreign upon British Fishermen in the North Sea*, 1881 (c. 2878).

[2] See the picture of the "devil" in Mr Higgin's Report.

Britain, Germany, Belgium, Denmark, France, and Holland. Effect was given to this arrangement by the Sea-Fisheries Act of 1883,[1] which gave the Crown power to make regulations for the conduct of sea-fishing boats in the North Sea by means of Orders in Council. The matters dealt with in the Act are :—

1. A renewed statement of the exclusive rights of British fishermen to fish in their territorial waters ;

2. The maintenance of good order among fishermen at sea ;

3. Close times for oyster-fishing ;

4. The prevention of wilful damage to fishing gear ; and

5. The lighting and registry of British sea-fishing boats.

It also provided for legal proceedings, and simplified these to some extent. For the enforcement of the Act, certain classes of persons were appointed fisheries officers : these were commissioned officers of the Navy, Consular and Customs officers, Board of Trade and Coastguard officers. They were given power both with regard to British and foreign boats acting in contravention of the Act, which included boarding, search, arrest, and detention. All the above, it must be remembered, applied only to boats fishing in the North Sea ; and with respect to French boats fishing in the English Channel, the

[1] 46 and 47 Vict. c. 22 (1883).

Act of 1843 was still held to continue in force. Difficulties arose between Great Britain and Belgium, with regard to proceedings under the Act of 1883, and to simplify these a further Declaration between those countries was entered into, and this was given effect to in another Sea-Fisheries Act.[1] These Acts, with the Merchant Shipping Acts, the Sea-Fisheries Act of 1868, and the various Orders in Council made to give them effect, constitute the existing body of sea-fisheries police legislation.

Another aspect of international regulation had long engaged the attention of those interested in the sea-fisheries. This was the traffic in spirituous liquors in the North Sea. For a long time boats specially fitted out for the purpose had traded in that area among the fishing fleets, and supplied "tobacco, spirits of a vile quality, scents, obscene cards and photographs."[2] These boats were known as "coopers" or "bum-boats," and were sailed chiefly from Dutch and German ports. Some of them were English smacks, but these usually ended in being sold in foreign ports and worked under a foreign flag. One at least was owned, fitted out, and sailed by an Englishman. They were officially described[3] as "floating-grog-

[1] 54 and 55 Vict. c. 37 (1891).

[2] *Correspondence relating to the Liquor Traffic in the North Sea*, 1888 (c. 5263).

[3] *Report by Mr W. H. Higgin, etc.* (c. 2878), 1881.

shops of the worst possible description, uncontrolled or unregulated by any superior power or force whatsoever." An exhaustive inquiry was made in 1881, and much evidence was obtained showing the "nefarious nature of the trade carried on by these 'bum-boats,' and the dreadful evils therefrom resulting, evils which not only include theft, gross breaches of trust, assaults, robbery, obscenity, and smuggling, but even in a few cases resulting in violent deaths."[1] Fishermen sold their catches, gear, and sails for the goods supplied by these boats, and there was a direct inducement to trade with them, for tobacco could be obtained from them at a low cost, being free of duty. The question of the abolition or regulation of the traffic came up for discussion at the Conference held at the Hague in 1881, which resulted in the North Sea Convention, but no settlement was arrived at; and it is almost incredible that the regulation of the "coopers" was objected to as an interference with trade. A further inquiry was made by a committee appointed by the Board of Trade in 1883, and this body presented a report in which the evils of the trade were again insisted on, and interference was recommended as "imperatively necessary." In 1886 a final inquiry was made by Rear-Admiral Gordon-Douglas and Mr H. N. Malan, and the same conclusions and recommendations resulted.

[1] *Report by Mr W. H. Higgin, etc.*, p. 7.

As a result of these various investigations, a Conference[1] was held at the Hague in 1886, to consider the best way in which to deal with the evil. An attempt had, in the meantime, been made by the Mission to Deep-sea Fishermen, by fitting out special smacks which worked on the fishing grounds and did their best to minimise the evil; but international treatment of the traffic was obviously the only effective remedy, and the Conference brought this about. As a result, a Convention was agreed upon, which was signed in 1887 by the representatives of Great Britain, Germany, Belgium, Denmark, Holland, and France. This bound the signatory Powers to effect such legislation as would prohibit entirely the sale of liquor in the North Sea, and would make the liberty to traffic in provisions and other articles (liquor excepted) subject to the possession of a licence. It was arranged to bring the Convention into force at a date to be subsequently fixed on, and, for this purpose, an Act of Parliament[2] was passed in 1888. This Act, however, never came into force, for France declined to ratify the Convention. The other Powers, therefore, entered into a Protocol in 1893, by which they agreed to enforce the Convention as far as their own subjects were concerned, leaving it to France to give her adhesion

[1] The British delegates were Mr C. M. Kennedy and Mr C. Cecil Trevor.

[2] The North Sea Fisheries Act, 1888, 51 and 52 Vict. c. 18.

at a later period. The result of this last agreement was the happy settlement of the matter, and in the same year the Act of 1886 was repealed, and another Act was passed,[1] which gave effect to the provisions of the Convention. Acts of Legislature of the other participating Powers were also passed, and these came into force in May 1894, since which date the liquor traffic has been made illegal in the North Sea, and trafficking in all other goods has been made subject to the possession of a licence.

This is a very brief account of the history of international fishery regulation. It will be seen that the arrangement of joint action is a tedious and difficult matter; ratification of the Conventions, even if they are satisfactorily arranged, is always uncertain; and the exact working of international regulations cannot easily be foreseen. But the existing legislation applying to the North Sea fisheries is on the whole satisfactory, when the difficulties encountered in attaining it are considered; and if it falls below the standard of what is desirable, it is largely on account of the great expense of policing such an extensive area, and because much energy and elasticity are difficult to apply to official methods, even by repeated Acts of Parliament.

[1] The North Sea Fisheries Act, 1893, 56 and 57 Vict. c. 17.

CHAPTER V

THE SELECT COMMITTEE OF 1893

It will be remembered that the Commission of 1883 made certain recommendations which resulted in the imposition of restrictions on the areas on which trawling might legally be practised. Other recommendations were also made which had a very important effect on the future of sea-fisheries administration. At the time when the report was issued the Scottish Fishery Board had been in existence for about three years, and was actively engaged in the administration of the fisheries under its control. There was, however, no fisheries office in England. Under an Act of 1861[1] two inspectors were appointed by the Home Secretary, whose duties were to undertake the inquiries necessary for the administration of the fresh-water fisheries, and to lay annual reports before Parliament, which were to include statistical accounts of those fisheries, as far as that was practicable, and were supposed to contain sugges-

[1] Salmon Fishery Act, 24 and 25 Vict. c. 19.

tions for their better regulation and improvement. We have seen that the Commissioners of 1878 (who were also the inspectors of salmon fisheries) advised that the Home Secretary should have power, after due inquiry, to issue Provisional Orders restricting trawling in defined areas. To carry out such inquiries, some authority was necessary, and they advised that the powers possessed by the salmon inspectors should be extended so as to include the sea-fisheries also. This was not done immediately, so that when the Trawling Commission met there was no authority in England having jurisdiction over the sea-fisheries, except the Board of Trade, in so far as it had authority under the Sea-Fisheries Act of 1868, and the Acts amending this, to regulate the oyster and shell fisheries, and to grant orders conferring rights of "several fishery."

This state of affairs was unsatisfactory, and the Trawling Commission made recommendations designed to remedy it. We have already seen that, on their advice, the Government effected legislation which gave the Scottish Fishery Board largely increased powers and resources, and enabled them to institute the scientific investigation of the Scottish fisheries. The Commissioners went further, however, and, taking a comprehensive view of the situation, they recommended that a central authority should be created, with powers "to supervise and control the fisheries of Great Britain, if not of the United Kingdom," and that money should be annually granted by Parliament so as to enable this body to carry out scientific work and collect proper statistics. They also advised that an authority similar to the Scottish Fishery Board should be created for England; and that, in the meantime, powers to restrict or suspend any mode of fishing, and to spend money on scientific research, should be conferred on the Home Secretary, or on the President of the Board of Trade.

Now, these recommendations, so far as they related to the Scottish Fishery Board, were carried into effect almost immediately, and that body became a very real and practical fisheries authority. A very different result followed, however, in the case of England, and for several years no attention was paid to the results of the Trawling Commission so far as they affected that country. The Board of Trade did indeed undertake the collection of fisheries statistics in 1885, but this step is stated[1] to have been taken on the initiative of the Duke of Edinburgh, who was then Admiral-Superintendent of Naval Reserves, and who had paid some attention to the matter; and, following his advice, the Treasury consented to an annual expenditure of £500 on the acquisition of this information!

[1] *Report of the Inter-departmental Committee on Fishery Statistics*, 1902, p. v.

Instead of creating an English Board on the model of the Scottish authority, the Government instituted the present Fisheries Department of the Board of Trade, and the system of local committees, which is the present form of fisheries administration. The Salmon and Fresh-water Fisheries Act of 1886[1] transferred the powers and duties of the Home Office, with respect to those fisheries, to the Board of Trade, and at the same time made the Board take cognisance of the sea-fisheries. The inspectors of salmon fisheries were made inspectors also of sea-fisheries, and they were required to prepare an annual report to be laid before Parliament, containing a statistical account of the fisheries, with suggestions for their improvement. In making this change, the Government legislated along the line of least resistance; and in instituting the system of local committees they followed their policy of local government, which resulted in the institution of the county councils in 1888. By the Sea-Fisheries Regulation Act[2] of that year the present system of sea-fisheries administration came into existence.

The Sea-Fisheries Regulation Act cannot be regarded in any way as resulting from the recommendations of the Trawling Commission. It gave the newly-constituted county councils power

[1] 49 and 50 Vict. c. 39. [2] 51 and 52 Vict. c. 54.

to form district fisheries committees. On the application of a littoral county or borough council, or of two or more of these bodies, the Board was empowered to issue, after due inquiry, an order constituting a district sea-fisheries committee, and defining the area over which such a committee had jurisdiction. The members of these bodies were to be members of the councils, with the addition of representatives from the Boards of Conservators,[1] and of members nominated by the Board of Trade and representing the fishery interests—the fishermen, fishing-boat owners, and fish-salesmen of the neighbourhood. Their powers for the regulation of the fisheries are fairly extensive, and they may make by-laws, which, however, do not become operative until confirmation, after due inquiry, by the Board of Trade.[2] The expenses of administration are met by a rate imposed on the area returning the members. The Act of 1888 was amended, and further powers were given to the committees, by the Fisheries Act of 1891,[3] which also gave them powers to enforce the Shell-fish Act of 1877;[4] and by the Sea-Fisheries (Shell-fish) Regulation Act of 1894.[5]

The enactments we have been considering have practically fixed the present position of

[1] The local authorities having charge of the salmon and fresh-water fisheries. [2] Now the Board of Agriculture and Fisheries.

[3] 54 and 55 Vict. c. 37. [4] 40 and 41 Vict. c. 42.

[5] 57 and 58 Vict. c. 26.

sea-fisheries regulation and administration, and we come now to the latest phase of the question. The question of the effects of trawling has been finally settled; and under the powers exercised by the Fishery Board in Scotland, and by the District Committees in England, large portions of the British coastal waters have either been closed against that method of fishing, or considerable restrictions have been imposed on those practising it. The latest phase of fisheries restriction concerns fishing on the high seas; and the inquiries we have now to consider must be regarded as initiating a future policy of fisheries restriction in extra-territorial waters by the force of international agreement.

Two public inquiries belong to the period I am now considering. In 1893 the House of Commons appointed a Select Committee to consider the state of the sea-fisheries of the United Kingdom. I will endeavour to trace the causes which led to the appointment of this body. A remarkable development of the sea-fisheries had taken place during the interval between the report of the Trawling Commission and that of the Committee referred to; and this change is characterised by the great increase of steam trawling vessels, and the decrease in the number of smacks, and by an extension of the area fished over. The former change is represented in the following table:—

FISHING VESSELS

	Steam.		First-class Sailing Vessels.	
	No.	Tonnage.	No.	Tonnage.
1883	225	6,654	8058	244,097
1892	627	28,271	7319	244,668

These figures[1] (which relate to the United Kingdom) show that, during the period under consideration, the number of steam fishing vessels, which were mostly trawlers, had been nearly trebled, and that they were, on the average, larger boats than those used ten years previously. At the same time, the number of sailing vessels had actually decreased, although, since the total tonnage was slightly increased, their average size was greater than at the previous period. Another important change, the substitution of the otter-trawl for the beam-trawl, had also taken place with regard to the fishing apparatus of the steam vessels, and this change represented a very great increase in efficiency.

A result of great significance attended these changes in the catching power of the British fishing marine: changes which also took place, though

[1] *Report of the Select Committee on Sea-Fisheries*, 1893, Appendix II., p. 379.

to a lesser extent, in other North Sea fishing countries. Under the influence of the greatly increased catching power, the North Sea fishing grounds were becoming less profitable than was formerly the case. One ground after another was discovered, exploited, and, though never entirely abandoned, changed for a new one. There was, it is true, no suggestion of exhausting the fish-supply, but the result of the great extension of trawling was that the catches made by the vessels were less than in the days when the North Sea was virgin ground. In the words of Professor M'Intosh,[1] "man (was) treading too closely upon the supply." The evidence brought before the Committee, whether furnished by scientific experts, practical fishermen, or statisticians, was practically unanimous on this point, and the Committee had to come to the conclusion that "a considerable diminution (had) occurred among the more valuable classes of flat fish, especially among soles and plaice." For the first time within the modern period, a public inquiry revealed clear and unequivocal evidence of the impoverishment of the fishing grounds over extensive areas.

This impoverishment of the fishing grounds was made apparent to the trawling trade in the diminution of their catches, and naturally gave rise to much uneasiness. The agitation which

[1] *Report of the Select Committee on Sea-Fisheries*, 1893, Question No. 3516.

followed was unique among its kind : hitherto one class of fishermen had called for interference with the operations of others in the interests of their own branch of the trade, but the North Sea trawlers now called on the Government for interference with their own methods. An association of persons interested in the sea-fisheries and the allied trades—the National Sea-Fisheries Protection Association—had been formed in 1882, and by the end of 1892 this body was said to represent, directly or indirectly, 80,000 persons. The growing depletion of the North Sea fisheries was discussed at successive annual meetings of the Association, and at most of these meetings there was an almost unanimous opinion that the cause of the falling off in the yield of the North Sea grounds was the extensive capture of immature fishes on certain grounds off the Dutch, Danish, and German coasts. Resolutions to this effect were agreed on at meetings of the Association in 1888, 1890, and 1892 ; and the Conference of 1888 (in which, as in others, the influence of trawlers predominated) agreed to petition the Government to enter into negotiations with the Continental Powers for the establishment of a prohibition, by international law, of the capture of immature fish. At the Conference which met at Hull in 1890, the delegates agreed, both for themselves individually and for the companies and fleets which they represented, to abstain from trawling on certain defined grounds in the North Sea,[1] on which small fish were particularly abundant. This self-denying ordinance is said to have been voluntarily observed for two seasons, after which it broke down. In 1891 an unofficial international Conference was held in London, at which representatives of the fishing trade in the North Sea countries met and discussed the question, and agreed that investigation, scientific and otherwise, should be instituted. These investigations were never made. Finally, in 1892, the Annual Conference of the Association suggested definite legislation, and agreed to request the Government "to enact a law to prohibit the sale of undersized flat fish in British markets—undersized flat fish being as follows:—Brill, under 12 inches in extreme length; lemon soles, 11 inches; plaice, 10 inches; soles, 10 inches; turbot, 12 inches." A deputation from the Association afterwards waited upon the President of the Board of Trade, and urged the appointment of a Select Committee to consider the expediency of prohibiting the landing of undersized flat fish. This was done by a motion in the House of Commons in March 1893; and the fishing trade obtained the comfort of an inquiry, though, to be sure, they are still waiting for legislation.

[1] The defined area was bounded on the east by the German and Danish coast, on the west by the meridian 7° 30′ E., on the north by latitude 56°, and on the south by latitude 53° 50′.

The terms of reference to the Committee were wide, and the inquiry was a somewhat comprehensive one into the whole question of the British sea-fisheries. Its chief interest, however, centred round the question of fisheries impoverishment, and the alleged cause of this, the capture and destruction of immature flat fishes. There was, on the whole, unanimity of opinion that this was a true cause, and two remedies were suggested to put an end to the practice. One was a direct remedy, and involved the prohibition of trawling on the area defined. To effect this would have required international agreement, and similar legislation in the countries entering into the agreement, and an international sea-fisheries police. The other remedy was an indirect one: it was proposed to make the landing and sale of undersized fish illegal in the North Sea countries. It was contended that, even if international agreement was not to be obtained on this question, the prohibition of the sale of flat fish in Great Britain would still do a great deal towards finding a remedy, for the English markets were by far the greatest ones for this class of food. By making a market for these small fishes impossible, fishing would be practically stopped on the eastern grounds of the North Sea, for trawlers would avoid working on them, and so obtaining unremunerative catches. Other remedial measures were suggested, and I only mention one of these as showing to what an extent legislative restriction in the case of the sea-fisheries may be contemplated. Professor M'Intosh suggested that one-quarter of the whole North Sea should be closed alternately against all forms of fishing, except perhaps herring fishing, leaving the other three-quarters open.[1] It need hardly be stated that this proposal did not commend itself to the Committee.

The further history of this undersized fish agitation may be stated at once. The Select Committee did not adopt the size limits suggested by the National Sea-Fisheries Protection Association; but, feeling that the limits which ought to be adopted in this country should approximate to those in force abroad, they suggested that 8 inches for soles and plaice, and 10 inches for brill and turbot, should be the sizes in question. They also recommended "that a strong effort should be made to secure the adoption of uniform regulations for limits of size and other matters by the nations interested in the North Sea fisheries." Now, there is no evidence that any effort was ever made to obtain this international agreement, and certainly no government ever attempted to legislate on the lines suggested by the Committee. For years the promoters of the Immature Fishes Bill endeavoured to secure its passage into law, and were unsuccessful. In 1900, however, the Bill made some

[1] *Report of the Select Committee on the Sea-Fisheries*, 1893, Question 3495.

progress, and was again referred to a Select Committee. That body made the usual laborious inquiry, and met with the same unanimous testimony as to the growing impoverishment of the North Sea grounds for flat fishes, and the same agreement among the deep-sea trawling trade as to the remedy. They felt "that the subject of the diminution of the fish-supply is a very pressing one, and that the situation is going from bad to worse";[1] and they were convinced that the destruction of immature fish was undoubtedly a cause. But the Bill necessarily involved considerable opposition on the part of the inshore fishermen; and though their reasons are somewhat obscure, the Committee rejected the measure. And there the matter rests.

The Select Committee of 1893, however, made some other recommendations which resulted in legislation of a comparatively harmless nature. As we have seen, the state of fisheries administration differed notably in the two divisions of the United Kingdom. In Scotland there was a strong central authority, but no system of local government, and no evident need for such. In England, on the other hand, there were the newly-formed local committees and a weak central authority, obviously hampered by its intimate connection with the Board of Trade. Both systems lacked the element

[1] *Report from Select Committee on the Sea-Fisheries Bill*, 1900, p. iv.

of direct representation of the fishing trades, and this theoretical disadvantage appealed strongly to the Committee, who were, in addition, strongly impressed with the idea of constituting a symmetrical system of fisheries administration in the United Kingdom. "At the present moment," they report,[1] "while in England there are sea-fishery committees, there is no fishery board; in Scotland, there is a fishery board, and there are no district fishery committees. Furthermore, the district fishery committees in England, and the fishery board in Scotland, both labour under one and the same disadvantage, that of being without any directly elected representative element." They urged strongly, therefore, that measures should be taken to assimilate the two systems to each other; that the fishery boards should be partly constituted of representatives of the local committees, and that the committees themselves should be directly elected from representatives of the fishing interest, in what manner they did not state. It is, perhaps, not to be regretted that this recommendation did not wholly commend itself to the Legislature, and that, in so far as it was realised, it had no practical effect.

Certain enactments were, however, made. The English Sea-Fisheries Regulation Act was amended by the Fisheries Act of 1891,[2] and by a further

[1] *Report, Select Committee*, 1893, p. v.

[2] 54 and 55 Vict. c. 37.

Act in 1894,[1] and these Acts increased the powers of the committees for making by-laws, and gave them authority to enforce the Shell-fish Act of 1877, and to spend public money on cultivating shell-fish (molluscs and crustaceans), in stocking public fisheries, and in making scientific experiments and observations with those ends in view. In so far as they went, these increased powers were of some utility, but little or nothing has been done by the committees in the way of restocking the shell-fish beds.[2] The legislation applying to the Scottish system was useful, just so far as it was demanded by those conversant with the sea-fisheries in that country. The Sea-Fisheries Regulation (Scotland) Act of 1895[3] reconstituted the Fishery Board, and gave the Secretary for Scotland power (which was immediately taken advantage of) to appoint a scientific superintendent to supervise and control such scientific inquiries as the Board might deem necessary for carrying out the provisions of the Fisheries Acts. The police cruisers under the control of the Board were afterwards increased in number, and that body was given authority to extend its jurisdiction over the coastal waters to a distance of thirteen miles out to sea, at any time when international

[1] The Sea-Fisheries (Shell-fish) Regulation Act, 57 and 58 Vict. c. 26.

[2] Except during the last year or two, when the Lancashire Sea-Fisheries Committee began to "transplant" mussels and cockles.

[3] 58 and 59 Vict. c. 42.

sanction might be obtained to such arrangements. All these powers were sought by the Fishery Board, and, no doubt, have proved, or will prove, eminently useful. The remainder of the Act conferred powers upon the Board (which they do not appear ever to have asked for) to form district fisheries committees in Scotland on the model of the English bodies, but with the addition of the "directly representative element" on which the Select Committee laid such stress. They were empowered to form such authorities on application, and after due inquiry, by a county or borough council or the commissioners of a police burgh. The "directly representative element" was to be obtained in the following way. The county and burgh assessors were instructed to form a register of persons entitled to return the element, by prefixing a "distinctive mark" to the names of such persons on the register of county council or burgh voters as were entitled to possess the qualification included in the expression "fishing interests." Each of these fishing voters was to be entitled to vote for a certain number of representatives on the district fisheries committee. The elections were to take place on the same days, in the same manner, and at the same place, as the elections for county councillors.

It is a striking commentary on the utility of all this complex machinery, and on the familiarity of the Legislature with fishery questions and needs, that no district committees have been, or are likely to be, formed in Scotland. The reason for this is the great difference between the fisheries of the two countries, and the satisfactory manner in which the administration of the law is already provided for by the Fishery Board staff. Another reason which may be assigned is that the expenses of these local committees would have to be met by rates incident on the areas constituting them, whereas the expenses of the Fishery Board's administration are provided out of Imperial funds.[1] "I do not think," the chairman of the Board told the Select Committee,[2] "that Scotland is ever willing to be assessed. Scotland's view is that she pays too much of the Imperial taxation at present for what she gets in return."

The consideration of this legislation completes our review of the growth of sea-fisheries administration; and I will take the opportunity later on to indicate what lines future development will probably follow. Meanwhile, its general direction during the latter half of the nineteenth century may be very briefly summarised. The

[1] The contribution of the Treasury to the Fishery Board for Scotland is of the nature of an "equivalent grant." See a speech by Mr Bonar Law at the Fisheries Conference at the Board of Trade, 1903.

[2] *Report of the Select Committee on Sea-Fisheries*, 1893, Question 3194.

Royal Commission of 1863, as we have seen, marked the change from the policy of legislative restriction, which was that of the earlier administration, to that which gave almost perfect freedom from restriction of any kind ; and however much this policy may have changed in our own time, there can be no doubt that it was justified in 1866, and that the absence of restrictive regulations materially assisted the enormous development of British fishery which took place during the next few decades. The report of this Commission also initiated the policy of international regulation in matters of police which resulted in the Fisheries Acts of 1868, 1883, 1888, 1891, and 1893. The Commissioners held optimistic views as to the resources of the fishing grounds, which were perhaps justified by the state of development of the fisheries in their time. As time went on, and the fishing fleets increased in number, and more especially when steam trawling became extensively practised, it was seen that these views were no longer tenable, and that the marine fisheries could not be conducted as if they were inexhaustible. The pendulum then swung back to the policy of legislative restriction, and we have followed in a summary manner this development. But, unlike the legislation that preceded the inquiry of 1863, this has been founded on a real attempt to understand the causes likely to affect the prosperity of the fisheries; and though the attempt at fisheries investigation has received tardy recognition and support, and has been carried out in a superficial and wholly inadequate manner, there is no doubt that it has given a surer foundation for legislation, and that by persevering in it we shall by and by succeed in legislating justly and permanently in the interests of a hard-working (and perhaps long-suffering) population.

CHAPTER VI

THE FISHERY BOARD FOR SCOTLAND

ALTHOUGH the administration of the British sea-fisheries, in the modern sense of the phrase, may be regarded as beginning with the consolidation of the law which resulted from the inquiry of the Royal Commission of 1863, it is nevertheless very instructive to consider the early history of the regulation of the industry both in Scotland and in Ireland. The Fishery Board for Scotland has existed since the beginning of the nineteenth century, and though in the course of over a century's administration many changes have taken place, the essential features and functions of this famous authority have remained much the same, and its history has been one of almost continuous orderly and progressive development.

The Scottish herring fishery owed its development to jealousy of the Dutch. In the eighteenth century many complaints were made that the fishermen of that nationality were robbing Scottish seas of their fish, and several attempts were made to break down the practical monopoly enjoyed by Holland of the herring fishing and curing industry. The Dutch herring fishery in Scottish seas was at one time of considerable magnitude. "Since that year, 1594," says a State paper of the time of Charles I.,[1] "the Hollanders have cũ thither w^th^ al their Fleet of Busyes sũtimes 3000 Saile." Fishing companies were formed to exploit Scottish waters, but most of these organisations had an unfortunate career, and little good was accomplished by this means. At last an expedient in accord with the economic doctrines current at the time was adopted, and an earnest and thoroughly successful attempt was made to establish a herring fishery on the coasts of Scotland, by means of a very direct system of protection. When we consider only the present prosperous condition of the Scottish sea-fisheries, it is not easy thoroughly to appreciate the difficulties that had to be encountered in establishing a flourishing industry in a very poor country, and on a comparatively inhospitable coast like that of the eastern sea-board of Scotland. And in these latter times we have become so thoroughly saturated with Free Trade ideas, that it is difficult to ascribe to the early protective systems the credit to which they are undoubtedly entitled.

It is well to note that from its beginning the

[1] *Domestic, Charles I.*, vol. clii., No. 63, 1629; quoted in Mackenzie's *History of the Outer Hebrides*, Paisley, 1903.

work of the Scottish Fishery Board had three sides. It was in its inception a semi-commercial body, which had for its object the creation of a fishing and curing industry, employing for means to this end a system of bounties and other means of artificial encouragement. Round this system, as a nucleus, another system of regulation of the methods, both of fishing and curing, and also of the seasons when fishing might legally be carried on, was developed. The payment of bounties gave occasion for the collection of the commercial statistics of the industry, and in this way a unique and most valuable store of information was gradually accumulated. Finally, there is the scientific side of the work of the Board. This was a feature of the administration almost from the first, and at the present time the statistical and scientific work of the Fishery Board forms perhaps the most striking feature of the administration.

The semi-commercial objects of the Board are indicated in the title of the enactment: "An Act for the further Encouragement and better Regulation of the British White Herring Fishery,"[1] which gave it practically the present form.[2] This Act constituted a Board of (unpaid) Commissioners, the "Board of British White Herring Fishery," to take account of the herring fishery, not only of

[1] 48 Geo. III. c. 110 (1808).

[2] Previous to the establishment of the British White Herring Board the fisheries of Scotland were under the charge of the "Board of Manufactures."

Scotland, but also of England and, later on, of the Isle of Man.[1] The duties of this body were: (1) to disburse the sum of money annually voted by Parliament for the payment of bounties, (2) to "brand" herrings destined for export, (3) to administer the regulations relating to the manner of curing and packing herrings, and (4) to collect statistics and furnish annual reports to Parliament. It had an inspectory staff, with districts and branding stations, and it was given the assistance of Government vessels for marine superintendence.

Two kinds of bounties were paid, which were :—

1. Tonnage Bounties

For herring vessels—£3 per ton per year was paid to every "buss" or herring vessel over 60 and under 100 tons burden, built and owned in Great Britain, and equipped for the capture of herrings in British waters.

For cod and ling vessels—

1820 to 1826, 50s. per ton.
1826 to 1827, 45s. per ton.
1827 to 1830, 35s. per ton.

All the tonnage bounties ceased in 1830.

2. Bounties on Fish Cured

On herrings—1808 to 1815—2s. per barrel of this fish caught in British seas and cured and packed according to the regulations prescribed by the Board.

[1] The English and Manx stations were abandoned latterly, and the Board became purely a Scottish authority.

1808 to 1815—in addition to the above bounty, 2s. 8d. on each barrel of herrings exported was also paid.

1815 to 1826—4s. per barrel of herrings cured gutted.

1827—3s. per barrel of herrings cured gutted.

1828—2s. " " " " "

1829—1s. " " " " "

The herring bounties ceased altogether in 1830.

On cod and ling—1822 to 1830—4s. per cwt. was paid on fish cured dry, and 2s. 6d. per barrel for fish cured in pickle (these bounties were earned by vessels not receiving the tonnage bounty).

Cod and ling bounties ceased altogether in 1830.

Now, what was the effect of this very thorough-going system of protection? This has, of course, been very much discussed, and the opinion has been very freely expressed that the Scottish bounty system had very little effect on the development of the herring fishery, and that, given a wise administration, the industry would have developed concomitantly with the growing wealth and population of the country.[1] The view one takes of the question is of course largely dependent on his adherence to one or other of the two present schools of opinion with regard to the utility of protective measures in commerce. It is very difficult, of course, to obtain such information now as would enable us satisfactorily to settle the

[1] See Spencer Walpole, "The British Fish Trade," in *International Fisheries Exhibition Literature*, London, 1883, for an exposition of these views.

question. On the whole, it would appear, however, that the bounty system had a very real effect in establishing the Scottish herring fishing and curing industry. It was wisely planned, the sums paid were fairly liberal, and the whole system was gradually abandoned. In 1809, when the payments were first made, the total cure was only 90,000 barrels, and in 1830, the year when the bounties were discontinued, this had risen, with very minor fluctuations, to 440,000 barrels. That the catch and cure of herrings fell only very slightly for a few years after the change, seems to be a sufficient answer to the somewhat cheap argument that vessels were fitted out "to catch the bounties" rather than the fish. After 1834 the catch of herrings, the amount cured, and the amount exported all gradually increased, although the vicissitudes of the seasons had, of course, their effects on the fishing. A policy which was persisted in after the abandonment of the bounties—that of branding herrings meant for export—had, without doubt, a most important share in the perpetuation of the stimulus afforded by the bounty system.

When the bounty system was discontinued in 1830, a total sum of £927,110 had been awarded on the results of the cod, ling, and herring fisheries. The protective policy of the Board was, however, far from being abandoned. An annual sum of £3000 was voted for the repair and construction of fishing piers and harbours, and the well-known branding system which had come into operation with the beginning of the Board was still retained, and has been continued to the present day. There was always a direct oversight over the herrings cured and exported: every curer was bound to give notice of his operations; his stores were always open to inspection by the fishery officers; and he was compelled to pack the proper quantity of herrings into barrels of a regulation size. But the Board took no cognisance of the quality of the fish, or the cure, unless the merchant desired to obtain their certificate of excellence. Then it was the duty of the officer at the curing station to open and examine a sample of the barrels of fish to be exported, and if the contents came up to a certain standard, he caused a brand to be burned into the head of the barrel. The brand indicated that the fish were not injured in the catching, that they were properly cured, and that the barrel contained a certain average number. It also indicated the condition of the fish as regards size and the state of maturity of the reproductive organs (ovaries or "roes," and testes or "milts"). The "Crown Brands" in use at the present time are: "LA. FULL" (large herrings with ripe reproductive organs—ovaries and testes), "FULL," "MAT. FULL" (smallish herrings with ripe reproductive organs), "SPENT" (mature herrings which have spawned), and "MATTIE" ("maiden" herrings—those in which the ovaries and testes are not fully developed).

Now, the branding system, though it continues in operation to the present day, was the subject of a long-standing dispute between the Treasury and the Fishery Board. One gathers that the objections which the former body made to it were not at first based on principles of political economy, but had their origin in the reluctance of the governments of the time to maintain an expensive fisheries establishment on the coasts of Scotland at Imperial expense. But later on the Treasury seem to have decided that the perpetuation of the branding system was directly opposed to sound principles of economy, and they deputed Mr (afterwards Sir) John Lefevre to make inquiry into the grounds for its retention. This gentleman came to the conclusion that the discontinuance of the system was likely to cause "serious derangement and contraction of that [herring curing] trade, and consequent loss and inconvenience to those engaged in it, and to the large bodies of the working classes employed, not only in fishing, but also in the various operations of curing for the European market."[1] He recommended that it be maintained, but, recognising that it was, "in effect, a bounty on the export white herring trade at the

[1] Board of Fisheries (Scotland): *Copy of Reports, etc., on the Subject of the Fishery Board in Scotland*, with correspondence, printed in 1856.

expense of the other classes of the community," he advised that a small fee be charged by the Board for the service of branding herring barrels.

No effect was given to this recommendation at the time, and in 1855 the Treasury again took the matter up, and issued a minute in which they urged the abolition of the brands, and with this the necessity for the existence of the work of the Board as a separate organisation. The various functions exercised by that body were to be relegated to the Admiralty, the coastguard service, and the Customs. The annual vote of £3000 for the repair and construction of fishing harbours was not to be discontinued, but each application of this nature was to be considered by itself, and provided for in the estimates. The Fishery Board replied to these proposals by a statement in which they indicated the reasons for the retention of the system. The Treasury now issued a commission to examine into the whole question anew. The members of this body (which reported in 1856) found themselves, in the end, diametrically opposed on the main questions submitted to them, and the result was that no action was taken. In 1859, however, the Board began to charge a fee of 4d. for each barrel branded, and the result of this action was to justify the continuance of the brands, for there was practically no falling off in the number of barrels of cured herring submitted to their officers for certification.

6

The Royal Commission of 1863 were the last public body to deal with the vexed question of the herring brands, and the whole of the arguments for and against the system are summarised in their report. On the one hand, we have the contention of the Board that the system had proved of immense benefit to the herring trade by establishing a preference for Scotch cured fish on the continent of Europe. Barrels of herring passed to the shores of the Black Sea "current as a bank-note." It avoided serious inconvenience to the curers in foreign markets, in that it obviated the necessity for the inspection of the fish, which would have required the opening of the barrels, and the consequent deterioration of the product. It was a guarantee to the buyer that the goods he bought were of sound quality. Even at that time the competition with Norwegian cured herrings was being felt, and it was urged that the cessation of the system of official brands would most probably have been of great advantage to the curers of the latter nationality. These contentions were not seriously combated by the Commissioners, who seem to have been of the opinion that it was not a public duty to safeguard the home merchant against foreign inspection and official inconvenience, or the foreign buyer against fraudulent or incompetent British tradesmen. And they expressed the optimistic opinion that, even if the branding system were discontinued, the trade in Scottish herrings would be as flourishing as ever. But the real spirit in which they dealt with the question is indicated in the following quotation from their report.[1] "We conceive," they said, "that such a violation of a great principle of public policy is involved in the very existence of the brand, with its concomitant system of regulation and inspection. It is a direct violation of the greatest of all commercial principles, and that which is now regarded as the commercial policy of this country — the principle of Free Trade, and the policy of removing every description of restriction and protection from commerce." Holding such views, the Commissioners saw no necessity for the existence of the Fishery Board and its staff, and they unhesitatingly recommended its abolition. At this time the Board had other functions besides those to which I have alluded. They administered the Convention Act of 1842, which provided for regulation of fishing boats on the seas, as well as several other enactments relating specially to the herring fisheries; they policed the territorial waters in the interest of the exclusive fishing rights of British subjects; they administered the annual vote of £3000 for the repair and construction of fishing harbours; they were collecting what has proved to be a most valuable series of fishery statistics; and even then they were encouraging

[1] *Report, Royal Commission of* 1863, p. 134 (octavo edition), 1866.

or directly instituting scientific investigations. All this activity would have come to an end, not necessarily because it was expensive or useless, but because it was in direct contravention of the prevalent doctrines of political economy. Police duties the Commissioners would have relegated to the Admiralty—and we know now that fishery superintendence at sea has always been grudgingly performed by the naval service; the collection of statistics would have been entrusted to the coastguard—and this was the means latterly adopted in England, and which has resulted in the most faulty system of statistical collection yet devised by any European country; scientific work would have been left to take care of itself, as it has been in England, with the result that assistance from public sources has been obtained only under the greatest pressure. Fortunately, the recommendations of the Royal Commission of 1863 left the Scottish organisation practically untouched.

So much for the commercial side of the functions of the Fishery Board. A later series of enactments developed what we may call the purely administrative side, while leaving the branding system pretty much as it was. The Fishery Board (Scotland) Act of 1882 [1] dissolved the old "Board of British White Herring Fishery," and constituted the present Fishery Board in its place. Under the Act the Board came to consist of nine members,

[1] 45 and 46 Vict. c. 78.

of whom one was chairman (and administrative head, with a salary), three were sheriffs of Scottish sheriffdoms, and the remaining five represented various fishing interests. All these members were nominated by the Crown. Several later Acts conferred additional powers: the Sea-Fisheries (Scotland) Amendment Act of 1885[1] gave powers to prohibit or restrict any method of fishing in the territorial waters, and powers to institute, and resources to carry on, scientific investigations. The Herring Fishery (Scotland) Act of 1889[2] gave powers to close all the territorial waters by by-law against beam-trawling, and excluded a number of areas lying outside the three-mile limit. The Sea-Fisheries Regulation (Scotland) Act of 1895[3] altered the constitution of the Board, which now consists of seven members—a chairman, a sheriff, a "person of skill in the branches of science concerned with the habits and food of fishes," and four other members. This latter Act gave powers to create sea-fisheries districts as in England, and it also enabled the Secretary for Scotland, the Minister to whom the Board was made responsible, to appoint a scientific superintendent to institute and conduct such investigations relating to the fisheries as the Board might from time to time require.

The actual administration of the fishery laws is

[1] 48 and 49 Vict. c. 70.
[2] 52 and 53 Vict. c. 23.
[3] 58 and 59 Vict. c. 42.

carried out in Scotland by the officials of the Board, who are the secretary, the general inspector, two assistant inspectors, and a staff of fisheries officers. There are twenty-six fishery districts round the coast, in each of which there are one or more officers. The officers must have been coopers by trade, and they must pass an examination before entering the service. There are five fishery cruisers belonging to the Board, and these boats are assisted generally by Admiralty vessels. The cruisers undertake marine superintendence at sea: they enforce the by-laws which close the territorial waters against trawling (except in one or two restricted areas); they maintain order among fishing boats at sea in virtue of the powers conferred by the Sea-Fisheries Acts, and on the high seas in virtue of the regulations of the international conventions. They administer several special Acts relating to the herring fisheries.

The duties of the fishery officers are confined principally to the sea-coast. They see that the barrels used in the export herring trade are of the proper size; they examine and brand the measures employed in the trade between the fishermen, merchants, and curers; and they examine the herrings submitted to them, and affix the official "Crown brands" to those which they judge worthy of this distinction. The collection of statistics is made by them and by the correspondents, whose returns they supervise. They carry out the regulations of the Acts of Parliament I have mentioned so far as they can on land; they arbitrate in disputes and restore nets, gear, etc., lost and recovered; and they assist in carrying out the provisions of the Sea-Fishery Acts which deal with the registration, lighting, numbering, etc., of fishing boats. Finally (and in this respect many of them have been quite exceptional men), they aid in the conduct of the scientific investigations undertaken by the Board.

A considerable amount of scientific work was instigated by the White Herring Commissioners, and, though no regular department of the old authority existed for this purpose, some results of first-rate importance were obtained. Most of these investigations had a very practical bearing, and they seem to have been initiated as the result of complaints that the sprat fishing in the Firth of Forth was responsible for the destruction of a vast quantity of small herrings. Investigations were therefore carried out in 1836, which showed that the sprat was a perfectly distinct fish from the herring, and that the young fishes known as "sprats" were a mixture, in variable proportions, of the two species. These researches were continued from 1843 to 1847 by H. Goodsir and J. Wilson, and were extended to the elucidation of the natural history of the herring. It had been made known previously by Dr Walker[1] that the

[1] *Transactions*, *Highland Society*, 1803.

eggs of the herring were heavier than sea-water, and sank to the bottom on being emitted by the parent fish, and this fact was confirmed in these later investigations, and it was also determined that the food of the fish consisted of small pelagic crustaceans. No further work was done till 1856, when Dr Buys Ballot suggested an inquiry into the course of the great herring fishery, and the Board of Trade issued instructions for the collection of samples from all parts of the coast of Scotland, observations being made at the same time and recorded on a form revised by Professor Huxley. Much material was thus collected, but there is no record of its examination.

Several investigations were then made into the effects of trawling. Complaints were common that the trawl destroyed the spawn and fry of fishes, and Professor Allman made a number of dredgings between 1860 and 1863, with the object of determining whether or not this was the case. The demersal nature of herring ova was again confirmed in the course of these investigations, and the incubation period of the egg was found to be from twenty-five to thirty days. Two principal spawning periods were found to exist, one in the spring and the other in the autumn. These researches ceased with the agitation which originated the inquiry of the Royal Commission which reported in 1863, and no further biological work was carried out.

Another suggestion was made by Dr Ballot and given effect to, and numerous observations were made with the intention of determining what possible influence the temperature of the sea and other meteorological conditions might have on the abundance and migrations of the herrings. Certain conclusions were drawn from these observations, but the work was not continued later than 1878.

All this work, however, was of a very desultory nature, and was only done under the pressure of the various agitations which arose from time to time with regard to the alleged pernicious effects of various methods of fishing. When these agitations ceased, scientific work was again abandoned. A very different spirit actuated the Board when it was reconstituted in 1882, and was made evident in the appointment of a biologist—Professor J. Cossar Ewart, to whom the credit of the organisation of the scientific work of the Scottish Fishery Board belongs—as a member. A statement was then published in which the necessity of scientific observations was made clear. The Board was constituted for the purpose of superintending the fisheries and for taking "such measures for their improvement as the funds under their administration may admit of," and it was soon discovered "that without further information as to the habits and life-history of the food-fishes it would be impossible to submit satisfactory reports to Parliament, either as to the improvement or as to the regulation of the fisheries."[1] A scientific committee was therefore appointed, suggestions for research work were drafted, and application was made to the Treasury for funds to carry on investigations. Meanwhile several expeditions were made on the cruisers *Vigilant* and *Jackal*; various scientific men began research work; and with the funds at their disposal the Board assisted in the equipment of a marine laboratory at St Andrews, under the direction of Professor W. C. M'Intosh—an institution in which much research work of notable value was afterwards effected. It was soon found, however, that this organisation was quite inadequate, and the Board came to feel keenly: "(1) That almost everything has still to be learned regarding the habits and life-history of our food-fishes; (2) that, if provided with even limited funds, the Board, with the assistance of the officers already in its service, will be able to remove not a little of this ignorance; (3) that the fishermen, fish-curers, and the country generally are profoundly interested in the scientific as well as the practical side of the fishery industry, and are prepared to do their utmost to secure for the Board whatever may be necessary for its successful prosecution."[2]

[1] *Second Annual Report, Fishery Board for Scotland*, 1883, p. xix.
[2] *Ibid.*, p. xxii.

A further appeal to the Treasury, widely supported by Scottish fishermen, curers, merchants, and public bodies, was then made, but with no result. Nothing of importance was done until the report of the Trawling Commission was issued. Experiments and observations at sea were so strongly recommended by this body that the Treasury were compelled to act, and in 1886 provision was made for the organisation of the scientific side of the Board. A small steamer, the *Garland*, was purchased; scientific men were employed; and from this time onward scientific investigation became an integral part of the work of the Board. A great portion of this work was carried on at sea on board ship, and many investigations were made in laboratories not under the control of the Board. In 1884, however, a small station (which was destroyed by fire some years later) was erected at Tarbert, on Loch Fyne; and in 1893 a laboratory and sea-fish hatchery were established at Dunbar. Finally, in 1900 the present laboratory and hatchery at Aberdeen were built and occupied.

It is difficult to summarise shortly the large amount of scientific work which has been carried on under the auspices of the Scottish Fishery Board, and I can only indicate the chief lines along which research has been directed. When the report of the Trawling Commission came to be discussed, it was seen that there was urgent necessity for the investigation of the effects of various kinds of fishing on the abundance of fish on a fishing ground, and that this should be done was one of the chief recommendations of the Commission. It was thought that valuable results might be obtained by excluding trawl fishermen from some particular area, and observing for a number of years any effect which this cessation of fishing might have on the fauna of the ground. Certain areas off the east coast of Scotland were therefore closed by by-law, under the powers conferred by the Sea-Fisheries (Scotland) Amendment Act of 1885; definite "stations" or trawling lines were marked out on the chart; and monthly trawling experiments were made over these stations. The procedure in these experiments was to trawl on every occasion with uniform fishing gear for a certain time, and always over the same strip of ground. The fish caught were then counted and recorded, and at the same time a number of other observations—the identification of the invertebrate animals caught by the trawl; the determination of the "plankton" by "tow-net" experiments; physical determinations, such as the temperature and specific gravity of the sea-water; and meteorological observations—were made and recorded. All these observations (which are published in the Annual Reports of the Board) were collated year by year, and deductions were made as to the apparent changes in the abundance of fish which had resulted from the cessation of the method of trawl-fishing.

The primary object of these experiments, which were made continuously from 1886 till 1901, was to ascertain whether a decided increase in the abundance of food-fishes resulted from the cessation of commercial fishing. We now know that certain considerations were overlooked which have, to a great extent, invalidated the usefulness of the observations, and further, that the vessel and fishing gear employed were too small for the attainment of trustworthy results. A great number of results, many of decided economic value, and others of purely scientific interest, were obtained, however, during the observational work of the *Garland*, both on the East Coast stations and elsewhere. To the former class belong the establishment of these, among other facts: (1) the rate at which fishes grow; (2) the size and age at which sexual maturity—that is, the stage at which the fish spawns for the first time in its life—occurs; (3) the fecundity of fishes, or the number of eggs produced during each season by the mature females of each species; (4) the migratory movements of fishes; (5) the time of the year during which spawning occurs in each case; (6) the distribution of fishes with respect to depth, nature of ground, etc., and at different periods in their life-history; and (7) the food of fishes. To the purely academic class of facts belong the determination of the bottom and pelagic faunas of the fishing grounds; and as an instance of this kind of work I may mention the long series of papers by Dr T. Scott on the crustacean fauna of the Firth of Forth and other areas.

We understand by the life-history of a fish or other marine animal the knowledge of the series of stages through which it passes, from the time when it is spawned until the time when it becomes a sexually mature creature. The initiation of this department of ichthyological research is usually credited to Professor G. O. Sars of Christiania, who made out the life-history of the cod about 1864; but some facts of this kind were known, with respect to the herring, at the beginning of the nineteenth century. Very little, however, had been done at the time when the scientific work of the Scottish Fishery Board commenced, and the pioneer worker was Professor M'Intosh of St Andrews, who carried on investigations for the Board after its formation in 1882, and who was its scientific member from 1893 till 1895. It is not too much to say that to him and his pupils we are indebted for a very large part of our knowledge of this subject.

Physical and chemical research at sea, that is, the determination of the periodic changes in the temperature, salinity, specific gravity, etc., of sea-water, the direction and causes of ocean currents and drifts, and the nature of the sea-bottom, began in this country with the famous voyage of the *Challenger*, and was first taken up in relation to sea-fishery matters by the German Kiel Kommission. The importance of this kind of investigation was from the first seen by the Scottish Fishery Board, and several expeditions were made with this object in view. Such work formed a regular part of the routine investigation of the *Garland*, and within the last few years, when trawling experiments were practically abandoned, physical research has become for the time the most important part of fisheries observations.

Finally, I have to mention two directly economic departments of the Board's work: the collection of commercial fisheries statistics and the artificial cultivation of sea-fish. The collection of statistics has been carried out by the Scottish authority since the beginning of the nineteenth century. For a long time only statistics relating to the herring fishery were collected; but very soon after its reconstruction in 1882 the system was applied to other sea-fisheries, and at the present time it is the most perfect fishery statistical system in existence in any part of the world. The information thus obtained has been of the greatest value in sea-fisheries administration, and this department alone of the Board's work has amply justified all the expenditure in relation to Scottish fisheries.

Economic fish-hatching was first practised in Great Britain by the Scottish Fishery Board. I shall discuss this subject later on, and it is sufficient to state in the meantime that opinion differs very much as to its public utility.

Many scientific researches other than those I have indicated have, of course, been undertaken by the scientific staff of the Board, or by investigators working at their suggestion, and it would take too long even to summarise the objects aimed at and the results obtained. Anyone who glances through the scientific reports issued during the last twenty-three years will recognise that the Board have interpreted their duties liberally and wisely, and have not only done their best for the encouragement and administration of the Scottish fisheries, but have, in a truly catholic spirit, sought to obtain all the information possible with respect to the important industry committed to their charge.

CHAPTER VII

FISHERIES ADMINISTRATION IN ENGLAND

An active administration of the sea-fishing industry, such as I have just described for Scotland, did not come into existence in England until comparatively recent times; and even at the present day the fishery authority in the latter country is a much less active body, and with more limited functions, than in the sister country. Why this should be the case is difficult to make out, and one can only suggest reasons. The constitution of the Scottish Fishery Board is almost unique in this country among authorities exercising considerable powers of regulation, and it is perhaps the case that its "semi-private" status, and its practical freedom from matters of departmental routine, has preserved it from that condition of mediocrity which is so characteristic of the English central authority. Then in England there has not been in modern times any system of bounties or other protective aids, round which, as in Scotland, the general administration of the fishing industry might centre. Finally, the influence of the Royal Commission of 1863, which discouraged so strongly all attempts at the regulation of fishing, was more strongly felt in England than in Scotland, and no doubt had considerable effect in retarding the growth of a central authority.

The Sea-Fisheries Act of 1868, which gave effect to the recommendations of the Commission of 1863, provided for the regulation of the sea-fisheries only so far as the preservation of order or the interests of the navigation of fishing boats were concerned. It gave the Crown power to make Orders in Council for carrying out the matters referred to in the Act. These were: the policing of the territorial waters in the interest of the exclusive fishing rights of British subjects; the registration, lettering, numbering, and lighting of fishing boats; and generally all matters connected with the actual conduct of fishermen at sea, but apart from the actual regulation of the methods of fishing. It provided for the constitution of corporate bodies with rights of "several fishery," that is, the exclusive privileges of fishing on limited portions of the foreshore or sea-bed. It also attempted to provide for the international regulation of the deep-sea fisheries. Commissioned officers of H.M. ships, British Consular officers, and officers of Coastguard and Customs had powers to carry out the provisions of Orders made under the Act of 1868.

But there was no actual supervisory staff or fisheries office, and it was not until 1886 that such was created. The Salmon Fishery Act of 1861 had made somewhat elaborate provision for the regulation of the fresh-water fisheries, and placed their general superintendence under the Home Office. Two inspectors were appointed, who (with the local "conservators or overseers for the preservation of salmon"), were entrusted with the task of carrying out the provisions of this Act. One of the duties of these officials was to prepare and lay before Parliament an annual report containing a "Statistical Account of the Fisheries, with such other information as may be collected, and suggestions for their regulation and improvement." This was the germ of the English central authority. In 1886, the Salmon and Fresh-water Fisheries Act transferred these inspectors from the Home Office to the Board of Trade, and at the same time extended the provisions of the Act of 1861, so far as this concerned the preparation of reports, to the sea-fisheries. From 1886 to 1903 the Board of Trade contained the department entrusted with the regulation of the fisheries. During the last few years of the nineteenth century the condition of this department seems to have become very unsatisfactory, and, in response to a widespread demand for its reform, another transfer took place in 1903, and the Board of Agriculture and Fisheries became the department responsible for the superintendence of the English sea-fisheries.

We have to consider not only a central but also a local regulation of the English fisheries. This latter was provided in 1888. Apparently it was on account of the satisfaction experienced by the Government of the time in having passed the Local Government Act of that year, that the same principle was applied to the regulation of the fisheries. There was no precedent for such a course, and there were strong reasons why the system in existence in Scotland should also be applied to England, as had been suggested by the Trawling Commission of 1885. The Sea-Fisheries Regulation Act of 1888, however, led to the establishment of a series of local fishery authorities, to whom the actual regulation of the English industry was committed. Under this Act, and two others—the Sea-Fisheries Act of 1891, and the Sea-Fisheries (Shell-fish) Regulation Act of 1895—the English system of sea-fisheries regulation grew up. These Acts gave the county and borough councils powers to establish Local Fisheries Committees for the regulation of the industry in defined areas. On application by one or more of these authorities, the Board of Trade (and from 1903 the Board of Agriculture and Fisheries) had power to issue an Order for the creation of a district committee, and define the area of sea-coast and sea under the jurisdiction of the latter. Usually this area is that portion of the sea out to the three-mile limit adjoining the littoral of a single county, or of several such areas, in which latter case the committee is a joint one. Each committee consists of a certain number of members representing the county and borough councils within the contributory area, and of at least an equal number of members nominated by the central authority, and representing various fishing interests. This latter category of members includes representatives of the local Boards of Salmon Conservators, fishermen, fishing-boat owners, merchants, and others. Each Local Fisheries Committee obtains the money necessary for carrying out the provisions of the Sea-Fisheries Regulation Acts and other enactments by a local rate raised by the rating authorities within the area represented.

A local committee is not in itself a legislative body. It may draft by-laws providing for the regulation of the fisheries under its charge, but before acquiring legal force these by-laws must be confirmed by the central authority. A by-law, on being suggested, is advertised and submitted to the Board, and the latter may at once confirm or reject it; but usually a local inquiry is held by an inspector, and as a result of this, the Board either confirms, or rejects, or suggests modifications of the proposed regulations. On confirmation of the by-law the local committee has powers to enforce its provisions and to exact penalties for their contravention. The principal matters embraced by the by-laws in force in the fishery districts are :—

1. Regulation of the forms and dimensions of fishing nets and other apparatus, including the restriction or prohibition of methods of fishing which are regarded as objectionable ;

2. Regulation of the seasons of the year during which defined methods of fishing may be practised ;

3. Regulation of the sizes below which shell-fish (molluscs and crustaceans, but not sea-fish) may be removed from a public fishery ;

4. The (nominal) prohibition of the discharge into the sea of sewage and other substances regarded as detrimental to the health of sea-fish or shell-fish, or the practice of sea-fishing.

In order to carry out the provisions of these by-laws, the local committees may appoint superintendents and fishery officers, and may provide and maintain vessels for the purpose of marine superintendence.

The by-laws made by the local committees are of course rather varied, since local conditions affect the general nature of the administration differently in many places. Those of the Lancashire and Western Sea-Fisheries Committee (abstracted in Appendix IV.) illustrate very well their general nature. Speaking generally, the by-laws are directed towards the restriction of trawling,[1] the regulation of the sizes and meshes of fishing nets, and the minimising of the capture of undersized and immature sea- and shell-fish. Thus, steam trawling vessels are absolutely forbidden to fish in the English territorial waters, and even sailing trawlers are not allowed to fish in the Northumberland territorial waters. In most other districts there are considerable restrictions on trawling: defined areas may be closed entirely, or for a certain portion of the year, against this method of fishing. Where it is allowed, the regulations in force may limit the size of the trawl-beam, or that of the meshes of the net; or trawling may be allowed, subject to the provisions that the hauls are of limited duration, and that the net be raised and cleared, and undersized fishes returned promptly to the sea. Shrimp-trawling is subject to many restrictions, and in some cases is absolutely forbidden. All these regulations are based on the current belief that trawling in territorial waters, whether for sea-fishes or shrimps, destroys great numbers of immature fishes, and that its unrestricted practice is detrimental to the permanence of the local fisheries.

Many committees regulate the fishing for shell-fish, that is, oysters, mussels, cockles, shrimps,

[1] See the chart in the *Report of the Select Committee* (*H.L.*) *on the Sea-Fisheries Bill*, 1904. This represents graphically the areas of coast where trawling is prohibited or restricted.

prawns, crabs, and lobsters. Very full powers are conferred on them for this purpose by the Sea-Fisheries Regulation Acts and by the Sea-Fisheries (Shell-fish) Act of 1877. Certain sizes for molluscs, crabs, and lobsters are laid down, under which it is illegal to remove the specified shell-fish (usually oysters, mussels, cockles, crabs, and lobsters) from a fishery. Crabs and lobsters may not be taken, except for bait, when "soft," that is, when the animal has cast its hard shell or exoskeleton. Close seasons are prescribed for oysters and mussels, and periwinkles in some cases. Finally, the kind of apparatus used for catching these animals may be defined, and certain objectionable forms may be prohibited entirely. Local fishery committees may also spend public money in restocking a public fishery for molluscs or crustaceans, and they may also undertake the artificial culture of these fish. The object in these regulations is to prevent the capture of immature or breeding shell-fish, and to provide for the maintenance of a sufficient stock on the fishing grounds, so as to ensure the permanence of the fishery.

The powers of regulation possessed by the local fishery committees are therefore ample, but in some respects they are curiously limited. Thus, they have no powers to restrict or to interfere in any way with the methods of fishing in the areas under the jurisdiction of the Boards of Salmon Conservators, or in those cases, which are not uncommon, where the fishing rights of a certain area belong exclusively to some person or corporation, in virtue of any local or special Act of Parliament, or of a Royal Charter, or by right of immemorial usage. In such cases the consent of the persons enjoying the exclusive fishing right must be obtained before the by-laws of the committee, in the area administered by which the fishing occurs, can be enforced. With respect to the matters which may form the subjects of by-laws, there are several curious exceptions. Thus, shell-fish may be cultivated and fisheries may be stocked, and scientific experiments ancillary to those objects may be made; but with regard to sea-fishes proper these powers do not exist. Again, a local committee may impose a legal limit on the sizes of shell-fish which may be fished for, but not on those of sea-fish. There is what is apparently a very salutary provision in the Sea-Fisheries Regulation Act of 1888, which enables a committee to take steps to prohibit the discharge of sewage or other matters into the sea, if such substances should prove detrimental to sea-fish or sea-fishing. Most of the committees have obtained a by-law to this effect, but this provision has turned out to be more ornamental than useful. A saving clause forbids interference in such cases where the sewage, etc., is discharged in virtue of the powers conferred by any local or general Act of Parliament. Now, since the Board of Trade have held that the Public Health Act of 1875 conferred such a right, it happens that in most, perhaps in all, cases the by-law is inoperative. Again, the committee may only interfere when it can be proved that the discharge of a noxious substance in the neighbourhood of a fishery is prejudicial to the health of the shell-fish or other animals concerned, but not if the same contamination of a fishery should be prejudicial to the health of persons using the fish as food. At present, our knowledge of the physiology and pathology of marine animals is so slight, that satisfactorily to prove the detrimental effect of sewage or other waste liquids is in most cases very difficult, or even impossible.[1]

Then with regard to scientific research the local committees are in a most unfortunate situation. There is no provision in the Sea-Fisheries Regulation Acts enabling them to expend public money for this purpose, except in so far as the investigations are undertaken with the object of stocking a shell-fishery. It has happened frequently that scientific investigations would have proved most useful in some question of regulation, but the machinery for the prosecution of such has not generally been in existence. Several of the fishery committees, it is true, have a scientific staff. Such was the case in Cornwall and in

[1] An examination of the Statutes relating to the public health and to the fisheries will show that there is, at the present time, no real prohibition of the pollution of a public sea-fishery by sewage.

Devon, and at present it is the case in Northumberland, and notably in Lancashire. In the case of the latter authority there are two marine laboratories where scientific investigations are carried on; a small scientific staff is employed, and the vessels and officers of the committee assist in such work. This organisation has been made possible only by the assistance of the former technical instruction committees of the counties and boroughs, and by the provision in the Act of 1895 which legalises the expenditure of public money on investigations connected with the culture of shell-fish. These provisions are, however, far from being satisfactory, and it must be confessed that the amount of scientific work which has been carried on by the local committees is paltry and inadequate in comparison with the value of the industry concerned. The provision for the collection of fishery statistics is also very unsatisfactory. This is work which could be performed very well by the local organisations, especially in regard to those small fisheries which are only of local importance, but which may nevertheless be the object of much solicitude. The Act of 1888 does empower the committees to collect statistics, if required by the central authority, and with the assistance of money provided by Parliament. But hitherto such assistance has not been provided.

On the whole, then, the system of local regulation of the fisheries, as originally contemplated by the Sea-Fisheries Regulation Acts, cannot be said to have been very successful. It is obvious, when one considers the conditions of the fishing industry, that the area of administration is much too limited. Overlapping of interests must continually occur, and there is not necessarily any co-ordination between contiguous authorities. Then it is the case that the rateable value of some of the districts is too small to allow of the upkeep of an adequate inspection staff. These considerations have been instrumental in leading to the amalgamation of authorities in some cases, as in that of the Lancashire and Western District Committee, which includes not only Lancashire, but also Cheshire and most of the Welsh maritime counties. This general tendency may be observed, and there is little doubt that the fisheries would be much better regulated by authorities representing groups of counties than by committees of the councils of each of those areas. This amalgamation of the district authorities was the plan suggested by the Committee on Ichthyological Research for the purpose of scientific investigation. Where it has taken place, the administration has been most successful. As a result of the amalgamation of authorities in some cases, the work of the committees is very unequal, as a glance at the last report of the inspectors of fisheries for England and Wales will show. Thus, the Lancashire authority has an administrative staff consisting of a superintendent and about thirty fishery officers, and is provided with a steamer and some half-dozen sailing cutters for police superintendence at sea. There is also a scientific staff, consisting of an honorary head and two assistants, with the usual laboratory aid. The income of the Committee in 1902 was £7717, and there were seventy-four convictions for infractions of the by-laws. Compare with this the condition of the Glamorgan District during the same year, when the income was only £241, the administrative staff consisted of one officer, and no convictions at all were obtained.

It is generally agreed that the system under which the regulation of the fisheries is obtained by rates levied on the maritime counties is not altogether a fair one. There is at first sight something to be said in favour of the argument that the expense of administration of an industry like sea-fishing should be borne by the areas immediately benefited. But it appears much more reasonable to argue that, since the whole country benefits by the labour of the fisherman, by receiving cheap and abundant food, the task of sustaining and developing the industry should not be left in great measure to the maritime counties, but should be provided for from Imperial sources. It is at any rate an anomaly that such purely inland centres as Manchester or Blackburn should be charged with this expense, while London and Bristol should be exempt.

The practical working of the committees has shown that their constitution is open to grave criticism. There is no guarantee of continuity of policy in respect to principles of legislation. Though one is inclined to defer to the principle of representative government in the case of the fisheries, as in most other things, it is nevertheless the case that, in placing the regulation of the fisheries under an indirectly elected representative authority, we thereby set up an administrative machine which is at once unwieldy and unnecessary, and which in many cases makes the administration the object of insincere and semi-political agitation.

The constitution of the English central authority is not less unsatisfactory than that of the local committees. Until a comparatively short time ago this authority was a sub-department of the Board of Trade, which consisted practically of an assistant secretary, and of three inspectors of fisheries. This department is not directly concerned with the actual regulation of the industry, but exercises a kind of supervisory control over the working of the sea-fisheries committees. A great portion of its work consists of the administration of the Acts relating to the fresh-water fisheries, and this forms the subject of a separate official report. The function of the Central Fisheries Department may be gathered from a perusal of the annual reports of the inspectors. Much of the work of the department consists in holding local inquiries either into the necessity for new by-laws proposed by the local committee, or in the consideration of applications for Orders conferring rights of "several fishery." For the rest, the annual reports form presumably the statutory statistical statements regarding the sea-fisheries which are demanded by the Acts of 1871 and 1886. They contain accounts of the working of the Sea-Fisheries Acts giving effect to the International Conventions, and of those provisions of the Merchant Shipping Acts which refer to fishing boats. Returns from the local committees are published, and a summary of the returns made by the collectors of fishery statistics is also appended: in the latter one may glean such information regarding the weather as this: "The usual weather has been experienced, but nothing remarkable"; or regarding the fisheries, that they were good, and on the whole better than in previous years.

The principal defect in the constitution and working of the central authority lies in what one may call its intelligence department. Apparently the routine matters dealt with above have in the past absorbed the whole time of the staff, and there has been neither opportunity nor inclination for original observation of the conditions of the fisheries. It must have happened frequently that highly technical questions have been submitted to the officials of the department, and apparently there have been no resources available for the study of these. It is true that the Treasury makes an annual subsidy to the Marine Biological Association of from £500 to £1000, on condition that the scientific men in the service of the Association should advise the Board on fishery matters, should occasion arise. I am not aware, however, that this advice has often been invited. There is everything to be said for the employment, under the Board, of scientific men with a special knowledge of the conditions of the fisheries, who might undertake the investigation of any questions arising in the consideration of the working of the local committees, or in the preparation of legislative remedies. This defect in the constitution of the Board has been noticed very frequently in the various reports of public inquiries into the fisheries. "As regards investigation," reported the Select Committee of 1900, "your Committee feel that the materials for forming a just conclusion upon such matters are not what they might be. . . . Your Committee were particularly struck by the fact that not only is there much doubt as to the precise position of foreign law in regard to restrictive legislation affecting fisheries and its result, but that upon the question of what has been achieved in the United States of America certain information is not easily available."[1]

Since 1903 the control of the fisheries has been tranferred from the Board of Trade to the Board of Agriculture. When this was suggested, hopes were entertained that the central fisheries authority would be provided with the means for investigation, so that they might form independent judgments respecting the necessity for changes in the law relating to fisheries, or for any other purposes. This has not apparently been provided for, and the present Fisheries Department at the Board of Agriculture is not much more satisfactory in this respect than when it was at the Board of Trade.

[1] *Report, Select Committee of* 1900, p. v.

CHAPTER VIII

THE SEA-FISHERIES OF IRELAND

There is thus a marked contrast between the manner in which the fisheries have been administered in the northern and southern parts of Great Britain. In Scotland the authority has always been (in modern times) a strong and active one, exercising a vigilant control over a continually growing industry, and enjoying a relatively liberal measure of State support. Such an authority never existed in England, and it is only during the last fifteen years of the nineteenth century that the supervision of the national sea-fisheries has been attempted; and even now the central authority is by no means so powerful or well equipped as the corresponding Scottish body. The weakness of the English administration has, however, had little effect on the development of the fisheries, for the natural energy of the people, the wealth of the country, and the comparatively hospitable character of the English coast, both on the North Sea and in the Channel, were advantages which more than compensated for the lack of regulation or the absence of bounties or other artificial means of encouragement. In most respects Ireland offers a strong contrast to the conditions in the sister kingdom, and the history of her fisheries is a curious and instructive study, into which I can enter only very briefly. Although a central authority, possessing relatively large powers of regulation, has nearly always existed in modern times, yet the administration has until quite recently generally been characterised by apathy or even abuse. There has been no continuity in the policy of this authority, and State support has been alternately given and then withdrawn. And to these causes of depression are to be added the general poverty of the people, and economic changes without parallel in either England or Scotland.

Apparently there has always been abundance of fish off the Irish coasts, so that the limited development of the fisheries is not to be traced to natural causes. There are, of course, no statistics prior to the beginning of the nineteenth century which might give us any notion of the extent of the fishing, but there are other indications that the seas had abundant natural resources. From the time of the Norman Conquest to the beginning of the seventeenth century, the English sovereigns derived a considerable revenue by granting licences to fish in Irish waters. Thus the Dutch gave Charles I. £30,000 for permission to fish off the west coast, and

Philip II. of Spain agreed to pay £1000 per year for the privilege of fishing off the north coast. In 1650, again, Sweden, in return for certain services rendered to England, was permitted to send 100 vessels to take part in the fishing in Irish waters.[1]

There is unfortunately little doubt that, in many instances at least, the development of the Irish fisheries was intentionally discouraged by the English Government. During the Commonwealth, various petitions were presented to Parliament, praying that the Irish fisheries might be discouraged in some way, because of the injury which the competition of the fishermen there was inflicting on the trade of England, especially with Spain and the Straits. One such supplication stated that sometimes as many as 200 vessels from Holland, France, and England might be seen at Wexford, taking cargoes of fish from Irish fishermen. If this continued, the petition stated, it would be folly to catch herrings in the English Channel, since the cost of a barrel of this fish there was double what it would be at Wexford. Apparently this request was complied with, for according to Prendergast,[2] the Irish fishermen were to a great extent exter-

[1] See *Report on the Coast and Deep-sea Fisheries of Ireland*, by the Royal Commissioners on Irish Oyster Fisheries, 1870; also a rather scarce pamphlet by J. A. Blake, entitled *The Present Position of the Sea-Fisheries in Ireland, and how they may be made to afford Increased Food and Employment* (133 pp.; *Citizen* Office, Waterford, 1868).

[2] *Cromwellian Settlement of Ireland*, 1865.

minated by the transplanting laws. By the beginning of the nineteenth century the fisheries were evidently in great need of encouragement. In 1804 the Marine Society of London promoted a scheme to fish on the Nymph Bank, off Wexford. No aid was sought from the Government, but a Bill was introduced into Parliament. Petitions, however, poured in from English fishing stations, including Harwich, Gravesend, and Faversham, and in consequence of this opposition the Bill was lost by a small minority.

We have seen that a very thorough-going system of protection by means of bounties on the tonnage of fishing vessels, and on the catches made, was initiated in Great Britain in 1809. This affected Scotland principally, for it was there that the herring fisheries were most in need of artificial aids. But though this encouragement was at least equally necessary in Ireland, where the sea-fisheries had declined ever since the Union, it was not until 1819 that it was attempted. In that year an Act[2] was passed providing for the establishment of a fisheries authority and a bounty system on the coasts of Ireland. A Board was created, consisting of twenty unpaid commissioners, with a secretary, three clerks, and twenty-four inspectors (involving an annual expenditure in salaries of

[1] *Report on the Coast and Deep-sea Fisheries of Ireland*, 1870.

[2] 59 Geo. III. c. 109.

about £3249). The functions of this Board were to administer the bounty fund, to improve and construct fishing harbours, and to give loans to fishermen for the purchase of boats and gear.

The principal bounties were :—£2, 10s. per ton on vessels over 15 and under 60 tons burden ; £3 per ton of whale-oil ; 3s. a barrel on herrings, pilchards, and mackerel cured according to the regulations of the Board (this was not paid to vessels earning the tonnage bounty) ; and 4s. per cwt. on dried cod, ling, hake, haddock, "glassen," and conger.[1] "Under the operation of this system a great increase in the activity of the trade was experienced, much capital was drawn to it, and large sums were circulated among fishermen, curers, etc."[2] The fishery began to assume respectable dimensions. The statistics for the period during which the bounties were in operation are :—

	Vessels.	Men.	Bounties.
1819	27	188	£573
1820	119	755	4,260
1821	4,889	21,422	14,150
1824	10,882	52,482	30,642
1826	10,823	57,809	18,719
1828	12,126	59,321	12,162
1829	12,611	63,642	10,203

[1] *Report of the Commissioners of Inquiry into the State of the Irish Fisheries*, 1837. The "glassen" is the "coalfish" (*Gadus virens*).

[2] *Ibid.*, First Report, p. x.

The catches of fish during the same period show corresponding increases. In 1819 the export of dried fish was 40 tons, and this rose to 3019 in 1829. Herrings in 1819 amounted to 1193 barrels, rising to 16,855 in 1829. Of the fishing vessels registered in the latter year, there were :—

218 decked vessels of an average tonnage of 28,
769 half-decked " " " 12,
2483 open sailing boats, and
9522 rowing boats ;[1]

figures which contrast very favourably with those for 1901. The fisheries were therefore in a very respectable condition, and this in spite of the gross abuses, the errors of management, and the flagrant jobbery of the administration.[2] It was, in fact, according to Mr J. R. Barry (for long an Irish inspector of fisheries), "a period of unexampled prosperity."

It can, of course, be argued that the development of the fisheries during the period 1819–1829 was illusory, and depended entirely on the payment of the bounties. This line of argument has, indeed, been adopted, both with regard to the Irish and the Scottish bounty systems, by those who are opposed on economical grounds to the principle of protection. It is true, no doubt, that the progress of the fishery depended to some extent on the payment of the bounties; for, when the latter were reduced in 1824, the

[1] *Report on the Coast and Deep-sea Fisheries of Ireland*, 1870.
[2] *Ibid.*, p. 9.

statistics showed a decided decline in the numbers of men and boats employed; and a few years later, when they were withdrawn altogether, they showed a further decrease. But they rose again, showing that the industry had become established; and there seems little doubt that, but for a series of lamentable events, the bounties would have conferred permanent benefit on the Irish fishing industry.

The Scottish bounty system was discontinued in 1830. But though after that year no further payments were made on the tonnage of fishing vessels or on the catches and exports of fish, the whole establishment of the British White Herring Commissioners, with its system of regulation, inspection, statistics, and brands, was continued. Every chance was thus afforded for the impetus which the bounties had given the fishery becoming permanent, and an annual sum of £3000 was still paid the Commissioners for the erection and improvement of fishing harbours. Altogether, a sum of £927,110 had been paid away in bounties to the Scottish fishermen. In Ireland, on the other hand, where the need of encouragement of the fisheries was still more pressing, only £163,376 had been spent in bounties, and when the latter were abolished, a few years after their cessation in Scotland, a very different course was pursued, and the whole fisheries establishment was practically abolished. The Commissioners remonstrated, but to no avail. The Irish Fishery Department became a nominal branch of the Board of Inland Navigation, and, for all practical benefit it could confer on the fishing industry, ceased to exist. A period of depression followed, and in 1835 the state of the industry had again become such as to call for the appointment of a Royal Commission of Inquiry.

This body reported in 1837, and a Bill was introduced in 1838 by the Chief Secretary (Lord Morpeth) and the Attorney-General (Mr Serjeant Wolfe), to give effect to its recommendations. Apparently the prospect of further encouragement of the Irish fisheries proved alarming to fishermen in Scotland, and adverse influences were brought to bear against the Bill. It was apparently regarded as unfair to the latter country that the bounty system should be re-introduced into Ireland after it had ceased in Scotland. The Bill was committed for 16th May 1838, but was deferred three times a week till 23rd July. On the day before that date a deputation from Scotland, headed by the Duke of Sutherland, waited on the Government and protested against the proposals of the Bill. On the following day the latter was abandoned. "There was every reason to justify the belief that the interests of the Irish fisheries on that occasion were sacrificed in order to appease the jealousy of Scotland."[1] No action was then taken until 1842, when an Act of that year[2] trans-

[1] See *Report on the Coast and Deep-sea Fisheries of Ireland*, 1870, p. 8.

[2] 5 and 6 Vict. c. 106.

ferred the superintendence of the fisheries to the Commissioners of Public Works, and gave this body almost absolute powers to make by-laws for the regulation of methods of fishing, both in the sea and in inland waters. Whether or not the creation of this authority had any effect on the development of the fisheries is uncertain, but at any rate the industry now began to improve a little.

Then came the great potato famine of 1847. Whatever benefit the legislation I have alluded to may have had on the fisheries was nullified entirely by this great calamity, and the Irish fishing industry received a shock from which it has never recovered. The immediate effect of the famine may be summarised in the following table[1] :—

		Vessels.	Fishermen.
1830	Fisheries under stimulus of bounties and loan funds . . .	13,119	64,771
1836	Fisheries under depression caused by withdrawal of bounties .	10,761	54,119
1845	Fisheries immediately before the famine .	19,883	93,073
1848	Fisheries immediately after the famine .	15,932	70,011
1865	. . . . . .	9,300	40,946

[1] *Report of the Royal Commission on the Sea-fisheries of the United Kingdom*, 1866.

Thus, during the twenty years following the famine, the number of boats and fishermen was diminished by more than one-half. There was no question of a decrease of fish, nor were there any other natural events which could be held accountable. The sole causes of the decline of the fisheries were the impoverishment of the coast population resulting from the effects of the famine, and the loss of a great part of the market for the fish. Then the emigration following the famine contributed further to the depression of the fishing industry. "It might have been anticipated," reported the Commissioners of 1866,[1] "that during the famine the fishermen at least would be secure from its ill-effects, and would not only have plenty of food themselves, but would be the means of averting starvation from others. But this was not the case. It was found that the people would not live wholly on fish, nor would they, out of the small means remaining to them, buy fish in preference to meal or potatoes; the fishermen, therefore, suffered not only from the loss of their own crops of potatoes, but from want of market for their fish. They shared to the full extent in the sufferings of the famine, and as most of them became physically incapable of going to sea, it was frequently found that men were starving when fish were in abundance on the coast. In many

[1] *Report of the Royal Commission on the Sea-fisheries of the United Kingdom*, p. 24 (the 8vo edition).

parts of Ireland the fishing population has not yet [1868] recovered from the depression and ruin caused by the famine ; and the subsequent emigration, by taking off the youngest and ablest of the fishermen, and leaving behind the old, the feeble, and the incompetent, has still further operated, not only in reducing the numbers, but in lowering the average condition, of those who remain behind."

"Multitudes had to part with their boats and gear for anything they could obtain, to procure the means of appeasing the hunger of themselves and their families. At last nothing would be advanced on boats and materials, and a large amount of both rotted on the beach."[1]

The result of these disastrous events was, therefore, that when the Royal Commission of 1866 came to report, they had to point out the striking contrast between the state of the fisheries in Great Britain and Ireland. While in the former countries the industry was everywhere in a flourishing condition, and gave every sign of indefinite expansion, everything in Ireland indicated great depression and want of prosperity. Even the small numbers of fishermen and boats for 1865 gave an exaggerated impression of the state of the fisheries. Very few indeed of the persons returned as fishermen lived entirely by fishing. At some places, such as Dungarvon, Waterford, and Kinsale, they were real fishermen ; but almost all

[1] *Report, Royal Commission on Irish Oyster Fisheries*, 1870.

the rest were small farmers who fished only at irregular intervals and in a casual manner, and at the time when fishing would probably have been most successful they were mostly attending to their farms.[1] It was a case for some exceptional kind of State encouragement. Nevertheless, the Royal Commissioners of 1863, influenced, no doubt, by the prevailing Free Trade doctrines of their time, made no specific recommendation. The industry was left to work out its own salvation, and the legislation in force was allowed to perpetuate a system of entirely futile and unprofitable administration.

There was, indeed, little left to administer. The Commissioners of Public Works, who had charge of the fisheries under the Act of 1842, had extensive powers. They were enabled to impose any restrictions or prohibitions in relation to methods of fishing which they regarded as necessary. They had, in fact, "an almost absolute authority to make regulations with respect to the different modes of fishing"[2] carried on in Ireland, presumably with the object of the development of the industry. How did they employ this power? It must be remembered that they had to deal with an ignorant people, who were intolerant of innovation, and who were not averse to indicating this spirit in a lawless fashion. Methods of fishing

[1] *Report, Royal Commission of* 1863, Evidence, Q. 37,334.
[2] *Ibid.*, *Report*, p. 110 (8vo edition).

were poor, and capable of great improvement, but such attempts were usually resisted. Trawling was introduced into Galway before 1820, but failed, on account of the violence with which the prejudices of the native fishermen manifested themselves.[1] It was again attempted on a larger scale in 1852, and, though opposed by complaints, intimidation, and actual violence on the part of the Claddagh fishermen, was persisted in until 1863. Then the latter men took the law into their own hands, and by violence and intimidation prevented the trawl-owners from exercising their legal rights of fishing. Boats and gear were then rendered idle, and a memorial[2] presented to the Lord Lieutenant (Lord Carlisle) by the fishermen, "the magistracy, the gentry and inhabitants" of the Claddagh, in Galway, prayed for the suppression of this method of fishing. This was in 1863, and when the Royal Commission of that year came to inquire into the question, they were compelled to hear the evidence of the trawl-owners privately, as the latter persons alleged that they were in "bodily fear" should their views be expressed publicly.[3]

In these circumstances, the spirit of the administration is easily intelligible. No apparent attempt at the real encouragement and improvement of the fishing industry seems to have been attempted.

[1] Hardiman, *History of Galway*, 1820.
[2] Quoted in *Report, Royal Commission of* 1863.
[3] *Report, Royal Commission of* 1863, p. 45 (8vo edition).

The Commissioners made many by-laws, most of them prohibitions or restrictions of trawling in certain localities, and in deference to local prejudices: regulations which most probably in many cases only served to retard the development of the industry, though no doubt they prevented for the time local agitation and disputes. The duties of the department seem to have been confined to the elaboration of these local restrictions. Beyond this, their policy was one of non-interference with the course of the industry. The "Inspecting Commissioner" of the Board found it somewhat difficult to inform the Commission of 1863 what his duties actually were. He had "to carry out the directions of the Board; their policy was to do as little as possible, but to preserve peace if possible." "To be candid," he said, "I have at times considered that our department was a species of delusion. We were supposed to be the persons having charge of the sea-fisheries of Ireland. Our duties, though strictly observed, according to the instructions given in the Act, were mistaken by the public. It was believed that we were to be the encouragers of the fisheries, and many persons, who perhaps felt that that duty would have devolved upon themselves as proprietors, looked to us as the parties whose duty it was to do that which we thought we had no right to do."[1]

[1] *Report*, *Royal Commission of* 1863, Evidence, Qs. 37,014 and 37,050.

Under this system of administration the sea-fisheries of Ireland have on the whole declined from the time of the Royal Commission of 1866. I give the returns of the numbers of vessels, men, and boys engaged in the industry since 1865, for each fifth year:—[1]

	Vessels.	Men and Boys.
1870	8999	38,629
1875	5919	23,108
1880	6459	24,348
1885	5667	21,491
1890	5655	21,987
1895	6551	25,085
1901	6561	26,161

Even these figures, discouraging though they be, do not represent the real depression and poverty of the industry. Of the vessels engaged in 1901, only twelve were steam trawlers; the majority of the second-class sailing boats were less than ten tons in net register, and more than half of the total number of vessels were rowing boats. In 1901 this fishing population landed on *all* the coasts of Ireland fish of all kinds of a total value of £374,109.[2] Long-line fishermen in the same year earned, on the average, from 20s. per week

[1] Taken from the Annual Reports of the Inspectors.

[2] In 1902 the quantity of fish (exclusive of shell-fish) landed on the coasts of Ireland was 556,868 cwts., worth £296,606.

(at Kinsale, for about thirteen weeks) to 2s. 6d. per week (at Queenstown, for fourteen weeks).[1]

Now contrast these figures with those for the west coast of England and Wales.[2] The Board of Trade statement gives the total value of the fish landed on that coast as £772,245; of this amount, £299,288 represents the value of the fish landed at one English port (Milford) alone, a figure which is not far short of that representing the value of the whole of the Irish industry. There is no question here of unfavourable natural conditions so far as Ireland is concerned. The seas off the west and south coasts of the latter country have been described as a "mine of wealth," and though this estimate of their value is perhaps to be discounted, it is no doubt the case that these areas are capable of an enormously greater exploitation than they at present undergo. Fleetwood trawlers have, in fact, within the last few years exploited the Blaskets fishing grounds, off County Kerry. All the causes contributing to the depression of the industry are economic ones: the maladministration of the early part of the century; the unfortunate withdrawal of the bounties; the positive discouragement due to English or Scottish jealousy; the famine and resulting emigration, and the further

[1] *Report on the Sea and Inland Fisheries of Ireland for* 1901. Appendix No. 9, p. 46.

[2] *Statistical Tables and Memorandum*, 1901, p. 27.

reduction of the population; and, finally, the apathy of the administration.

This apathy came to an end, and an infinitely more hopeful *régime* was initiated, when the Irish Department of Agriculture and Technical Instruction[1] was created. This was the main expression of the new spirit in which Sir Horace Plunket, and those who were associated with him, began, some ten or twelve years ago, the cure of the economic disease which has afflicted Ireland for centuries, and who, by "helping the people to help themselves," are playing a more worthy and useful part than those who place their reliance on political shibboleths. A Fisheries Branch forms an important section of the Department. £10,000 is provided annually in the estimates for the expenses of the administration of the branch. Two inspectors and a scientific adviser, with several naturalists, form the staff. The Department administers loan funds (which one wishes were more ample) for enabling fishermen to purchase boats and gear. It endeavours to direct the industry, in the way of providing better transport and markets for the products of the fisheries, and every attempt is made to develop the latter by all possible means, such as by extending the fish-curing industry and developing the unique

[1] By the Agriculture and Technical Instruction (Ireland) Act of 1899. See *Ireland in the New Century*, by Sir Horace Plunket, London, 1904, p. 282, for a short account of the functions of the fisheries authority.

advantages for oyster-culture which the Irish coastal waters possess, in their freedom from sewage and trade contamination. Research is carried on energetically by the scientific adviser and his staff, both on shore, at a laboratory on the coast of Galway, and at sea in the cruiser *Helga*. Under the old conditions, prior to the establishment of the Board of Agriculture and Technical Instruction, scientific research had naturally no place in the administration of the Irish fisheries. It was not until the eighties that any attempts at the investigation of the Irish seas, from the point of view of the fisheries, were made, and then these were promoted first of all by the Royal Irish Academy, and later on by the Royal Dublin Society. These investigations were directed towards the exploration of little-known regions off the south and west coasts, and their object was not so much the elucidation of special problems of marine natural history as the survey of the sea from the point of view of the establishment of definite fisheries. Mr Spotswood Green, who later on became one of the inspectors of Irish fisheries, was the first naturalist to be engaged in this work. Later on the Royal Dublin Society promoted a more ambitious survey of the west-coast waters, and were successful in inducing the Government to contribute largely to the expenses of the investigation. This took the form of a survey, in the course of which fishing operations were carried out on a number of stations over an extensive area. Records were taken of the fishes and other marine animals captured, and more special investigations into such points as the distribution of mature and immature fishes, spawning periods, food, etc., were made on the material so obtained.[1]

It is perhaps too much to expect, at the present time, that a return might be made in Ireland to the early system of bounties on the results of the fishing. But it is most probably the case that at no time like the present, when the fishing industry is being administered with a sympathy and energy which had no place in the administration of the past,[2] would the application of this policy be more productive of good. If private enterprise and capital cannot be directed towards the sea-fisheries of Ireland, then direct protection might, even if it should be considered by many as economic heresy, be of incalculable benefit.

[1] See Holt, *Sci. Proceedings Roy. Dublin Soc.*, vol. vii. (N.S.) pt. 4, pp. 225–477, 1892.

[2] I may give, as an instance, the work of the Congested Districts Board during the last few years. See the Reports of this authority.

CHAPTER IX

FOREIGN RESEARCH ORGANISATIONS

Even a brief mention of the authorities concerned with sea-fisheries administration in foreign countries would take more space than is consistent with the aims of such a work as this. No civilised country has failed to regulate in some way or other the fisheries within its own waters, and even a summary account of the methods and results of these bodies would be tedious and uninteresting to the general student of the British fishing industry. Fishery administration is, moreover, of local interest only, since general principles do not govern it so much as a consideration of those natural and economic conditions peculiar to the locality which is the area of administration. Fisheries scientific research is of much more general interest; but even here a great amount of work must be undertaken for each particular area which need not necessarily have any direct importance in relation to the fisheries of another country. Nevertheless, no account of fisheries investigation in any one country can pretend to be satisfactory which does not include some mention of two of the most notable research organisations in existence — the German "Kiel Kommission," and the United States "Commission of Fish and Fisheries."

The Kiel Kommission

The German "Kommission zur Wissenschaftlichen Untersuchung der Deutschen Meere in Kiel," usually known as the Kiel Kommission, was established in 1870, at the suggestion of the Deutsche See-Fischerei Verein, a powerful and influential fisheries society. The German title "Kommission" must not be interpreted according to our English notions of the functions of a "Commission," Royal or otherwise. In this country such a body is generally constituted for the investigation of some matter of administration, and I have already given some account of the great Commissions, appointed either by the Crown or by a public department, which, from time to time, have inquired into the condition of the British sea-fisheries. The methods of a British Royal Commission are fairly well known. It does not generally make any investigation on its own account, but contents itself with the examination of a great number of witnesses, partial or otherwise; and from the mass of opinions so accumulated it sifts out what it regards as the truth concerning the matters submitted to it, and it then makes certain recommendations as to the manner in which a legislative remedy can be attained. In case it should make a too exhaustive inquiry, the subjects which it may investigate are always strictly limited by its "terms of reference."[1] It usually "sits" for a number of years, after which it publishes a report, the bulk of which is greatly augmented by the "minutes of evidence," containing, among a mass of valueless statements, all the useful information which it has been possible to obtain by the cumbrous method consecrated by long usage. Finally, one must not omit to note that, when the whole matter has ceased to attract public attention, the report is presented, and is then decently interred in the Libraries among the Parliamentary Papers of the year. By this time another government may have succeeded that which secured the appointment of the Commission; but whether or not this is the case, the result is usually the same—the whole thing has ceased to excite any interest, and the recommendations of the Commission are soon forgotten and are quietly ignored.

The constitution and methods of the Kiel Kommission are entirely different from those which I have indicated above. When, in 1870, it became apparent that little was known of the natural

[1] The scrupulous care taken so as not to exceed the "terms of reference" extorts our unwilling admiration.

conditions on which the sea-fisheries depended, a strong agitation was set up for the appointment of a body whose business it would be to investigate marine biology, so far as this was suggested by the condition of the sea-fisheries. Five professors at the University of Kiel were therefore appointed to undertake such work. At the present time the Commissioners are Hensen, Brandt, Reinke, and Krümmel, responsible respectively for the subjects of physiology, zoology, botany, and geography, at Kiel, and Heincke, Director of the biological station at Helgoland. The President of this body (Hensen) receives an annual salary of £90, and each of the other members a salary of £45. An annual grant of about £7500 is made by the German Government for these salaries and the expenses of the Kommission, which are the equipment of laboratories at the University of Kiel, the chartering of steamers for scientific work at sea, the purchase of apparatus and materials, the salaries of assistants and collectors of statistics, and the printing of the beautiful reports—the *Wissenschaftliche Meeresuntersuchungen* — in which the scientific results are published. From time to time the Government has also made extra grants for special investigations and surveys, the most notable of which are the cruises of S.M.S. *Pommerania* in the Baltic and North Seas in 1871–2, the "Plankton-Expedition" in the North Sea and Atlantic in 1889, the *Valdivia* deep-sea expedition of 1890, the recent Antarctic exploring voyage of the *Gauss*, and in 1901 the German share of the international scheme of fisheries investigations which is now being carried out. In 1892, shortly after the cession of Helgoland by Great Britain to Germany, the Government of the Empire established the present biological station on that island, at a cost of about £2875, and in 1897–8 it also gave a sum of £400 to assist in the equipment of a fisheries museum in connection with the laboratory. An annual grant for the station and staff is also made, which in 1897–8 amounted to about £1037. These are considerable sums, and in Germany, where the emoluments of scientific men in the higher ranks of their profession are on the whole less than in Britain, they represent more than they would in this country, and are a sufficient indication of the interest displayed by the Fatherland in the prosecution of scientific research.

The Kiel Kommission consists, then, of a body of men all whose time, apart from that occupied by their strictly professional duties, is occupied with sea-fisheries research, and who sit in "permanent session." They are exceedingly active investigators, and each has made most important additions to our knowledge of marine biology and fisheries science. They are all colleagues of one university, and are thus in constant touch with each other. Instead of being restricted to the investigation of particular "practical questions," they are given a free hand in relation to the subjects which they may investigate. They are not concerned with the actual administration of fishery laws. It is to these conditions, no doubt, that the success of their work is to be attributed. Finally, they differ from their British colleagues in that their recommendations are occasionally acted upon.

The amount of scientific work of first-rate importance carried out by the Kiel Kommission is very great, as a reference to the six reports or *Jahresberichte* published from 1873 to 1893, and the five volumes of *Wissenschaftliche Meeresuntersuchungen* dating from 1894, will show. I can only refer very briefly to the nature of this work, which began with the preliminary survey of the Baltic and North Seas by the *Pommerania* in 1871–2, in the course of which biological and hydrographic researches were made, and the sea-bottom was examined from biological and chemical standpoints. About the same time the inspection of the fish-markets was undertaken, and a very detailed system of statistical collection was instituted, in the course of which the amount of fish landed at German ports, and the numbers of boats and men engaged, were tabulated. The area fished over was also delimited and charted, and an estimate was made of the productivity of the sea, from which it appeared that the yield in food of a given sea area was from one-fifth to one-half of that of a similar fertile and cultivated land-surface. In the meantime, the general investigation of the economic fauna of the sea was also commenced, and such subjects as the reproduction and food of fishes were investigated. The work on the herring, carried out about this time (1878), is very noteworthy. Kupffer and others investigated the natural history and embryology of this fish, and Heincke, in several papers in the *Jahresberichte* and in two colossal volumes[1] published by the Deutsche See-Fischerei Verein, made a most exhaustive study of the variability of the morphological characters of the herring, which has resulted in the demolition of the migration theory long held. This work greatly extended our knowledge of this important food-fish, and supplemented in a considerable degree the earlier work of the Scottish Fishery Board. Following these, a number of papers on general fisheries subjects have appeared, and a most fertile and original line of research was instituted by Hensen and his pupils—the quantitative determination of the fish-population of the sea, and of the planktonic organisms which form the ultimate food-material of these animals. I shall refer to this work later on, and in the meantime only notice it as one of the most remarkable and suggestive studies which has hitherto been made in marine biology.

[1] *Naturgeschichte des Herings, Abhandlungen Deutschen See-Fisch. Ver.*, Bd. ii. Hefte 1–2, 1898.

I have referred in the briefest possible manner to the scientific work of the Kiel Kommission. It is necessary to mention that a large proportion of it has been of academic, rather than of what we speak of in England as "practical," interest. This distinction, however, is more apparent than real. In Germany, fisheries scientific work has always been approached in a different spirit from that which prevails in England, where we are continually confronted with a desire on the part of the official people that scientific work on which public money is to be spent should have a direct economic or practical object and outcome; and where scientific men are compelled to make this an excuse for official encouragement and support. It is to the existence of this spirit that the inadequate nature of English fisheries investigation is due. No one, for instance, a few years ago would have suggested the investigation of the function of respiration in marine fishes and molluscs, or the bacteriology of the alimentary canal of these animals, at the public expense, without serious misgivings and a kind of apologetic tone in his advocacy. Nevertheless, at the present day, when questions of sewage contamination and its effect on fish-life and public health are receiving so much attention, the want of data on just these subjects is most seriously felt. One must, of course, distinguish somewhere a division of scientific investigation into researches of "purely scientific" and "economic" interest; but it is better that the catholic spirit, as exhibited in the work of the Kiel Kommission, should prevail, than that scientific research should be narrowed and limited as has unfortunately been the case in England.

The American Fish Commission

The United States Commission of Fish and Fisheries resembles the German Kiel Kommission in many ways. It is not an administrative body in the sense of a British fisheries authority, being concerned only with the acquirement and application of scientific knowledge. Like the German organisation also, it is not part of any public department, and is responsible only to Congress.

The Fish Commission was established in 1871, and the original resolution of Congress defined its duties as follows: "To prosecute investigations on the subject [of the diminution of valuable fishes], with the view of ascertaining whether any, and what, diminution in the number of the food-fishes of the coast and the lakes of the United States has taken place; and, if so, to what causes the same is due; and also whether any, and what, protection, prohibitory or precautionary measures should be adopted in the premises, and to report upon the same to

Congress." The resolution provided for the establishment of a Commissionership, stipulating that the person appointed to this office should be of recognised scientific attainments, and should have a knowledge of the natural history of the animals forming the objects of the fisheries. He was also to be a civil officer of the Government, but, on being appointed Commissioner, should receive no additional salary. There was only one person at the time possessing these qualifications, and Professor Spencer Baird, then assistant secretary of the Smithsonian Institution, became the first Fish Commissioner.

The work of the Commission has three sections :—

1. The systematic examination of the marine and fresh-water fishery areas of the United States, with reference both to biological and physical problems ; systematic zoological and general biological research ; collection of specimens of the national marine and fresh-water faunas for museum purposes and for research.

2. Practical fisheries investigation—the collection of commercial fishery statistics, with a view to ascertaining the extent of man's interference with the marketable faunas of the seas, rivers, and lakes, and with a view also to the development of commercial fisheries, to the construction of treaties and tariffs, and to finding the best markets for producers and consumers ; and the study of fishing methods

and appliances, whether destructive, inefficient, or serviceable; and

3. Fish-culture. This was not contemplated when Congress established the Commission, but was undertaken later on at the suggestion of the American Fish-Cultural Association. It includes the introduction and multiplication of useful fishes and other marine animals at the public expense. It was provided for by a special "appropriation" of money.[1]

All these three departments of work have been developed very vigorously, and pure scientific research by itself, and in relation to fishery questions, has been carried out on a scale with which we are quite unfamiliar in Europe. At first the Commissioner and his staff made parties which worked all along the coast at temporary stations. The research work of the Commission was then, and is still, carried out to a very large extent by volunteers—scientific men and women belonging to the universities, museums, and schools of America, who give their time freely to this work, and who are assisted by the funds at the disposal of the organisation. At first this work was almost purely biological. The Commission at that time possessed no laboratories or exploring vessels, but were assisted freely by the vessels of the

[1] The appropriation from Congress in 1900, for all purposes, was $454,500. Most of the States, however, have Fish Commissions, and make additional appropriations.

Coast Survey and Revenue marine services, and of the Navy Department. The co-operation of many national services, the lighthouses, lightships, etc., was also obtained, and large numbers of fishermen assisted by collecting and forwarding specimens. Later on, however, the Commission became equipped in such a way as to call forth the envy and admiration of fisheries workers on this side of the Atlantic. The first vessel acquired, the *Fish-Hawk* (450 tons), was built specially in 1880 for work in connection with fish-culture. Then a larger steamer of 1000 tons, the *Albatross*, was built, and was put in commission in 1883 for special sea-fisheries services, and was staffed by naval officers detailed to the technical parts of deep-sea research work.[1] Marine laboratories were then established for scientific, fish-cultural, and practical fisheries scientific work, and the chief of these, the magnificent institution at Woods Hole, Boston, is probably unequalled among the marine stations of the world.

The artificial propagation of fresh-water and sea fishes has been carried out by the American Fish Commission to a much greater extent than in any other country. This proposition was laid down and acted upon very thoroughly: "It is cheaper to make fish so plenty by artificial means,

[1] See Tanner, *Bulletin U.S. Fish Commission*, vol. xvi. (for 1896), 1897, for a lengthy description of the *Albatross* and her equipment.

that every fisherman may take all he can catch, than to enforce a code of protection laws." Thirty-five hatching stations, including the Woods Hole laboratory, are engaged in this work, and are assisted by the steamer *Fish-Hawk* and other smaller vessels, and by the famous Commission "fish-cars," specially fitted railway carriages which are engaged continually in the work of transporting fish to the hatcheries, and eggs and larvæ from these stations to the waters to be stocked. In the year 1900 these cars made journeys of 101,796 miles altogether. The extent of the fish-hatching work may be gauged from the fact that in that year 1164 millions of young fishes and larvæ were hatched and distributed throughout the waters of the United States. The bulk of these were fresh-water or anadromous fishes, but they included 265 millions of cod (hatched at Woods Hole), 87 millions of flat fish, and 77 millions of lobster fry. It is claimed that this work is thoroughly successful and has been attended with beneficial results. Opinion in Europe is not generally in favour of the improvement of the sea-fisheries by artificial propagation, although this work is carried on both in Norway and in Britain. American expert opinion seems, however, to be quite unanimous. "The great river fisheries of the United States, which produced in 1880, 48 million pounds of alewives (*Clupea pseudoharengus*), 18 million pounds of shad (*Alosa sapidissima*), 52 million pounds of salmon, besides bass, sturgeon, and smelt, and worth at first hand between $4,000,000 and $6,000,000, are entirely under the control of the fish-culturists to sustain or destroy, and are capable of immense extension."[1]

But however opinion may differ as regards the utility of the fish-cultural work of the Commission, there can be no question as to the value (first of all to science, and ultimately, no doubt, to the commercial fisheries) of the immense mass of information embodied in the scientific papers published by the staff and by volunteer work, in the official reports—the *Bulletin of the U.S. Fish Commission* and the *Commissioner's Report*. Very many of these, perhaps the greater number, relate to surveys of fishing grounds in American waters, and are of interest to the student of American industries rather than to the general European reader. But a great number relate also to general biological problems and to systematic zoological work, and are therefore of universal scientific interest, and it is by these that the scientific work of the Commission is widely known. One result of all this work deserves special attention: although the scientific investigations had a close relation to administrative problems, and the diminution and protection of the fisheries, no legislative restrictions resulted

[1] U.S. Fish Commission, *Commissioner's Report for* 1884, 1886, p. 1161.

from them. Comparing the results of investigation, scientific and otherwise, in Europe with those obtained in America, one writer remarks: "In the United States, on the contrary, public opinion is generally antagonistic to fishery legislation, and our Commissioner of Fisheries, after carrying on, for fourteen years, investigation upon this very question, has not yet become satisfied that laws are necessary for the perpetuation of the sea-fisheries, nor has he yet recommended to Congress enactment of any kind."[1] It has to be remembered, however, that the condition of the sea-fisheries in America is very different from that in Great Britain and in the North Sea countries. Here there has been an intense and ever-increasing exploitation of the fishing grounds in recent years, such as does not yet exist in American waters, and in an area which is trifling in extent when compared with that which exists on the American sea-board and in the rivers and great lakes.

Finally, we have to note the condition which, in America, as in Germany and in Scotland, distinguishes the fisheries research authority from those existing in England and Ireland at the present day —its independence of any of the State departments. In America, as in Germany and in Scotland, the success of the scientific investigations, and in the

[1] *U.S. Fish Commissioner's Report for* 1884 (1886), p. 1149. This remark applies, however, to Federal statutes. Some of the States impose restrictions on fishing methods.

former country, their successful practical application, have depended on the entire freedom of the fishery research service from departmental routine.[1]

[1] See G. Brown Goode in *U.S. Fish Commissioner's Report for 1884* (1886), p. 1172.

PART II

FISHERIES PROBLEMS

"FISHERY doctors at the present day remind me of human doctors in my youth—they were always for doing something. I remember one of my teachers laid down the notable maxim, 'When you are in doubt, play a trump,' and I should think that those of us who have followed his advice in the last forty years must have largely added to the bills of mortality. Our fishery doctors are of the same mind as my friend. They are (or at any rate they ought to be) very much in doubt, and yet they continually want to play trumps in the shape of stringent regulations and restrictions. If I might tender a piece of advice, I would say—don't."—HUXLEY, "Fish Diseases," *International Fisheries Exhibition Literature*, London, 1883.

CHAPTER X

THE LIFE-HISTORIES OF FISHES

THIS is by far the most technical part of our subject, and it is quite impossible to give more than a mere summary of the present state of our knowledge regarding the complicated life-histories of marine fishes. Such subjects as the reproduction and growth of these animals have been studied continuously in Britain, Germany, and Scandinavia for the last twenty years, with the result that so much is now known that the gaps in our knowledge of the subject are capable of easy enumeration. I can only mention the more salient facts and principles of this department of marine zoology, and will refer the reader who wishes to study it in greater detail to the numerous memoirs contained in the literature of sea-fisheries science.[1]

[1] Cunningham's admirable account of British fishes should be studied. This work, *Marketable Marine Fishes*, was published by the Marine Biological Association in 1896. M'Intosh and Masterman's *Life-histories of British Marine Food Fishes* (Cambridge University Press, 1897) treats part of the subject in greater detail. In addition

The initiation of the study of the life-histories of marine fishes is generally ascribed to Professor G. O. Sars of Christiania University, though many observations of the breeding and habits of the herring were made in Scotland previous to the date of Sars' work.[1] The latter zoologist was, however, the first to make extensive observations on the subject. Sars found the ova of the cod and other Gadoid fishes in the sea in the neighbourhood of the Lofoden Islands, where there is an extensive cod-fishery.[2] He obtained them by means of a fine-meshed silk net, and by keeping them in jars of clean sea-water, was able to observe the hatching of the embryo at the end of a period of eighteen days. Sars also obtained the ripe ova from the body of the female fish, and showed that it was possible to impregnate them by milt taken from the male fish of the same species. This discovery was the germ of our modern methods of sea-fish culture, and it may be stated

to these works, Fries, Ekstrom, and Sundevall's *Scandinavian Fishes* should be consulted. This is now the standard work on North European ichthyology, but it is not easily obtained; and Day's *British Fishes* (1880–84), though less accurate in some respects, will probably be more useful to the general reader. These works (which represent, however, only a small fraction of the literature of the subject) will give a very fair idea of the present state of our knowledge.

[1] By Walker in 1803, Goodsir and Wilson in 1843–7, and Professor Allman in 1860–3. See *Scottish Fishery Board Report*, ii., 1887, p. xii.

[2] See a translation of Sars' own account of his work in the *Report of the U.S. Commissioner of Fisheries*, Washington, 1877.

here that very little advance has yet been made on the results obtained by the Norwegian professor. This was in 1864, and in 1865 Sars also obtained and identified the eggs of the mackerel; and another Scandinavan zoologist, Professor Malm of the University of Gottenborg, obtained and fertilised, in the same manner, the eggs of the flounder. As early, then, as 1864–8 it had been shown that the eggs of three important families of food-fishes were to be found floating about at the surface of the sea and undergoing development there.

From this time until the beginning of the eighties little general advance was made in this subject. The German Kiel Kommission, however, which was instituted in 1870, began to make investigations on piscine life-histories, and one of the first important contributions made by this body was a very complete investigation of the development of the herring. These investigations were published by Kupffer in the *Jahresberichten* of the Kommission for the year 1878, and still remain the most complete account of the development of this fish in existence.

Very little more was done in this country or on the Continent until about 1884. The state of general ignorance regarding the reproduction and habits of sea-fishes may be gauged by a perusal of the account of the life-histories of fishes given by Frank Buckland in 1879.[1] This account, which is very faulty, included nearly all that was known at the time. When the Scottish Fishery Board was instituted in 1882, this ignorance of a most important subject was keenly felt, and provision was at once made by that body for scientific investigation. Valuable observations were made by Professor Cossar Ewart and by Brook and Matthews in 1883–5,[2] on the spawning and structure of the herring. A very important step was taken by the institution of a marine laboratory at St Andrews, on the east coast of Scotland; and so much work was done there by Professor M'Intosh and his pupils, that the former must be regarded as the pioneer of systematic zoological research on the reproduction of North European marine fishes.

The Spawning of Fishes

Fishes are either male or female,[3] and the ova produced by the females are termed the spawn. At a certain season in the year, which extends over two or three months, and varies for each species, the female sheds a certain number of eggs, which are then fertilised by the male; and thereafter neither parent, as a rule, displays any solicitude

[1] In the *Report on the Sea-fisheries of England and Wales*, 1879, by F. Buckland and Spencer Walpole, Appendix, p. 178.

[2] *Scottish Fishery Board Reports for* 1883–5.

[3] With occasional lapses into hermaphroditism.

for the offspring. There are, however, certain exceptions to this rule, and these are of much interest to the naturalist. In some of the dog-fishes of British waters (*Mustelus*, the smooth-hound; *Galeus*, the tope; *Acanthias*, the pike-dog), and in some tropical rays, the development is analogous to that which takes place among the warm-blooded animals; that is, a kind of placenta may be formed, so that the development might be called "intra-uterine."[1] Much the same kind of thing takes place in the case of another British fish (*Zoarces viviparus*, the viviparous blenny). In these cases the young fish is born into the world in a highly advanced condition. The very general rule among fishes is, however, that unimpregnated eggs are laid by the female; the class is, with the exceptions noted, and a few others, oviparous, not viviparous.

In some cases there is a kind of parental care of the young. In the female of *Solenostoma* (a tropical fish) the eggs are retained, after spawning, in a brood-pouch which the female bears, and which is formed by the coalescence of the edges of the pelvic fins, and they remain there until the young hatch out. An analogous provision exists in the case of a British fish (*Syngnathus*, the pipe-fish), where two cutaneous abdominal folds form, *in the male*, a similar brood-pouch. In the butter-fish

[1] The structures concerned in the nutrition of the embryos in the two classes of animals are, of course, not homologous.

(*Centronotus*), again, the female forms the extruded eggs into a ball, and these are surrounded by the coiled body of the fish. The lump-sucker (*Cyclopterus*) of British seas deposits its eggs in one large mass in a rock pool, and thereafter the female indicates no concern for her progeny. The male, however, keeps guard over the spawn, and causes a current of water to flow over and through the mass of eggs by gentle movements of his tail. This paternal instinct is often fatal to the unhappy sire, who is sometimes left stranded by the receding tide, and either captured by small boys or destroyed by crows or other predaceous birds. The fifteen-spined stickleback (*Gasterosteus spinachia*) builds a nest constructed of sea-weeds cemented together by mucus.[1] It is the male in this case which is the architect; the female takes no part in the process, but, on the other hand, seeks to devour the eggs contained in the nest, and is only prevented from doing so by the efforts of the male.

There are, however, exceptions. The almost invariable rule (except in the dog-fishes, sharks, and rays) is for the female to shed her eggs into the sea. At the same time the male, who is "standing by," sheds the "milt" or spermatozoa, which then mix with the eggs and impregnate them. With these acts the parents cease to give any attention to the spawn.

[1] See the beautiful figure of the nest of the stickleback in M'Intosh and Masterman's *British Marine Food Fishes*.

All marine and fresh-water fishes have definite breeding or spawning seasons. Generally these are in the first half of the year. The cod, haddock, whiting, gurnard, and most flat fishes spawn between the beginning of February and the end of May in British waters; but the sole spawns towards midsummer, and the mackerel—which, however, is somewhat variable in this respect—is also a late spawner. Herring, on the other hand, may spawn at any time, and indeed these fishes may be found spawning in some part of the British seas all round the year. In many places there are two distinct herring spawning periods, a spring period and an autumn period, and there are also two distinct fisheries. This curious condition has recently been established for the cod also.[1] But in these latter cases it is quite improbable that the same fish spawns twice in the year. It is most probably a case of two distinct "races" or "schools" of herring or cod, one spawning in the spring and the other in the autumn.

As a very general rule, marine fishes are enormously prolific. The eggs laid annually by the females of many species are to be numbered by the million. Fulton first determined approximately how many ova were produced by each, and the following table gives the average numbers of

[1] Fulton, *Publications de circonstance*, No. 8: Conseil permanent international pour l'exploration de la mer, Copenhagen, 1904.

eggs produced annually by each female of some of the species investigated :—[1]

Turbot	8,600,000
Cod	4,500,000
Haddock	450,000
Whiting	120,000
Plaice	300,000
Flounder	990,000
Sole	570,000
Dab	105,600
Herring	31,000
Skates, rays, dog-fishes .	Few, a dozen or so

Fulton estimated these values by weighing the whole of the ovaries of a single fish, and then weighing a small portion, and actually counting the individual eggs contained in the latter. The value so obtained was then multiplied by the number representing the number of times the fractional portion of the ovary counted was contained in the total weight of both organs. Obviously, the total number of eggs obtained can only be an approximation to the number actually present ; but the values obtained give a sufficiently exact idea of the fecundity of the fish.

As a general rule, most sea-fishes which are used as food spawn in relatively deep water and at some distance from land. It has been supposed that in the case of most species a definite spawning migration takes place, and that the fishes congregate

[1] "Comparative Fecundity of Sea-fishes," *Ninth Report*, *Scottish Fishery Board*, pt. iii. p. 243, 1891.

together on some particular areas known as spawning banks. Except in the case of the herring, however, there is not evidence in favour of the existence of such definitely localised spawning grounds. It is more likely that the places which depth of water and other conditions constitute suitable habitats are also the spawning areas. If, on a chart such as that of the north-west portion of the Irish Sea, the portions where (say) spawning plaice are fished be marked, it will be found that practically the whole of the sea where the water is about twenty fathoms deep is a spawning area. Hensen, in his North Sea quantitative plankton investigations, found that fish eggs of any one species, such as the cod, plaice, flounder, etc., could not be assigned to any particular places, but were distributed generally over the whole area investigated by him.[1] In the case of the herring, however, definite spawning places, such as that on the well-known Ballantrae Bank in the Firth of Clyde, and some other places on the east coast of Scotland, have been found. There are some exceptions to the general rule that fishes deposit their spawn in deep water off shore. Thus, it is very probable that both flounders and dabs may frequent water near the shore, and of comparatively little depth (five to ten fathoms).

There are, however, some species of fishes which make very definite spawning migrations. Thus,

[1] *Wissenschaftliche Meeresuntersuchungen*, Band ii., Heft 2, 1897.

there is the well-known habit of the salmon, which ascends rivers to deposit its spawn in the upper reaches. The spawning migration of the eels is a very extraordinary one, and, in spite of much laborious research, this is very imperfectly understood. Fresh-water eels with ripe reproductive organs are never found in the rivers. When the breeding season approaches, a change in the appearance of the fish—the assumption of a "bridal-dress"—has been observed, and then a migration into the sea takes place. There is little doubt now that, having once spawned, the fish does not return into the river, but dies soon after the eggs have been deposited. This is also the case with the conger eel, which is supposed to spawn in very deep water. It has never been possible to observe the spawning of this fish in an aquarium, for the death of the parent has always taken place before the eggs were laid. There is reason for the belief that this is the normal occurrence in the sea also, except that the eggs are, of course, deposited before the degenerative changes leading to death (which have been observed in specimens kept in tanks) are thoroughly advanced. It is very probable that both conger eel and fresh-water eel only spawn once in their lifetimes, and that death soon follows the act of breeding.

The Eggs of Sea-fishes

Sea-fish ova conform very generally to one definite type of structure, though, as in the case of the breeding habits, some notable departures from such a type are known. Such an egg as that of the cod is a good example of all the rest. It is a small, perfectly spherical body a little over a sixteenth of an inch in diameter. When ripe, it is clear and transparent, and is not easily seen when floating in sea-water. It is bounded by a thin though fairly strong capsule or shell, within which is a mass of transparent "food-yolk" (see the diagrams at the end of this chapter), and at one pole of this spherical mass of yolk is the "germinal disc," a little cap of protoplasmic material which is destined to form the body of the embryo fish. Immediately over this germinal disc is a minute aperture in the shell—the "micropyle." The yolk is somewhat lighter than the germinal disc, so that, when floating in the water, the latter, and the micropyle, are directed downwards. Such an egg can be compared with that of the fowl. In the latter case there is a shell (which, however, is limy and opaque), and within the latter is the albumen or "white," and within the latter again the yolk, which corresponds closely, except in colour and opacity, with the yolk of the cod's egg. If a hen's egg be carefully broken into a saucer, it will be seen that the yolk comes to rest with a whitish spot at its summit: this spot is the "blastoderm" or germinal disc, and it gives rise to the body of the chick.

There are, of course, many variations from this type of structure. Fish eggs vary in size, the smallest common sea-fish egg being that of the solenette (*Solea lutea*), and the largest that of the halibut. The former is, roughly speaking, about $\frac{1}{32}$ of an inch in diameter, and the latter about $\frac{3}{16}$ of an inch, and within these limits the diameters of the greater number of sea-fish eggs are placed. These somewhat minute variations in size are, however, of great importance, for they are fairly constant for the eggs of each species in any one locality, and it is possible to determine the species of an egg found in the tow-net by measuring it with certain microscopic apparatus. In such an identification we are aided by other characters, such as the colour, the structure of the yolk, the presence and size of oil-globules within the latter, the markings and appendages of the shell, and other things.

There are two principal categories of fish eggs, according to their specific gravities. *All* sea-fish eggs are heavier than distilled water, and, if placed in the latter, will at once sink to the bottom. But the majority of sea-fish eggs are slightly lighter than sea-water, and when shed into this medium they rise to near the surface and float there. Such are termed "pelagic" eggs, and to this category belong the ova of the cod, whiting, haddock, plaice, halibut, sole, flounder, and, indeed, most of the fishes used as food by man. On the other hand, some fishes produce eggs which are slightly heavier than sea-water, and, when spawned, these at once sink to the bottom. Such are termed "demersal" eggs, and the best example of this type is the egg of the herring (but not those of the sprat, anchovy, or pilchard). There are others, of course, but they are spawned by species of no economic importance. These demersal eggs nearly all have another character in common; that is, they are all furnished with an adhesive coating when spawned, and this causes them to stick together. They are therefore always found in masses adhering to pieces of sea-weed, stones, shells, and other objects of the sea-bottom on which they were deposited by the spawning fish.[1]

Just as in the case of their breeding habits, so the Elasmobranchii (gristly fishes)—sharks, rays, and dog-fishes—differ very remarkably from the Teleostei (or bony fishes). The eggs of the former fishes are large, and are always very few in number, comparatively speaking. The empty capsules or shells of the ray are familiar to anyone who has grubbed among the débris lying on the sea-beach along high-water mark, as "mermaids' purses." They are oblong, black, leathery-looking objects,

[1] See Ehrenbaum, *Wissenschaftliche Meeresuntersuchungen*, Bd. vi., Abth. Helgoland, Heft 2, 1904, for a series of most exquisite photographs of such egg masses *in situ*.

about two inches in length and one inch broad, and corners are produced to form horns. Within these cases were the soft eggs proper, which consist, when the egg is alive, of a large mass of yellow yolk, on the surface of which is the blastoderm, or formative material of the embryo, or, it may be, the partially developed embryo skate itself. The eggs of the dog-fish are somewhat similar, but are more elongated, and the corners of the case are produced into long twisted cords. The live eggs of skates and dog-fishes can generally be procured only from the bottom of the sea, in water from five to twenty fathoms deep, by means of dredging. They too are heavier than sea-water, and sink to the bottom when emitted by the mother.

Impregnation and Development

In the case of these Elasmobranch fishes there is an actual physical connection between the sexes at the breeding season, and the eggs are impregnated while still within the oviduct of the female, and before the horny egg-capsule has been formed. In the Teleost fishes, whether they produce pelagic or demersal eggs, this connection is only an indirect one ; eggs and spermatozoa are shed by males and females into the sea at the same time. Whether the spermatozoa reach the eggs fortuitously, or whether there is some obscure attraction between these sexual elements, we do not know, but at any rate each egg soon becomes surrounded by a number of spermatozoa which adhere to their capsules. By and by one of these reaches the micropyle, and immediately passes through this aperture in the capsule into the protoplasmic germinal disc. As soon as this has happened the micropyle closes, so as to prevent the entrance of other spermatozoa. The egg is now impregnated or "fertilised," and development of an embryo begins. The germinal disc divides to form a number of cells or "blastomeres," and grows until it forms a skin enveloping the whole yolk-mass. On this skin the body of the embryo is formed, and in the course of a few days the young fish becomes apparent. First of all, the spinal cord and brain are formed, and round this central nervous system the whole structure of the little animal becomes built up. After a variable incubation period, the embryo hatches out from the egg-capsule. This incubation period depends first of all upon the species, and is usually from six days to about three weeks. But it also depends upon the temperature of the sea-water in which development takes place, and by altering the latter the egg of a flounder, for instance, may hatch out in from five to ten days. I am speaking just now of the small eggs of the bony fishes. The large egg of a skate or dog-fish pursues much the same course, but the incubation period in these fishes is prolonged, and may extend over the greater part of a year. In the case of a bony fish, the creature which hatches from the egg is called a "larva," and is one of the most helpless of organisms. It has very feeble powers of locomotion, and for a time it is physically incapable of feeding, for the mouth may not be formed, and the œsophagus or gullet is usually not a tube, but a solid cord of cells. This condition persists for about a week or fortnight, and the larva depends for its nutrition on the food contained in the yolk of the ovum from which it is formed. When the fish is hatched this food-yolk is contained in the "yolk-sac," a prominent rounded structure projecting from the belly of the larva, and which gives it a most characteristic appearance. At the end of about a fortnight this yolk-sac completely disappears, during which time the larva has been growing actively. It is now able to find and devour its own food, which consists naturally of very minute organisms—diatoms, micro-crustacea such as copepods, and the very small larva of various invertebrate animals. When it has grown for some time the "metamorphosis" takes place. It has hitherto been quite unlike the parent fish; the larva of a flat fish, for instance, like the plaice or sole, is almost exactly similar to the larva of a cod, is round, and has one eye on each side of its head. With the metamorphosis the whole appearance of the fish is changed. The round fish, like the cod or herring, takes on the adult colour and conformation, and the larva of the flat fish flattens from side to side, and the head begins to twist, so that by and by both eyes appear to lie on one side of the body. Sooner or later the fish passes out of its larval into its "post-larval" stage, and can be recognised easily as belonging to a definite species. Hitherto it has been drifting helplessly about at the surface, or indeed at any depth in the sea; but with the termination of the larval or post-larval stage it acquires the habits and enters the habitat of the adult. The assumption of sexual maturity may be long delayed, but after a period of from one to three or four years, depending on the species, the reproductive organs become mature and the fish begins to produce ova or spermatozoa, according to its sex.

When we consider the enormous differences in the fecundity of various fishes, we encounter a difficulty which at first sight is not easily explained. A turbot, we have seen, may spawn each year some nine millions of eggs, each of which is potentially a distinct fish; on the other hand, a skate lays two eggs at a time, and probably only produces a dozen or so during its hatching season. Yet common experience shows that skate are much more numerous in our seas than turbot, in spite of this almost incredible difference in fecundity. Every species of organism in the sea is subject to enormous destruction. There can be no doubt that the pelagic eggs of the turbot are devoured by numerous predaceous animals, as are also the larval and the post-larval stages. It is clear that of the nine millions of fertilised eggs produced by a male and female turbot only two or three can reach reproductive maturity, else the species would be on the increase, which we may be sure is not the case. To compensate for this prodigious mortality among fishes in the sea, two distinct means have been evolved. On the one hand, the destruction is permitted (if we may think of natural selection as something personal) and is compensated for by the great increase of the individuals produced. An incredible number of larvæ are bred, all of which, except two or three, are destroyed. On the other hand, the destruction may be minimised, as in the case of the skate. In the turbot we have enormous fecundity associated with small eggs, an insignificant store of food-yolk, rapid development, and small and almost helpless larvæ. In the skate we have a very restricted degree of fecundity associated with large eggs unattractive as food, with a large store of food-yolk, a lengthened incubation period, and large and vigorous fishes when hatching occurs. The young skate, when it issues from the capsule, is perfectly formed, and can feed and hide itself. The mortality is therefore reduced to a minimum among marine animals. In the viviparous fishes the same end is attained by another means, viz. the nutrition and

[1] Countless numbers must also be destroyed by physical agencies; larvæ and post-larvæ may be stranded on the beach or may die in the brackish water of estuaries.

growth of the embryo while still in the "uterus" of the parent. Generally it may be said that, the more prolific a fish is, the greater are the destructive agencies at work on the eggs and young; and conversely, the less prolific it is, the more perfect are the means securing the nutrition, and safety from enemies, of its offspring.

Migrations and Habits of Fishes

Dismissing the very early history of young fishes, we have now to consider the migrations, habits, and food of the adolescent and mature stages. It is very commonly the case that, while the mature adults inhabit the sea at some distance from land, and in relatively deep water, the young forms live near the land, in comparatively shallow waters. It would appear that one reason for this distribution is that there is a richer fauna near the land, and that food is more abundant there. But imperfectly understood physical conditions also tend to produce this contrast in the habitats of the young and mature stages. In the case of the plaice, for instance, it happens that the spawning areas are so situated that the resultant effect of winds, currents, and tides is such as to impel the drifting eggs and larvæ towards the shore. So we find that, a month or two after the time when the eggs of this fish may be taken in the tow-nets offshore, the young are present in the shallow waters inshore. On almost any sandy beach on the north-west coast of England immense numbers of these little plaice, no bigger than one's finger-nail, may be picked up in the shallow pools left by the receding tide. But these may only be seen for a few weeks in May or June, and then they disappear. If we now fish in water from one to several fathoms deep with a fine-meshed trawl-net, we may get very large numbers of plaice about an inch long, and these belong to the same brood as the fish which were being stranded on the beach a month or two earlier. Then, still later in the year, we may find the fish a little bigger and a little further out at sea. As it grows,[1] the plaice gradually moves out into deeper water. Finally, when it has reached the size of maturity (13 to 17 inches long), it has come to inhabit the deep water of fifteen or more fathoms, some considerable distance from shore. The inshore migration, be it remembered, from the spawning grounds to the "nursery" is a purely passive one, and depends on the natural movements of the sea-water. The offshore migration, on the other hand, is an active one, and depends on the inherited instincts of the fish. I am speaking here of the plaice, and such other flat fishes as resemble it in habits. It must be understood that these migrations of the eggs, larvæ, and growing young

[1] It only grows during part of the year. Growth practically ceases between the months of October and March.

vary with each species and with the locality studied. As an instance of a life-history differing from that of the plaice I may cite that of the fresh-water eel; here the adult descends from the rivers into the sea to spawn, and the young eels ascend the rivers as "elvers" to feed and grow to reproductive maturity. Opposed to such a life-history is that of the salmon and some allied forms. These fishes ascend the rivers to spawn, and descend again into the sea, where they grow to maturity. Such migratory periods as that of the plaice, eels, and salmon are comparatively simple; but there are others which are not yet understood. So much has been written about the migrations of the herring that I hesitate to mention the subject here. The old theory had nothing to commend it but its simplicity. It was supposed that the fish had its home somewhere in the northern seas, and that regularly every season the shoals migrated southward in a mass. This explained why the fishing season is generally a little later the farther down the coast, starting at (say) Wick, we go. But it does not explain why in the summer and later herring fisheries the fish caught always have ripe reproductive organs. If the shoals which are fished on the north-east coast of Scotland in summer are the same that visit the south-east coast of England in late autumn, then it is difficult to see how in *both* cases the fish can be spawning. Many observations have, in fact, led to the belief that the fish which form the fishery at any one place are peculiar to that place. The Wick herring are a different school of fish from those which appear in November at Lowestoft. It is fairly certain now that the herring which frequent Loch Fyne belong permanently to the Clyde basin, and spawn somewhere lower down the Firth. Heincke, a member of the Prussian Kiel Kommission, made a most laborious investigation of the herrings of the German North Sea and Baltic coasts and elsewhere, and showed that there is a probability that, in addition to the distinction into spring and autumn (or summer and winter) herring, there are also a number of local races or varieties, and that each of these have their own spawning ground and migration paths. They travel to and from the coast, visiting for a long series of years the same ground, and then perhaps deserting it in a perfectly arbitrary manner.

It is very probable that the migrations of fishes are much less perfectly defined than our knowledge at present leads us to believe. Most species are possibly always "on the move." But we only recognise certain broadly defined paths. We say, for instance, that the eggs and larvæ of plaice migrate from the open sea towards the shore, but it is quite probable that vast numbers of eggs and larvæ drift farther *out* to sea and are destroyed because the young forms do not find the habitat suitable to their mode of life. We can find those which reach the shallow, sandy shores, but we are unaware of the proportion which go elsewhere. Fishermen are always struck with the apparent facility with which plaice find areas of sea-bottom where food is very abundant. A "strike" or deposit of mussels or other shell-fish larvæ may take place on a certain area, and in a short time an extensive bed of young molluscs is formed. Then it is very often the case that enormous numbers of plaice may be found feeding on these young shell-fish, and the fishermen immediately credit the fish with some occult power of scenting out this food from great distances. It is a much more probable explanation that the plaice, which are continually moving about in all directions, come across this food by pure accident, and are immediately arrested. If this goes on for a few weeks, there will soon be a vast number of fishes aggregated on one limited area, not by reason of any remarkable powers of sense possessed by them, but in a perfectly simple and commonplace manner.

Food of Fishes

Finally, I may notice the different habits which have been adopted by various fishes in respect of the manner of feeding. There are two principal categories of marine fishes, characterised by the zone of sea frequented and the kind of food usually sought for.[1] Pelagic fishes, of which the herring and mackerel are the best-known types, live generally in the open sea, and frequent water of all depths along the shallower part of the continental slopes. At certain periods shoaling movements occur, and it is then that the great fisheries are held. These two fishes are plankton-feeders, subsisting on the pelagic life of the sea, crustacea (copepods and schizopods) usually. Such plankton-feeding fishes are furnished with appropriate feeding organs; in these species the gills are provided with "gill-rakers," comb-like structures attached to the gills, which act as strainers. When the creature takes water into its mouth, any small organisms, such as copepods, become strained out by the gill-rakers, and are then brushed off by the tongue and are swallowed. These fishes are caught by appropriate fishing apparatus—mackerel by drift-nets or hooks, and herring by drift-nets. The drift-net is simply a vertical wall of netting of great extent which drifts in the sea, and herring or mackerel striking against it become enmeshed. On the other hand we have the bottom-living species, like the sole, plaice, cod, etc., which live at or near the bottom of the sea, lying on, or

[1] From the point of view of the naturalist, fishes may be divided into shore and deep-sea species. The former inhabit the seas within the 100-fathom contour line, and the latter live in the great ocean depths—down to 2000 fathoms or more. There is, of course, no absolute distinction between these two categories. Probably the deep-sea forms have originated from shore or pelagic species.

actually in, the mud and sand forming the bottom deposits. In such species gill-rakers are not required, and are absent, for the food consists of comparatively large animals, such as small shell-fish like mussels (in the case of the plaice), or worms (in the case of the sole). These animals live in the mud or sand, and are caught individually and swallowed by the fishes. The fishing apparatus adopted for the capture of these latter species is the trawl-net, which sweeps along the sea-bottom, or hooks fastened to long lines, which also lie on the sea-bottom.

I have given here only the barest summary of the principal classes of facts relating to the natural history of marketable fishes, and will again refer the reader to the abundant literature which deals with the subject. Although our knowledge is still very far from being complete on this head, yet so many investigations have been made during the last twenty-five years that we have now a very fair notion of the principal facts in the life-history of fishes. The subject is one of very great interest, and the reader who is interested generally in sea-fishery investigations may very profitably pursue it further.

CHAPTER XI

METABOLISM IN THE SEA

On taking a general view of life in the sea, it becomes possible to group the multitudinous assemblage of organisms contained there under three great categories, according to their general habits and method of occurrence. There are first of all a great number of plants and animals which live throughout the greater part of their existence permanently rooted to the sea-bottom, either in deep or in shallow water, or burrowing among the deposits which cover the sea-floor. These are the sea-weeds, the zoophytes, animals like crabs, lobsters, and their kindred, star-fishes and sea-urchins, molluscs like the mussel, oyster, or cockle, sponges, sea-anemones, and a host of other creatures which are either sedentary, or which, if they do move about, have a very limited range of movement. All these organisms have been grouped together by Haeckel and called the *Benthos*. They are found everywhere on the sea-floor, though they are most abundant in fairly shallow water, down, perhaps, to about fifty fathoms. Opposed to this class of organisms is another more limited one, which has been called the *Nekton*. These animals are very active, possessing powerful organs of locomotion, and they swim about in the sea, with, in many cases, very considerable ranges of migration. The fishes themselves are the best examples of nektonic animals, but many other creatures also fall under this category, such as cetaceans like the whales, dolphins, and porpoises, and molluscs like the squids and cuttlefishes. Then contrasting strongly with both these classes is the group of organisms which Hensen has called the *Plankton*, under which category we now include the vast assemblage of plants and animals which, possessing little powers of locomotion, simply drift about in the sea at the mercy of winds, tides, and currents.

This latter class, by reason of its universal distribution throughout all the seas of the world and throughout the whole body of the water, from the surface to the bottom, is by far the most abundant. Planktonic plants and animals are found everywhere and at all times. Even when the sea-water may appear most pellucid, it contains an abundance of microscopic life, and it is no exaggeration to say that in some places, and at certain times in the year, every drop of water may be inhabited by one or more organisms. Usually the creatures forming the plankton are so small as to be invisible to the naked eye, but sometimes they are so numerous as to discolour the water. They have an importance in the natural economy of the sea which is quite incommensurate with their size as individuals. Every class in the animal kingdom is represented in the plankton, and whole groups of plants have no other method of occurrence. Amongst the plants are the diatoms, which are to be regarded as minute sea-weeds or algæ composed each of a single organic unit or cell, the desmids and other unicellular plants, spores of sea-weeds, etc. The animals are extremely varied in character. At the bottom of the scale of life are the protozoa, or animals of microscopic size, each of which, like a diatom, consists of one cell. These organisms, amongst which are the foraminifera and radiolaria, protozoa provided with limy and flinty skeletons respectively, are the most numerous, form the great bulk of the animal plankton. Then we have the "jelly-fishes," by which popular term is meant a multitude of larger organisms—medusæ, ctenophores, siphonophora, and the like. Crustacea are very abundant, particularly the copepoda, a very large group of minute animals belonging to the same class as the shrimp and crab. Among the molluscs, a group called the pteropods ("winged-shells" or "sea-butterflies") are so abundant in the plankton as to form the major portion of the food of the whale.

Worms, too, are abundantly represented. All these groups of animals, with the unicellular plants and an incredible number of bacteria, form what we may call the permanent portion of the plankton, which, throughout their lives, pursue this drifting, pelagic existence, which is characteristic of the assemblage of organisms we are considering. But there are a vast number of other animals which have a planktonic phase ; which, when young, drift freely about in the sea, but which, when they enter on their adult career, belong either to the benthos or to the nekton. This transitory plankton consists chiefly of the eggs and larvæ of molluscs which live resting on, or burrowing in, the mud or sand at the sea-bottom, the larvæ of sedentary worms, of crustacea, and of zoophytes, star-fishes, etc., and the eggs and larvæ of ascidians and fishes. For a variable time these and other animals belong to the plankton, and it is in this stage that they become distributed far and wide in the sea by the mechanical agencies of the winds and currents.

Of all the departments of marine investigation the study of the plankton is the most attractive, because of the astonishing variety and abundance of life which is contained in it, and because of the surpassing interest of the problems which we encounter in this kind of work. Its study is comparatively recent, and may be said to date from 1845, when Johannes Müller, the great anatomist and physiologist, began to use the "tow-net" in the sea off Helgoland. The method thus initiated was prosecuted by Huxley, Haeckel, Vogt, Gegenbaur, and a host of others,[1] and at the present day it is employed by every marine naturalist. In all questions and studies belonging to marine biology or economic fisheries research, the study of the plankton becomes indispensable at some stage or other.

Generally speaking, there are two principal points of view from which the study of the fauna and flora of the sea can be approached. The latter form a vast storehouse of biological material on which the systematic biologist, or the investigator who concerns himself with the identification and recording of species of plants and animals, can draw at will. Then there are the life-histories of marine organisms to be studied; and in the plankton we meet with stages in the development of nearly all marine organisms, so that the latter is a great storehouse of material for the comparative embryologist. An excellent sample of this latter kind of work is to be found in the researches on the life-histories of the British marine fishes carried out by M'Intosh and the St Andrews school of zoologists; but an enormous number of such investigations have been carried out in all civilised countries. The distribution of

[1] See Haeckel, *Plankton-Studien*, G. Fischer, Jena, 1885 (or the English translation in the *U.S. Fish Commissioner's Report for* 1889–91, Washington, 1893), for a historical account of plankton investigations.

the animals and plants of the plankton in the different seas of the world is a department of research closely related to those I have just mentioned. This work was first systematically pursued by the naturalists of the *Challenger* in the famous expedition of 1872–6, and has been taken up by every marine exploring expedition of recent times. Such research, purely zoological, embryological, and distributional, is characteristic of the marine investigations of Britain, America, France, and Italy more particularly. In Germany the study of the fauna and flora of the sea has been approached from a somewhat different standpoint and by different methods.

If we might compare the investigation of life in the sea with the study of the population of a great city, these two lines of marine research can be illustrated rather well. The British and American investigations might be compared with the methods of the census enumerator, whose task it is to identify and record the individual inhabitants, with respect to occupation, locality, etc., or with the "amateur vagrant," or journalist, who searches for curious and interesting types of humanity. But we can also consider a great city more as a polity than a congeries of individuals, however interesting those may be individually, and study the economical relationships and interactions of the different classes of its population. This latter method of investigation may be compared with the plankton studies of a modern school of German biologists.

Victor Hensen, who was the first to make a systematic study of the plankton of the sea from this latter point of view, attempted to answer two main questions: (1) What does the sea (or any given small volume of it) contain at a given time in the way of organisms; and (2) how does this material vary from season to season and in different places? Formerly the quality only of the plankton had been taken into account; Hensen endeavoured also to determine the quantities of the different organisms in it. To attain these results it was necessary to devise an entirely new scientific method, and by the exercise of great patience it became possible at length to devise quantitative fishing apparatus. The ordinary plankton net is a conical bag of silk cloth, the meshes of which are so fine as to strain out practically all the smaller microscopic animals and plants found in the sea. This net is usually one to two feet in diameter at the mouth, which is kept open by an iron ring, and it may be a yard or more long. It is simply dragged through the water from a vessel travelling slowly, and a portion of the water entering its mouth is strained through the fabric of the net, which retains the organisms present. Now, though it may be possible, by the use of such a simple contrivance, to obtain relative ideas of the quantities of plankton in the sea at different times and places, it is practically impossible to obtain any correct estimate of the absolute number of organisms present. This latter knowledge is what Hensen tries to obtain by the use of a specially constructed net, which is lowered down to the bottom of the sea and is then slowly hauled up to the surface. By a series of ingenious calculations, in which the "filtration capacity" of the net, the depth to which it is lowered, the speed with which it is hauled up, etc., are factors, it is possible to calculate what fraction of the water entering the mouth of the net passes through its meshes. The plankton present in the net is, then, that which was present in a column of sea-water of a certain cross area, and extending from the surface of the sea down to the depth to which the net was lowered. It is, in fact, a sample of the contents of the sea, both in quality and quantity, in the place where the experiment was made. A number of such fishing experiments are made, and an average is struck from their results and expressed in this way: Every square yard (or square metre) of (say) the North Sea or the Baltic contained so much plankton at the time when the experiments were made.

By a series of ingenious operations,[1] the plankton "catch" is then removed from the net and is

[1] It is quite impossible to give even a brief account here of the methods involved. The reader is referred to a paper by Jenkins in *Proceedings and Transactions of the Liverpool Biological Society*, vol. xv., Liverpool, 1901, or to an appreciative paper by Reighard in the *Bulletin of the U.S. Fish Commission*, vol. xvii., Washington, 1898. Hensen's original memoirs are published in the *Wissenschaftliche Meeresuntersuchungen* of the Kiel Kommission.

preserved for future study. This consists in the measurement of its volume or weight, in the chemical analysis for nutritive material, and in the enumeration of the separate individuals belonging to the different species of plants and animals caught. All these determinations have been made by the Kiel biologists, and the solution of the various difficulties encountered in these investigations is a striking tribute to German patience and technical skill. Obviously, the results obtained can claim to be only approximations to the truth. Many sources of error exist, the principal of which are: (1) the difficulty of measuring the exact quantity of water filtered by the net; (2) the fact that many of the smaller organisms (diatoms) in the sea slip through the meshes of the silk cloth; and (3) the fact that the distribution of the plankton is rather irregular, so that an exact estimation of the organisms present in one part of the sea may not be true of adjacent regions. All these, however, are errors which are minimised as much as possible, and will, no doubt, ultimately be got rid of more or less completely. They certainly do not justify the somewhat severe criticism which Hensen's method has received,[1] both in Germany and Britain: Hensen's results may, not

[1] As, for instance, in the partial and injudicial criticisms by Haeckel in *Plankton-Studien*, Fischer, Jena, 1895. An English translation of this paper is published in the *U.S. Fish Commissioner's Report for* 1889–91, Washington, 1893.

unreasonably, be compared with Lord Kelvin's estimation of the age of the habitable earth founded on experiments made on the cooling of certain rocks from high temperatures. These results, though only approximations, gave at least an approximate measure of the age of the globe, and prevented "unlimited drafts on the bank of time." Henson's results give at least a sufficient quantitative idea of the contents of the sea to enable us to arrive at results of extreme theoretical and practical interest.

All these investigations, the "tow-nettings" of the older naturalists and the newer Hensen and other quantitative methods, have furnished us with a mass of information relating to microscopic life in the sea, which, merely to summarize, would be beyond the compass of a work like this. We may note only a few salient points. The varying distribution of the plankton according to the season was one of the first things to be made out. Speaking in general terms only, a series of tow-nettings made on (say) the north-west coast of England, at the surface of the sea, would present a sequence approximately as follows: early in the year, in January and possibly February, there would be a general scarcity of life, but about the end of the latter month, or perhaps later, according to the season, we should expect to meet with an increase in the bulk of the plankton. This is the beginning of the "seedtime" of the sea, fishes and other animals are beginning to spawn, and by the end of March the eggs of the former and the larvæ of other marine animals, like crabs, are abundant. At this time, as on the land, there is a great development of vegetation in the sea; diatoms have become very abundant, so that, since these constitute the bulk of the catch, the maximum bulk of plankton in the sea occurs about this time. Other groups of marine microscopic animals, like copepods, also now become abundant. With the onset of summer this luxuriance of plankton passes away, diatoms are not so abundant, while larvæ of fishes and other marine animals have entered their nektonic or benthotic phases. Towards the middle of the summer and for some time later "jelly-fishes" become abundant. Such animals are *Noctiluca* (one of the causes of phosphorescence in the sea), ctenophores, medusæ, etc. There may also be a second maximum of diatoms during the autumn, again augmenting the bulk of the plankton. Finally, in the last two or three months a general scarcity in all forms of life again occurs.

This is only a very general scheme, and all plankton studies have shown that the nature and amount of microscopic life in the sea are greatly affected by a number of conditions. Inshore, in shallow waters subject to the influence of the land, of fresh water, and consequent changes of salinity and temperature, and under the influence of tidal streams and minor currents, great variations in the abundance of the plankton and the sequence of the various forms occur. Speaking generally, in shallow water the plankton is more abundant and more variable in nature and amount from place to place. It varies in the same place with the time of day ; catches made in the dark usually present some differences from those made in the daylight. It varies also with the depth. Fish eggs, for instance, are only found near the surface. Every zone of depth in the sea in any one place has a fauna and flora which are slightly different from those frequenting any other zone. Far out at sea, however, though this irregular distribution with the depth still holds good, the general nature and amount of the plankton is much more uniform, a result which is to be expected when the disturbing influences of the land cease to be apparent. Then, contrary to what might be expected on a first consideration, the colder seas in polar and sub-polar regions are richer in plankton than tropical and sub-tropical seas. This wealth of life in the colder waters of the globe is due almost entirely to the diatoms, and for a reason to which I shall refer later on.

All these results and many others have been obtained by the ordinary methods of plankton fishing. But when it became possible, by means of the Hensen methods, to enumerate the individuals of the plankton, many striking and suggestive lines of investigation opened up. The amount of labour entailed by these methods is very great—Hensen tells us that he took a week, working for eight hours per day, to enumerate the organisms in a single catch,[1]—but the results are commensurate with the labour employed. The most interesting, and those of most practical value, were obtained by the enumeration of the pelagic fish eggs in the Baltic and North Seas. In the course of three voyages in the North Sea in 1895,[2] Hensen and Apstein found, as the result of 158 hauls with a quantitative plankton net, an average number of 92 eggs and larvæ belonging to fishes used as human food per square metre of surface. The surface area of the North Sea is 547,623 million square metres, and a simple calculation (after applying certain corrections) showed that that sea contained in 1895 *at least* 157 billion eggs and larvæ of food-

[1] Haeckel (in the *Plankton-Studien*) has referred to this statement of Hensen's in a somewhat slighting manner, and has deprecated generally the value of quantitative investigations in biological science. Such a criticism seems very curious now, when quantitative methods have become so largely developed in general biological as well as in pathological investigations. The quantitative methods in connection with problems of variation and heredity developed by Heincke, Galton, and Karl Pearson are producing results of notable value, and the methods of the enumeration of the red blood-corpuscles of the human blood in health and disease, and of the enumeration of microbes in sewage and other liquids, are essentially similar to Hensen's plankton estimations.

[2] *Wissenschaftliche Meeresuntersuchungen*, Kiel Kommission, Bd. ii., Heft 2, 1897.

fishes. The importance of this result is at once apparent, for, since it is easy to calculate the average number of eggs spawned annually by each species of fish, it becomes possible to estimate, within certain limits of error, the *absolute number of mature food-fishes inhabiting the fishing grounds of the North Sea.* By no other method known to us is this possible. A similar investigation of a portion of the West Baltic (the Eckenförde fishing area) gave most interesting results. It was estimated, from quantitative plankton fishing experiments, that during the four months, January to April 1885, there were spawned in all 370 eggs of cod and plaice per square metre of surface. Now, the numbers of cod and plaice captured during the same four months by the Eckenförde fishermen was also known (being calculated from a nine-year average), and knowing how many eggs may be produced from a mature cod or plaice, it is easy to calculate the number of eggs those fishes would have produced if they had been left in the sea. The result was 110 eggs per square metre. That is, all the cod and plaice, captured and free, on this fishing ground would have produced 480 eggs per square metre. But men captured (in the shape of the parent fishes) 110 eggs per square metre. Therefore in each year the Eckenförde fishermen captured one-fourth of the total number of adult plaice and cod present in their fishing grounds, a result which shows how much fishing operations tax the population of the sea.

In the sea and on the land one form of animal life depends for its sustenance on the capture and utilisation as food of some other form of life. It is easy to trace this in the case of any particular animal, such as man. A large portion of our own food consists of the flesh of other animals, and the remainder is some form of vegetable tissue. We know from constant observation the animals on which the fishes used as food by man feed. In the case of cod, we find that an almost constant and favourite form of food consists of crabs of various kinds. The cod (which is one of the foods of man) therefore feeds on the crab, and it now becomes our object to determine the food of this crustacean. The crab is catholic in its tastes, but we shall, in many cases, find it feeding on various worms inhabiting the bottom deposits of the sea, and these worms again we shall often find feeding upon the smaller crustacea (among other things). Pushing our inquiry still further, we may find these smaller crustacea feeding upon the copepods which live in the mud, and with these micro-crustacea our chain of animal forms which are linked together as the food and sub-foods of the cod (and man) comes to an end. Or if we take the plaice, again, as another food of man, we can establish another, though shorter, series. This fish usually feeds on small bivalve shell-fish living in the sea-bottom deposits, but we do not find that these shell-fish feed to any extent on any other form of animal life. These are only two cases out of many which could be given, in each of which inquiry into the foods and the foods of the foods enables us to establish series of animal forms linked together in such a way that one regularly preys on the other.

But it is not true that

> "Large fleas have little fleas
> Upon their backs to bite 'em;
> And little fleas have lesser fleas,
> And so *ad infinitum*."

Sooner or later each series of animal forms comes to an end, and we find that the last, and smallest, member does not prey on an animal smaller than itself, but obtains its food by eating some form of vegetable life, sea-weeds, diatoms or other unicellular marine plants. *In the sea, as on the land, all animal life depends ultimately on vegetable life for its sustenance.*

There is, in the long run, no essential *morphological* difference between an animal and a plant. However obvious may be the differences in form between a highly developed animal, such as a fish, and such a relatively highly developed marine plant as an alga, the corresponding differences between the lower forms of animals, such as the protozoa (say foraminifera and radiolaria), and the unicellular plants like diatoms, are not apparent on inspection. The real differences are physiological, not morphological. A plant feeds in a different manner from an animal. The latter must obtain for its food the living or dead tissues of another animal or plant; the former can utilise material which is not alive. The animal feeds on organised, the plant on inorganic, materials. Now, since it is only the plants which can convert inorganic materials into a form suitable for assimilation by animals, it follows necessarily that the animals are in the long run ultimately dependent on the plants. No matter how many forms of life may be intercalated between the cod and the diatoms or other plant-material on which the copepods feed, or between the plaice and the diatoms on which bivalve shell-fish feed, it is no less true that these plant-forms are the ultimate food of both cod and plaice. The plankton constitutes the "meadows of the sea." How rich these "meadows" are has been estimated by Hensen and his colleague, Brandt. In March, one particular species of diatom alone (*Chætoceros*) was so abundant in the West Baltic that there were 457 millions in every cubic metre of sea-water; that is, every block of water which measured about one-third of an inch along each side contained about 457 diatoms. Next to the diatoms, the group of micro-crustacea known as copepods are most important. Every cubic metre of West Baltic water was estimated to contain about

80,000 of these little animals. In some parts of the Antarctic Ocean the diatoms are so abundant as perceptibly to colour the surface water, and in the same region the deposit at the sea-bottom is a soft white ooze which consists almost entirely of the dead flinty shells of these organisms. The diatoms and the copepods form the fundamental organic food-material of the sea.

It is possible to estimate the productivity of the sea, just as one can estimate the productivity of the land. Hensen and Brandt found that each square metre of the Baltic produced on the average about 150 grammes of dry organic food-substance in the shape of plankton. A similar area of cultivated land produces (according to Biebahn and Rodewald) about 180 grammes of the same ultimate food-substance. The productivity of the sea, judged by the amount of plankton generated, is therefore about 20 per cent. less than that of cultivated land. The productivity of the sea may also be compared with that of the land by comparing the quantity of produce obtained in each case from similar areas; that is, the weight of fish obtained from an acre of sea may be compared with the weight of agricultural produce obtained from an acre of cultivated land. Some interesting observations of this kind are contained in the Report of the Fisheries Commissioners of 1866, according to which "an acre of good land carefully tilled produces [per annum] a ton of corn, or two or three hundredweight of meat or cheese. The same area at the bottom of the sea yields a greater weight of food to the persevering fishermen every week in the year."[1]

According to Brandt,[2] the fishermen of Northern European countries take from the North Sea about nineteen million kilogrammes of nitrogen, in the form of edible fish, every year. At any one moment there is about double this quantity present in the North Sea. Since this withdrawal of nitrogenous food-material continues year by year, the loss of nitrogen (and of course the other food-forming elements) must be made up. The nitrogen taken from the sea in the shape of fish is returned to it as nitrogenous compounds washed down from the land by rivers. On the death and decomposition of the bodies of animals and plants, the organic material of which they are composed is resolved, by the action of putrefactive bacteria, into compounds of nitrogen (ammonia, and salts of nitric and nitrous acid), carbonic acid, water, and other substances. The nitrogenous substances, being easily soluble in water, are soon washed into the sea by the agencies of rain and rivers. It has been computed that all the rivers of the world convey in this way no less than thirty billion grammes (about twenty-nine million tons) of

[1] p. 26 (8vo edition).

[2] *Wissensch. Meeresunt.*, Kiel Kommission, Bd. iv., Abth. Kiel, 1899.

nitrogen from the land into the sea every year.[1] Animals are unable to use these inorganic nitrogenous substances as food, but the plants can. By the agency of the latter the salts of nitric and nitrous acids and of ammonia are converted into the protoplasmic material of the plant tissue—that is, into a form which can be assimilated by animals. There is thus a perpetual cycle of changes—the nitrogen is taken from the sea in the form of fish food, and it is then assimilated and built up to form the substance of the living body. Then either after death, or during life in the ordinary processes of excretion, this living protoplasmic substance breaks down and decomposes, and is resolved by putrefactive and other bacteria into simple nitrogen compounds. These find their way into the sea through drains and rivers, and are utilised as food by plants.[2] The plants are then eaten, directly or indirectly, by marine animals, among which may be the fishes, and the latter may then be returned to the land.

An important part is performed by the bacteria of the sea in this cycle of changes. One class of microbes—the *putrefactive bacteria*—have the power of decomposing organic nitrogenous substance, and by their action the dead body of a fish, for instance, is resolved into simpler organic

[1] Brandt, *loc. cit.*, p. 217.

[2] Diatoms and unicellular plants chiefly, but also by some unicellular animals which feed like plants.

compounds. Then the *nitrifying bacteria* come into action and resolve these organic nitrogenous substances into, first of all, ammonia, then nitrous acid, and finally nitric acid.[1] But another set of bacteria, the *denitrifying bacteria*, also exist in the sea, and these reverse the action of the nitrifying bacteria, that is, they convert nitric acid into nitrous, nitrous acid into ammonia, and ammonia into free nitrogen. The latter is then returned to the atmosphere. It is probable that a considerable degree of denitrification takes place in the sea. But the denitrifying bacteria are more active in the warm tropical seas than in the colder polar waters. Therefore more of the nitrogenous compounds are broken down there, and there is less food for diatoms and other organisms which feed in the manner of plants. The plankton is therefore scarcer.[2]

Apparently, then, the atmosphere should be becoming richer in nitrogen because of this denitrification. But leguminous plants (peas, beans, etc.) have the power of taking free nitrogen from the air and utilising this as food. Every

[1] Carbonic acid and water are, of course, also formed in this process, and oxygen is taken up from its solution in the surrounding sea-water.

[2] Apstein (*Das Süsswasserplankton*, Kiel, 1896) and Brandt (*Stoffwechsel im Meere*) showed that, in the fresh-water lakes of Holstein, the plankton was more abundant where there was a large proportion of nitrates than where the proportion of these substances was relatively small.

flash of lightning, too, causes some of the nitrogen to combine with the oxygen, and to reach the ground as nitric acid. By these two processes the balance is kept between the processes of nitrification and denitrification, and the atmosphere retains a constant composition.

CHAPTER XII

HYDROGRAPHICAL INVESTIGATIONS

By far the greater portion of the literature of fisheries science deals with the biological investigation of the natural conditions of the fishes and other animals sought by the fisherman. Anyone making a somewhat cursory survey of this literature may well conclude that only such investigations as the life-histories of marine economic animals, their habits, food, abundance, migrations, and the like, are likely to prove of practical value. But a more attentive study will show that another line of research, which we may call the hydrographical investigation of the sea, is just as essential for a proper understanding of sea-fisheries questions. Such investigations deal with the depths of the sea, the nature of the deposits forming its floor, the movements of water caused by tides, winds, and ocean currents, the chemical composition of sea-water, its varying temperature, salinity, and specific gravity. The exact nature of the connections between all these phenomena (and meteorological changes) and the movements and abundance of fishes is not always apparent; but nothing is more certain than that such physical phenomena, and others, which we may call purely biological ones, are closely related. There are two main factors which govern the migration and abundance of fishes: the search for suitable foods, and some imperfectly understood conditions leading to the choice of suitable spawning localities. In each of these cases we may be fairly sure that physical events taking place in the sea are the remote causes which we seek.

Now, though this is well known, yet the exact nature of the connection is not easily seen. Fisheries science is less advanced than agriculture in this respect, but there are some instances that may be given of the manner in which the two sets of events are connected. A temporary abundance of plaice on a certain fishing ground may often be proved to be due to a "strike" of young mussels on the fishing ground in question, and this abundance of mussels can be traced to some particular set of the currents, which has transported the "spat," or larvæ, to that particular ground; and further, the growth of shell-fish may be promoted by a rich diatom flora, which again may be due to suitable conditions of weather. Again, it is well known that the spawning seasons of fishes are variable, and it is also known that the beginning of the spawning season depends to a considerable extent on the nature of the weather during the preceding winter. We know, too, that the incubation period of fish eggs depends closely on the temperature of the water in which they are developing. Thus, a flounder egg will hatch in from five to ten days, the incubation period varying with the temperature. Plankton studies show that the appearance and nature of microscopic life in the sea depend on the weather. Diatoms are more abundant during a temperate spring, when there is plenty of sunlight. It is well known that fishes are closely affected by the temperature of the water : soles seek deep channels in cold weather, and plaice may bury themselves in the sand in such circumstances. It has even been shown that there is an actual connection between temperature and the abundance of anchovies in the Scheldt fisheries. The catch of this fish varied in some years according to the average temperature of the water during the previous summer months.[1] There are other cases which might be quoted from a study of the literature, all showing that the connection between the abundance and movements of sea-fishes and the physical conditions of the medium in which they live is very close indeed.

The earlier hydrographical research in Great Britain was purely scientific in its aim. In the famous voyage of the *Challenger* in 1872–76 an

[1] See *Journal Mar. Biol. Association*, 1889–90, vol. i. (new series), p. 340.

immense amount of such research was carried out: all the seas of the globe were traversed, and an enormous number of observations were made. The methods of the *Challenger* were to make a series of soundings, at the same time securing a sample of the deposit forming the floor of the ocean. In this way the depths and contours of the ocean beds were determined, and a very full knowledge was obtained of the nature of the bottom.[1] The temperature, specific gravity, and salinity of the sea-water, both at the surface and at a number of depths down to the bottom, were also observed, and samples of water from various depths were taken in many parts of the oceans for chemical analysis. The movements of oceanic waters forming the great currents were also determined by direct observations, by floats, etc., and by a study of the temperatures and specific gravities. Barometric and other data were also obtained. The result of the *Challenger's* work was to give us a very full knowledge of the sea from the point of view of that department of physics called "oceanography." Little or no attention was, however, directed to the study of the practical problems of the sea-fishing industry, though, no doubt, the observations of the *Challenger* were of immense assistance in further hydrographical fisheries research.

[1] Our knowledge of these matters has been largely supplemented by improved methods elaborated by the deep-sea cable companies.

The earliest important application of these methods was made in Germany. The first large piece of work carried out by the Kiel Kommission was the cruise of S.M.S. *Pommerania* in the North Sea and Baltic. This was in 1872–3. This enterprise, described as a "physikalische, chemische und biologische" expedition, led to results of great importance,[1] and until the beginning of the eighties the results of the *Pommerania* expedition represented our knowledge of the hydrography of North European waters. When the Scottish Fishery Board began work, close attention was directed to physical investigation, and a beginning was made by a cruise by H.M.S. *Jackal* in the Moray Firth in 1883.[2] The resources of the Board were, however, inadequate for sustained hydrographical research, since they possessed no vessel equipped for the purpose. A number of other expeditions were, however, made, and when in 1887 they obtained a steamer to be exclusively employed in scientific work, physical observations were made almost continuously as part of the routine scientific investigation.

Scandinavia, however, more than any other country, has been the centre of this kind of investigation, and Professors Otto Pettersson (of

[1] For the full accounts of these voyages, see the Kiel Kommission's *Jahresberichten* for 1872–74.

[2] *Scottish Fishery Board Report for* 1886, p. 189.

Stockholm University) and Cleve (of Upsala) have long been associated with the physico-biological investigation of the North Atlantic, the North Sea, and the Baltic. In the investigations carried out by these hydrographers and their colleagues, two objects have apparently been kept in view: (1) the investigation of the movements of the water in these seas from the point of view of the fisheries—the migration of the herring to and from the fishing grounds, for instance; and (2) the elucidation of the conditions affecting the climate of the countries bordering on the Skagerack, the Cattegat, and the Baltic Sea. After much preliminary work, in which results of great importance were obtained, Pettersson and Ekman, in 1892, formulated a scheme for an international survey of the North Sea and the entrance to the Baltic. To obtain results on a large scale was beyond the resources of any one State, and it was seen that only by the simultaneous employment of a number of surveying vessels could the condition of such an extensive area be ascertained. The co-operation of Norway, Sweden, Denmark, Germany, and Great Britain was fortunately obtained. Great Britain was represented by the Scottish Fishery Board, and Germany by the Kiel Kommission. The survey was carried out in the months of May, August, and November of 1893, and in May of 1894, and the results of this, the first international fisheries scientific undertaking, are of such interest that I may profitably treat them in some detail.[1]

The characters of sea-water which are made use of by the hydrographer in tracing the movements of large bodies of water are :—

1. *The temperature at the surface and at a number of intermediate depths down to the bottom.* The temperature is always changing. Generally it is warmer at the surface than at the bottom. In all deep oceans the temperature of the water at the bottom is very little above freezing-point, and it undergoes hardly any variations.

2. *The density.* Sea-water is heavier than fresh water, because of the salt and other substances dissolved in it. The number representing the density expresses how much heavier is a certain bulk of sea-water (say a gallon), as it exists in the sea, than an equal bulk of pure water at the temperature of 4° C.

3. *The salinity*—that is, the salt-contents. The number representing the salinity expresses how many grammes of solid matter are dissolved in 1000 grammes of sea-water. The salinity varies with the source of the water. In North European seas (excepting the Skagerack, the Cattegat, and the Baltic, where the water may at times be very fresh) it may be as low as 30 and as high as 35·5.

[1] See Dickson in *Geographical Journal* for March 1896; and an excellent review by Cunningham in *Journal Mar. Biol. Association*, vol. iv. p. 233, 1896.

4. *The gaseous contents.* Sea-water always contains a certain amount of various gases—oxygen, nitrogen, and carbonic acid—dissolved in it. These are dissolved from the atmosphere or derived from the respiration or putrefaction of marine organisms. In deep, stagnant seas the amount of oxygen at the bottom may be very small.

5. *The plankton.* Different regions, such as the Baltic, the North Atlantic Ocean, the Arctic Ocean, or the Black Sea, have characteristic plankton organisms at certain periods of the year. By identifying the plants and animals present in any one place, it is possible to tell what was the source of the water examined.

Temperatures are determined by means of carefully constructed thermometers. If the temperature of the water at the sea-bottom or at any intermediate depth is required, a sample is obtained by means of a specially constructed bottle, which is lowered down open. When it reaches the depth required it is closed by means of a special arrangement, and a sample of the water at that depth is obtained. The bottle is so constructed that while it is being raised to the surface the temperature does not appreciably change. The latter is then taken by an ordinary thermometer. If the depth to be investigated is very great, the temperature is obtained by means of a "reversing thermometer," that is, an instrument which registers the temperature of the water at the depth to which it is lowered. Salinity is determined by a chemical method. A solution of nitrate of silver of a known strength is added drop by drop to a measured quantity of water under examination. The silver precipitates the salt as a white curd. From the amount of silver solution required to precipitate all the salt, the amount of the latter present in the sample is very exactly determined. The gaseous contents are estimated by somewhat more complicated chemical methods.

Now, by making use of these methods it was found by Pettersson and Ekman, and afterwards by the hydrographers of the 1893 survey, that at any one time the water of the North Sea might be derived from one or more of three sources:—(1) *North Atlantic water.* This enters the North Sea round the north of the Shetland Islands. Its entrance into the latter area is the result of the "Gulf Stream" current. The real Gulf Stream does not, of course, actually reach the British Islands; but the effect of the prevalence of cyclonic storms reaching our coasts from the south to south-west of the Atlantic is to drive the surface layer of the sea towards and to the north and east of the British Islands. This North Atlantic water is heavy, possessing a normal salinity of over 35 parts per thousand. Most of it in the North Sea enters from the north-west, but a small portion enters through the Straits of Dover. (2) *Baltic water.* This is very light water, with a salinity of 30 to 32 per thousand. It flows out as a surface current from the Skagerack along the Norwegian coast. It is produced by the rivers falling into the Baltic, and at certain seasons, owing to rainfall and the melting of snow, land and sea ice, its volume is enormously augmented. It is a mixture of fresh water with the salt water which enters the Baltic as a deep current. In addition to these two contributory kinds of water, two others may be present in North European seas, which are: (3) *North Sea water*, with a salinity of 34 to 35. At certain times in the year this forms the greater part of the water covering the surface of the North Sea. (4) *Bank water*. This forms an edging of variable width along the continental coasts. It is relatively light, possessing a salinity of 30 to 32 parts per thousand. Both Bank water and North Sea water are mixtures of the two original components, Atlantic and Baltic waters. Finally, a certain quantity of Arctic water may reach into the North Sea in some seasons. This is cold water, and has a salinity of less than 35. It enters the North Atlantic as a deep current.[1]

In May 1893 the waters of the North Sea had the following arrangement[2]:—There was little

[1] See Pettersson, *Scottish Geographical Journal* for 1894, and Hjort, Nordgaard, etc.

[2] Dickson's charts of the North Sea in 1893, published in the *Geographical Journal* for 1896, illustrate these changes very well.

Atlantic water either at the north or south entrances, and the bulk of the area was filled with water having the salinity characteristic of the North Sea; its saline contents were 34 to 35 per thousand. The Baltic current had not begun to flow out of the Skagerack; on the contrary, there was a decided inflow of Bank water northwards along the coast of Jutland, and southwards along the coast of Denmark, into the former area.

In August 1893 this state of things had altered greatly. North Sea water was restricted to the central portion and the coastal margins, and from the north and south large tongues of Atlantic water were projecting. At the same time a very wide surface current was flowing out from the Baltic through the Cattegat and Skagerack.

In November 1893 this restriction of North Sea water and the increase of Atlantic water was still in progress. But the outflowing current from the Baltic had ceased, and instead of it there was an influx of Bank water into the Skagerack from the north and south, as in May of the same year.

The observations in February 1894 completed the yearly cycle. The tongues of oceanic water entering at the north and south had now become continuous, and the greater portion of the North Sea was filled up by water of this origin. North Sea water proper was restricted to comparatively narrow margins on either side. Bank water, as before, was flowing from the north down the

Norwegian depression, and from the south along the continental coasts into the Skagerack.

These results of the international survey of 1893 showed, then, that the prolific fishing grounds of the North Sea were subject to important seasonal variations in respect of the nature and source of the water covering them, and of the organisms which composed the plankton inhabiting the sea. But the problem was one of very great magnitude and importance, and it was seen that, if it were to be investigated on a sufficient scale, a wider area would have to be taken into account, and a greater number of exploring vessels would be required. International co-operation was the only means by which the work could be done, and several attempts were made to secure this on the part of the States interested in the fisheries of the North Sea. There were other important reasons which made international co-operation in fisheries research very desirable. The agitation for some restriction on the capture of small flat fish in the North Sea had assumed its present form. The grounds on which these small fishes are captured are outside the territorial limits of any State; and while it is within the power of any one of the governments concerned to impose restrictions on the area exploited, or the methods adopted, *by its own vessels*, international agreement only could affect *all* the vessels catching these small fishes. A further argument in favour of international agreement is that this might lead to a virtual extension of the territorial limits in cases where this is of some importance. The experiments of the Scottish Fishery Board, which led to the closure of the Moray Firth, have been, to some extent, rendered valueless by the fact that foreign trawlers can, and do, fish in that area, though it is closed against British vessels. If international agreement to respect the closure of such an experimental area could be secured, it was felt that much good would be done. These considerations argued strongly in favour of the formation of an international association for marine fisheries exploration, and official people in touch with the British fisheries authorities seem to have been influenced by such arguments. The Select Committee of the House of Commons which considered the Sea-Fisheries Bill of 1900 made a recommendation in favour of international action. "No effort," they said, "ought to be spared, first, to arrange for international treatment of the subject generally [scientific investigation and regulation], and especially for regulation of the North Sea area."[1] Between 1893 and 1900 there was, it is quite evident, a growing feeling in favour of international research and regulation.

In 1899, therefore, the Swedish Hydrographical Commission made representations to the Swedish Government, which resulted in the extension of an invitation by the latter to those States interested in

[1] *Report, Select Committee of* 1900, p. vi.

the fisheries of North European seas to hold a conference, at which some plan for international research might be drawn up. The result of this invitation was that a meeting of representatives took place at Stockholm in June 1899. The States represented were Great Britain, Russia, Germany, Denmark, Holland, Norway and Sweden. Our country sent Sir John Murray, Professor D'Arcy Thompson, and Mr W. E. Archer to this conference. A scheme was recommended and passed unanimously by the delegates, and it was resolved to submit this to the States concerned.[1] No effect, however, was given to this recommendation, and it was felt that the information and time at the disposal of the delegates were insufficient to allow of a detailed programme being drawn up. A second conference was therefore held at Christiania, at the invitation of the Norwegian Government, in May 1901, and the proposals of the Stockholm conference were revised and put into final form.[2] Great Britain on this occasion was represented by Sir Colin Scott-Moncrieff and Professor D'Arcy Thompson, with the expert assistance of Mr W. Garstang and Dr H. R. Mill.

These proposals had reference to two main lines of research work which were mutually

[1] See *Journ. Mar. Biol. Association*, vol. vi. p. 101, 1900, for a full account of this scheme.

[2] *Journ. Mar. Biol. Association*, vol. vi. p. 389, 1902.

dependent on each other. On the one hand, there was the hydrographical work—the study of the physical conditions of the sea, the temperature and chemical composition of oceanic waters and their movements; and on the other, there was the study of the plankton, both from the point of view of hydrography and the natural history of economic fishes. Then there were numerous other departments of marine research, such as the migration of fishes, the distribution in the North Sea and other areas of the various stages of fishes, the nature of the bottom fauna, the distribution and abundance of fish eggs, and the elaboration of uniform statistics of the sea-fisheries by *the participating States*. The conference recommended that a central organisation be created to co-ordinate the researches, to prepare publications, and to act as an intermediary between the different governments.

The scheme thus propounded by the Christiania conference was accepted by the various States represented, and the legislature of each voted a sum sufficient for the purpose. Germany, Norway and Sweden, Holland, and the Senate of Finland accepted the programme, and agreed to continue to take part in the researches for the period of five years proposed by the conference. Denmark voted a sum sufficient for three years' work, and decided to consider whether the results achieved at the end of that time would justify their continuing their support.

Great Britain took up the same position. Russia also took part in the work, and Belgium decided on taking a share at the beginning of 1903. The Danish Government then invited representatives of the participating States to meet at Copenhagen, and at a third conference, held there in July 1902, the "International Council for the Exploration of the Sea" was constituted. In its final form this body consisted of the following members :—

Denmark : Captain Drechsel and Mr M. Knudsen.
Germany : Drs Hertwig and Krummel.
Great Britain : Sir Ed. Goschen and Professor D'Arcy Thompson.
Finland : Mr J. Alb. Sandman.
Holland : Drs Max Weber and C. H. Wind.
Norway : Drs Fridtjof Nansen and J. Hjort.
Russia : Dr Oscar von Grimm.
Sweden : Drs Pettersson and Trijborn.

With these members the following experts were associated :—

Denmark : Drs C. G. J. Petersen and C. H. Ostenfeld.
Great Britain : Dr H. R. Mill and Mr W. Garstang.
Sweden : Professor Cleve of Upsala.
Russia : Mr L. L. Breitfuss.

The council thus included most of the best-known North European hydrographers and fisheries investigators amongst its members. It then constituted a bureau for the purposes of administration and publication. This body consisted of a president (Hertwig), a vice-president (Pettersson), a general secretary (Dr Hoek), with a clerical and technical staff. Its headquarters were at Copenhagen. A central laboratory, with Dr Nansen for director and with a scientific staff, was established at Christiania. Each State contributes to the upkeep of the central organisation in the following proportion per annum :—

Denmark	£262
Germany	1250
Great Britain	1250
The Netherlands	262
Norway	262
Russia and Finland	1250
Sweden	262

and in addition to these sums, each State contributes the money necessary for the upkeep of its own exploring vessels and staff. Great Britain voted a sum of £42,000 for the three years over which the investigations were in the first instance to extend. Part of this sum goes for the upkeep of the bureau and central laboratory, and the remainder is spent on the vessels and staff employed in the investigations. The national organisation was entrusted, in England, to the Marine Biological Association, and in Scotland to the Scottish Fishery Board. Each of these bodies has hired a steam vessel for the work at sea, and employs a chemical and biological staff. In England the research work on shore is carried on at the biological station at Plymouth and at a marine laboratory at Lowestoft, organised for the purpose of these special investigations. Scotland makes use of the Scottish Fishery Board station at Aberdeen for the biological work, and a laboratory at University College, Dundee, for the hydrographical investigations. The direction of the researches is exercised in Scotland by Professor D'Arcy Thompson, and in England by Dr Allen and Mr W. Garstang.

Each State investigates a particular portion of the whole sea area. The investigations are sometimes referred to as if they were carried out in the North Sea only. The area in question is in reality very much wider than this. Britain has charge of the eastern part of the North Sea, the Atlantic as far north as the Færoe Islands, and to the west of the Outer Hebrides, and the English Channel. Germany investigates the western portion of the North Sea, and the Baltic Sea off the German coast. Russia has the rest of the Baltic (except the Gulf of Bothnia, which is investigated by Finland), and the Arctic Ocean to the north of the White Sea. Denmark has the Cattegat, the Belts, and the Sound, and the Færoe-Iceland channel. Norway and Sweden between them work the Skagerack and the seas off the Baltic coast of Scandinavia, and Norway also explores an extensive area extending fron Iceland and Jan Mayen to the opposite Norwegian coast.[1] Each vessel makes quarterly cruises along certain lines

[1] See the chart in *Journ. Mar. Biol. Association*, vol. vi. p. 402, 1902.

within the area assigned to it, and in the course of these cruises the hydrographical observations are made, and samples of the sea-water are taken for analysis at the laboratories on shore.

In reality these hydrographical observations form the least part of the sea-going work, so far as time is concerned, and very considerable attention is being devoted to the several questions of very great practical importance to the fisheries. These are: (1) the migrations of the principal food-fishes of the North Sea, especially herring, plaice, and cod; and (2) the important question of over-fishing by trawlers in the North Sea and adjacent fishing grounds. These two questions are treated *co-operatively* by the vessels working in the areas affected. Each question is entrusted to a committee, the conveners of which are Dr J. Hjort (migrations) and Mr W. Garstang (over-fishing). In addition to this co-operative biological work, each State is, of course, free to make whatever investigations are judged of importance.

"The chief aim of the whole work is to increase our knowledge of the conditions of the fisheries, and thus to further the interests of a rational exploitation of the sea. It must be remembered, however, that only those results are permanently and really useful which will bear the test of severe scientific criticism. The study of the sea is to proceed orderly and as rapidly as possible, but it would be unpractical to sacrifice the accuracy of the results, even if only a little, to a desire to reach an end more quickly."[1]

The international organisation has been severely, and perhaps rather unfairly, criticised in this country. Two main charges have been made against its methods and aims. It has been thought by some British naturalists that far too much attention was devoted to hydrographical observations, "which have not in any way explained the problems associated with the fisheries,"[2] and too little to general fisheries questions of a biological nature. Now, while the exact value of hydrographic research, as far as "practical" fisheries problems are concerned, may, in the present state of our knowledge, be a matter of opinion, there is no doubt that it is *a priori* extremely probable that an exact knowledge of meteorological and hydrographical events in the sea is of fundamental importance to the fishery investigator. There are, it is true, few actual proofs so far of the precise relationship between physical changes in the sea, and changes in the productivity of the fishing grounds. I have, however, quoted one such instance in the relationship between the temperature of the sea and the

[1] *Rapports et Procès-verbaux, Conseil Permanent International pour l'Exploration de la Mer*, vol. i., Copenhague, 1903. This book gives a very complete (and, of course, an official) statement of the formation of the international organisation, and a full account of the work contemplated.

[2] M'Intosh, *Evidence, Ichthyological Committee*, 1903, Q. 1217.

catch of anchovies in the Scheldt; and Hjort and Pettersson, both investigators of the first rank, have stated the probable relationship between the herring fisheries and hydrographical changes in the North Sea. The autumn herring fishery on the east coast of Norway is due, according to Hjort, to a "feeding migration," and is determined by the movements of the Bank water of the North Sea. The arrival of the herring shoals coincided in time with that of water of a relatively high temperature and of a salinity of 32–34.[1] Pettersson also[2] ascribed the appearance of the herring shoals in the Cattegat in autumn and winter to the movements of Norwegian and Danish Bank water. No one has yet contended that minute differences in salinity and temperature *as such* affect the movements of the herring. But this fish is a plankton feeder, and such organisms as copepods and diatoms are, no doubt, affected by these changes. And since every fish is, in the long run, a plankton feeder, we can recognise no essential distinction between pelagic fishes, such as the herring, and bottom-living forms like the plaice.

Two other main charges have been made against the methods of the international observations. One of these appears to me to be founded on some misapprehension of the precise methods

[1] J. Hjort, *Hydrographic-Biological Studies of the Norwegian Fisheries*, Christiania, 1896.

[2] See papers in *Scottish Geograph. Journ.*, 1894.

agreed on at the Christiania conference.[1] In all the agitations for fishery legislation since 1893, it has been tacitly assumed that the fishing grounds of the North Sea were being depleted. One of the objects of the international investigation is to determine this with certainty, and it has been assumed by the writer in question that this object was to be attained by the "fishery experiments" of the Christiania programme, that is, by trawling observations of the nature of those made by the Scottish Fishery Board on the east coast of Scotland. Now this method was (rightly) shown to be faulty when carried out in such an extensive area as the North Sea, and it was concluded that the results of the international investigation would not be of value. This would be a just criticism, if it were the case that an important part of the investigation was the determination by trawling experiments of the degree of depletion of the fishing grounds. But a reference to the official programme of the work to be undertaken will show that this was certainly not the case.

The other charge was made by the Committee on Ichthyological Research,[2] and referred to the probable accuracy of the results which might be expected from the organisation of the international work. Nearly all scientific work at sea, which has reference to the condition of the fisheries,

[1] D. N. Paton, in a letter to the *Times*, 31st March 1902.

[2] *Report* of this Committee, Memorandum, p. xxiv., 1903.

depends on the study of "samples," whether these be samples of sea-water, plankton, or fishes or invertebrates trawled from the sea-bottom. Naturally, the value of the deduction made from the study of such samples depends on their number, and it did not appear probable to the members of the Committee that these samples would be numerous enough. "We feel bound," the Committee pedantically state, "to express our grave apprehensions of the danger of using inadequately substantiated quantitative conclusions as a basis for action or regulation of fisheries—for if 'samples' misrepresent the actual conditions, or inadequately suggest the causes of those conditions, they may prevent the possibly quite legitimate grievances of the fishermen being redressed, or they may be detrimental to the supply of fish generally." Now, such a criticism is theoretically sound enough, but it may be urged, to some extent, against any scheme of fisheries research ever undertaken, or which may be suggested.[1] There is always the chance that

[1] An alternative scheme of North Sea fishery investigations was suggested by the Chief Inspector of Fisheries. In this it was proposed that a number of "reliable captains" of trawlers should furnish returns of their fishing operations to the Fisheries Department. At the same time sample boxes of fish would be bought from these vessels at the port of landing and examined by "trained experts," and if necessary these fish would be sent to the biological laboratories. Observations at sea were not apparently regarded as an essential part of the work. (*Report, Ichthyological Committee*, 1903, Evidence, Q. 1585, p. 71.)

conclusions founded on the study of samples may be wrong ones, and no one will deny that, the greater the number of observations, the more valuable the conclusions. In any well-considered scheme of fisheries or oceanographical research, this source of error is taken into account. The history of the science of the zoological distribution of animals on the surface of the earth (which science is based on the study of "samples") abounds with instances of errors of this kind; but the conclusions have, nevertheless, a very real value, because the errors were discovered and checked. There is no doubt that those who formulated and are carrying out the scheme of international investigations in connection with the sea-fisheries have considered this source of error, and are taking steps to minimise it. The more exploring vessels, voyages, and samples there are, and the longer the period of investigation, the more reliable will be the results. Even with much more limited resources than the international organisation possesses, very valuable results have been attained. If there were more vessels and a larger staff employed, it is, of course, certain that the ultimate results would be better. But there are limits to the generosity of governments supporting schemes of scientific investigation, and in the present case these were reached.

CHAPTER XIII

FISHERY STATISTICS

It will be seen that any discussion of sea-fisheries problems, such as I have attempted in these pages, involves constant reference to statistical information. The question of the impoverishment of the fishing grounds, for instance, would be a comparatively simple one, if we could obtain full and accurate figures showing, for a series of years, the exact number of vessels and fishermen working on the fishing grounds, the nature and extent of the fishing gear, and the quantities of fish of each species and of certain size-limits landed per year from the areas in question. Such data, however, as we can obtain are very imperfect, and are in many cases of very questionable value; and it therefore happens that our conclusions as to whether the yield of the fishing grounds is increasing or decreasing are, at the best, deductions from a great number of considerations, and cannot be regarded as having more than provisional value. Any proposed legislation which attempts to check the capture of immature fish is opposed in many quarters—by the inshore fishermen of the north-west coast of England, for example. It is claimed that a lower limit of eight inches in length for plaice would deprive these men of a considerable portion of the material by which they make a livelihood. Now, experience shows that the statements of fishermen with regard to the exact sizes of the fish which they catch are not always to be taken without question, and it becomes very important to ascertain for the area in question what proportion of all the plaice caught are under eight inches in length, and what is their market value. Such information would at once show what the effect of the proposed legislation would be, and whether it would or would not inflict hardship on any considerable class of fishermen. Speaking generally, no question of regulation can properly be discussed without the aid of accurate and copious statistics. And most scientific inquiries into sea-fisheries questions are now of such a nature that statistical information is quite indispensable, if our conclusions are to possess more than academic interest. The distribution of species of fishes, in respect of their different life-phases over several different areas, for instance, is one that occasionally becomes of considerable practical interest. Most of our knowledge on this head is derived from "fishery experiments," which are often very restricted in their scope, and which are necessarily treated somewhat inadequately. But a complete statistical statement of the number of fishes of the species considered, and of the different ranges of size, landed by fishermen from the areas in question would provide the data necessary, when supplemented by scientific investigation, for a complete understanding of the question.

Now, such considerations have always been present in the minds of those who have conducted inquiries into the condition of the sea-fisheries, and successive governments have repeatedly been advised to institute the collection of systematic fishery statistics. The Royal Commission of 1863, embarrassed by the lack of data on which to found an opinion as to whether the sea-fisheries were decreasing, were stationary, or were increasing, drew attention to this matter. "We think it a matter of great importance," they reported in 1866, "that fishery statistics should be systematically collected. It is only by such means that the constant recurrence of the panics to which the sea-fishing industry has hitherto been subjected can be prevented, and that any trustworthy conclusions can be arrived at regarding the effect of the modes of fishing which are in use."[1] No attention was paid to these words, and in 1878, when another inquiry had to be made into the alleged falling off of the fish-supply, the same lack

[1] *Report of the Royal Commission of* 1863 (8vo ed.), p. 178.

of information was commented on and the same recommendations were made.[1] Still no attention was given to the question of fishery statistics, and in 1885, when the Trawling Commissioners had completed a lengthy inquiry into the vexed question of the effects of this mode of fishing, further attention was directed to the matter. They regretted "the absence of any official fishery statistics, with the exception of those relating to the herring fishery and the cod and ling fishery of Scotland. The collection of such statistics was recommended by the Royal Commission of 1866, and again by the Commission of 1878. Eighteen years have elapsed since the recommendation of 1866 was made, and we are still without official statistics by which the accuracy of statements as to the decrease of fish may be tested."[2]

Almost while these words were being written, the officials at the Board of Trade were elaborating a scheme for the acquisition of the desired data. The ingenuous reader may imagine that the advice of such men as Huxley, Shaw-Lefevre, Mr Marjoribanks, Frank Buckland, Spencer Walpole, Lord Dalhousie, and Professor M'Intosh had at length borne fruit, and that some credit was to be ascribed to the laborious investigations of these gentlemen. But we are fortunate in possessing an official account of the reasons which induced those

[1] *Report of the Fisheries Commission of* 1878, p. xxxix.
[2] *Report of the Trawling Commission*, 1885, p. xii.

in charge of the fisheries of England to take steps, the utility of which had long been admitted by everyone conversant with the condition of the fishing industry. "The Board of Trade began the collection, in a systematic form, of statistics of fish landed on the coasts of England and Wales in 1885. H.R.H. the late Duke of Saxe-Coburg, then Duke of Edinburgh and Admiral-Superintendent of Naval Reserves, collected through the Coastguard some statistics as to the quantity and value of the fish landed, and in 1883 His Royal Highness read a paper [1] on the subject at a conference held in connection with the International Sea-Fisheries Exhibition at South Kensington. Copies of this paper having been sent to the Board of Trade, and the whole question having been duly considered, it was decided to establish a collection of fishery statistics for England and Wales, on the same lines, and generally by the same machinery, as had been recommended by His Royal Highness." [2]

The Treasury, being consulted, gave their consent to the scheme thus proposed, and voted an annual sum of £500 for the purpose. It was subsequently felt, however, that this sum was not enough, and it was increased to £700. The money so ob-

[1] Published in *Literature, Inter. Sea-Fisheries Exhibition*, London, 1883.

[2] *Report of Inter-departmental Committee on Fishery Statistics*, 1902, p. v.

tained was expended in the payment of collectors stationed round the coast. These collectors were mostly Coastguard officers, but some were Customs and Board of Trade officers; others were "connected with the fish trade"; some were private persons, but one at least seems to have been an alderman. The average annual salary enjoyed by them was about £3, but one was paid £25, two were paid £8 and £10 respectively, nine were allowed £63 in all, and a number received £1 per year. There were altogether 157 collectors at about 161 places. They had to send to the Board monthly statements which distinguished thirteen different kinds of "wet fish" and three kinds of "shell-fish," giving the quantities of these products landed, and their values to the fishermen as sold at the seaside. They had no statutory powers to demand a statement of any kind from anyone whatsoever engaged in the fishing trade, and they had no power to board vessels, and examine catches or books, or to examine markets or railway returns, beyond those enjoyed by any other member of the public. They were not, apparently, supervised in any way, or if they were, the supervision must have been the merest matter of form. Apparently they were left to employ what ingenuity they naturally possessed in furnishing the returns on which the official abstracts of the Board were constructed.

These annual abstracts—"Copies of Statistical Tables and Memoranda relating to the Sea-Fisheries of the United Kingdom," as they are officially termed—have now appeared since 1887, and they profess to give—

1. The quantity and value of all the fish landed annually on the coasts of England and Wales belonging to thirteen separate species, and to an unknown number of species placed in two categories: "prime fish not separately distinguished," and "fish not separately distinguished"; of crabs, lobsters, and oysters; and "other shell-fish";

2. The quantity and value of all the fish landed annually on the east, south, and west coasts of England and Wales;

3. The quantity and value of all the fish landed monthly on all the coasts;

4. The quantity and value of all the fish landed at each port of which the Board took cognisance;

5. The average prices of the fish landed;

6. A summary statement of the number of fishing boats *registered*, and the number of fishermen engaged in the industry; and

7. Imports, exports, and re-exports; statements of the fisheries of Scotland and Ireland, and of foreign countries.

Now, it is unfortunate that such an array of figures as are presented in the Statistical Tables and Memoranda should have a kind of fictitious value by virtue of their mere appearance, and from the accuracy of the manipulations to which they are subjected by the statisticians of the Board; for they are sure to be used by those who cannot be aware of the questionable value of the data from which they are constructed. All the subsequent treatment of the returns furnished by the collectors cannot, of course, render the annual statements of any real value, if the actual figures obtained at the fishing ports do not represent the real state of the fishing industry. That such is the case is beyond all doubt, and the literature relating to problems of fishery regulation and investigation contains plenty of statements showing the (in some cases gross) inaccuracy of the fishery statistics of the Board of Trade. This is now admitted, but a perusal of the evidence given in some of the public inquiries will show that the officials of the Fisheries Department were loth, in the past, to make any admission of the faults of their system, and they appear to have resented criticism, and at any rate they ignored for a long time the complaints and recommendations of those who, in default of any other material, were compelled to use their data.[1] But finally they recognised that improvement was desirable, and in 1900 an inter-departmental committee, representing the Board of Trade, the Treasury, and the Fishmongers' Company, was appointed by Mr Ritchie to inquire into the whole system, and as to how it could be improved, and "what additional cost (if any) would be entailed thereby."

[1] See *Report on Fishery Statistics*, Marine Biological Association, Plymouth, 1896.

The evidence submitted to this committee showed very clearly how very imperfect the system of collecting statistics must have been. Take the case of Grimsby, for instance. Over 60,000 tons of fish are landed yearly at this port. Some fifty boats arrive daily, all between the hours of 6 a.m. and noon, and the fish brought by them are landed on a pontoon which is about a quarter of a mile long. It is, of course, quite impossible that one man should be able to ascertain personally the quantities of fish of each different species contained in this mass of produce (about 300 tons), and the collector was obliged to depend on returns furnished by the railway company of fish carried away from the port. Now, the railway people do not distinguish between different kinds, their figures representing merely the gross quantity dealt with; and it was, therefore, necessary for the collector to ascertain as best he could, presumably by observation of the catches as displayed on the pontoon, how this gross quantity was to be apportioned among the species enumerated in his returns. Then an allowance had to be made for the fish sold for consumption in the neighbourhood, and a deduction had also to be made for the weight of boxes, packing, and ice carried by rail. Even then the figures could not represent the approximate number of fishes landed, for the catch consisted of fish of different sizes: one box of plaice might contain fifty large fish, for instance, while another might contain twice or thrice that number; and with regard to this very important consideration—the sizes of fish landed — no information was included in the published returns. In the smaller places the difficulty of estimating the quantity of fish landed would, of course, be less; but even at those places the collector could not always be at the fish docks or quays, and the catches might be landed by steam trawlers, sailing trawlers, by carts or by hand, and at all times during the day; so that even at the small fishing ports it must have been quite impossible for the collectors to ascertain for themselves what was the value of the trade of their district. In nearly all cases it seems to have been the custom to obtain the returns of fish landed from the railway returns of the amount of fish carried away[1]—a very different thing, for the amount of fish sold in the neighbourhood of the fishing ports must vary very considerably, and in some cases is quite a large proportion of the total quantity.

Then the number of fishing ports and districts included in the official list of places at which

[1] Even then the published returns were very far from accurate in some cases. The official figures for the quantity of mussels landed at Morecambe in the season 1901–2 were 1375 tons, but it was ascertained that 2500 tons were actually sent away by rail from that port during the same season. Further, all this quantity, with the exception of a very few bags, was landed direct from the local fishing grounds.

statistics were collected was incomplete, as anyone with local knowledge of the industry will be able to show. Altogether, 161 places or districts were taken into account. Two ports, Grimsby and Hull, head the list, and over 60,000 tons are landed at each of these places annually. Then follow 15 places at each of which over 2500 tons are landed, 18 places with an annual yield of from 2500 to 500 tons, and 121 places at which less than 500 tons are landed in the year.[1]

Now, taking the Lancashire Sea-Fisheries District alone, it will be found that nine ports or districts are omitted from this list, and at these nine places there are over 300 persons employed in gathering and landing shell-fish. It has been said that at the places included in the official list by far the greater portion of fish taken from the British fishing grounds are landed. But a knowledge of the yield of the local fisheries, small though they may be, is of vital importance for purposes of purely local regulation, and the omission of any consideration of the trade of these places is most unfortunate.

Other extraordinary errors in the official statistics may be detected by anyone possessing a local knowledge of any one area. Thus, the value of the "shell-fish" landed from the Lancashire Sea-Fisheries District for the year 1898 is stated in the

[1] See *Report of the Inter-dept. Committee on Fishery Statistics* for the complete list.

Statistical Tables and Memoranda for that year (p. 27) to have been £29,475. But the officials of the Lancashire Committee estimated the value of the cockles obtained from their fishing grounds to have been, for that year, *at the least*, about £13,370.[1] Then, a year or two before that a public inquiry was held by a Board of Trade inspector, in the report of which it is stated (and the statement is apparently accepted) that the value of the shrimps landed annually in the same district is about £50,000.[2] Thus we have :—

> Board of Trade figures for *total* shell-fish, £29,475.
> Local Committee's figures for cockles and shrimps only, £63,370.

Even then, the total value of Lancashire shell-fish is not stated, for no account is taken of mussels (and at Morecambe alone over 2000 tons are sometimes landed annually), oysters, periwinkles, and some other shell-fish.

But apart altogether from these defects in the actual working of the official system of collecting fishery statistics, it is evident to anyone conversant with the conditions of the industry that the whole system is at fault in many respects, and was, in fact, devised in some ignorance of the nature of the fishing trade. Far too few species of fishes

[1] *Report of the Lancashire Sea-Fisheries Laboratory for* 1899, p. 104.

[2] *Report of the Inspectors of Sea-Fisheries* (*England and Wales*) *for* 1895, p. 42.

and shell-fishes were included in the official list. Thus, lemon soles, witches, gurnards, skates and rays, congers, and other fishes were lumped together under the heading "fish not separately distinguished." These are all fishes of considerable economic value. Similarly, mussels, cockles, scallops, periwinkles, shrimps, and several kinds of prawn were included under the heading of "other shell-fish." This has been perhaps the principal defect of the old system, and is indeed very imperfectly remedied in the improved system which is now being introduced. Again, in the case of sea-fish, weight and value alone are considered, and no regard is paid to the quantities of the same species of fish, but of different sizes, which are constantly landed. Thus, "cod" may be large cod or codling; haddock may be "large" or "small"; and a "box" of plaice may contain 50 to 1000 fish, while boxes of about 100 are always distinguished from boxes of about 250. But no account whatever is taken in the official figures of these differences in size, though the differences in value may be very great. Another defect, which has often been commented upon, is so notable that it renders the Board's statistics of very little value for most purposes. No account is taken of the fishing ground from which the fish have been obtained. In late years the area exploited by British fishing boats has widened enormously, and the fish now landed at Grimsby, Fleetwood, or Milford may have come from the Iceland-Færoe Channel, the North Sea, the West Atlantic, the Bay of Biscay, or the Firth of Clyde. Nevertheless, this information, which for many purposes is perfectly essential, is not to be obtained in any of the official publications of the English fishery authority.

Fishery statistics have been collected in Scotland since 1809.[1] The payment of bounties by the Board of British White Herring Fishery on herring caught, cured, and exported, necessitated the collection of statistics, and these were confined in the first instance to herrings; but when the cod and ling fisheries were brought under the operation of the bounty system in 1820, account was also taken of the quantities of these fish caught and exported by Scottish fishermen. For a time no general statistics of fish taken were kept, only of those species which earned bounties. When these payments ceased in 1830, the collection of statistics was still continued, and from time to time various reforms were made, which rendered the returns more complete. The general discouragement of fisheries administration affected the system in 1857, in which year two Treasury Commissioners (Messrs Bonamy Price and Fred. St John) recommended that the Scottish statistics be "made less elaborate." Happily, no attention was paid

[1] See Fulton, *Report of the Scottish Fishery Board for* 1891, part iii. pp. 171–193.

to this advice, and though for a time the figures collected were not published, they were kept in manuscript form and were still accessible. When the Fishery Board was reorganised in 1882 the statistical system was retained, and has since then been greatly improved and extended; and since 1885 the officers of the Board have possessed statutory powers[1] to demand statements of all fish landed and cured in Scotland, from all persons engaged in the sea-fishing trade in that country.

The statistical system thus elaborated has furnished a mass of information of the utmost value, not only to those engaged in the administration of the Scottish fisheries, but to those investigating general questions relating to the natural conditions under which the industry is carried on, and is the most elaborate and complete system adopted by any fisheries authority. The method of collection resembles that adopted later on in England, but it is much more thorough, and the persons responsible for obtaining the information are aided greatly by the possession of statutory powers enabling them to demand compulsory returns. There are a number of correspondents stationed all round the coast, who make daily statements of the quantity of fish landed and of the numbers of boats and men engaged in the fisheries in their districts. These correspondents are super-

[1] Conferred by the Sea-Fisheries (Scotland) Amendment Act of 1885.

vised by the fishery officers, who are in turn superintended by inspectors. The returns are forwarded to the clerks of the Board, are abstracted, and are published annually in the General Reports. These annual returns include statements of :—

1. *Matériel*—the number of fishing vessels, arranged in various categories, *i.e.* steam vessels engaged in various fisheries; sailing vessels engaged in the line, trawl, and drift fisheries, and classified according to the length of keel; and rowing boats of different lengths. Also the length of lines and netting, and the value of the fishing gear employed.

2. *Persons engaged in fishing and allied industries*—fishermen and boys, fishmongers, curers, coopers, gutters and packers, boat-builders, and others engaged in making nets and gear, etc., carters, labourers, porters, hawkers, and clerks. Foreigners are distinguished in the returns from British fishermen and others.

3. *Fish landed.*—This includes herrings and fifteen other different species of fish, "flounder, plaice, and brill" (these are grouped together), "unclassified white fish," oysters, mussels, clams, crabs, lobsters, and "unclassified shell-fish." A separate statement is also given of fish which are landed and sold for use in a fresh state, and consumed in the neighbourhood. Much information is given with regard to herrings, such as the

number of barrels cured and exported, as well as those branded (under each class of brand), unbranded and rejected, the places to which the fish are consigned, etc.

4. *The industry at each "creek" or station*—boats and men, method of fishing, amount and value of fish captured, etc.

5. *Other statistics, complaints, prosecutions, etc.*

It will be seen, from a perusal of Part I. of the reports, that an almost exhaustive account of the sea-fishing industry of Scotland is rendered by the officers, and this is all the more valuable since it deals with almost every aspect of the fisheries, economic, commercial, and scientific, and is discussed very fully in the General Statement of the Board.

A thoroughly efficient and practical scheme of fisheries statistics would give all the information yielded by the Scottish system, but would, in addition, go much further in many respects. Not enough species of fishes are distinguished in either the Scottish or English system, and the list would have to be extended so as to include some twenty-five to thirty different species of sea-fishes, about half a dozen species of molluscs, and three or four species of edible crustacea. More information would have to be given as to the sizes of the fishes landed: when the fishing trade recognises several distinct classes of the same kind of fish, according to the average size, these should be distinguished in the statistics. The approximate locality in which the fish landed were caught should also be included in the returns. It would not be necessary to state this with great accuracy. Fishermen have generally a very fair idea where they are fishing, and all the fishing grounds have now local or general names, and these can usually be identified on the charts of the fishing areas round the British Islands. The nature of the fishing gear and the size and equipment of fishing boats are also factors of much importance, and much more information is required on these heads than is at present given.

There is absolutely no reason why all this information should not be obtained direct from the captains of fishing vessels, or from the fishermen themselves, in the case of shell-fish gatherers, or those who work along-shore or in small rowing boats. At the present time the masters of fishing vessels have to prepare returns of the fish landed for the information of their owners, and there would be no real difficulty in arranging that copies of these returns should be made and sent to the nearest custom-house immediately after the return of the vessel. Such returns would also state where the vessels making them had been fishing. And monthly or even yearly returns might also be furnished, giving particulars as to the vessel and its equipment and crew; all these returns could be treated as confidential, and published only in abstract. There could be no reasonable objection on the part of the fishing trade to furnish this information, unless, as has been pointed out, a certain reserve usually observed by a man when his income exceeds a certain figure, might encourage him to evade making fishery returns. The evolution of a system applying only to fishing vessels of the first and second classes could not possibly present any difficulty. To take account of the numerous class of fishermen who work along the shore would be more difficult, but even here there is no obstacle which could not be surmounted. At present the officers of a local fishery committee, in a district where administration is not a farce, know personally every fisherman in their area, and have exceptional opportunities for supervising the work of such a system of fisheries correspondents as exists on the Scottish coast. For both these methods of obtaining statistical returns statutory powers would be required. It should be obligatory on every fisherman to make a return, when required, giving the information alluded to above. Such statutory powers are actually enjoyed by the Scottish Fishery Board.[1]

Now, it was confidently expected that, when the Inter-departmental Committee on Fishery Statistics reported, a recommendation suggesting the re-

[1] They are, however, seldom exercised.

organisation of the official system on such lines as I have indicated would be made. This, however, was not the case. The Committee in their report suggest that the general evidence deprecated the adoption of compulsory powers — a conclusion which few readers who study the evidence will arrive at. The organisation of a scheme founded on compulsory powers would have entailed no little trouble, and an Act of Parliament would have been necessary. It is probable, then, that the general inertia of a Government department provided the reason why the recommendations of the Committee should have presented absolutely no originality. It is also probable that the Committee paid too much attention to the considerations suggested in the following questions and answers :—[1]

"Question 161. (*Mr Bence-Jones*) You do not think you will get from these captains what you get very often from farmers in the agricultural returns—'Ask my grandmother' is not an uncommon answer?—(*Mr G. L. Alward*) I am just expecting you will meet with the same results. I have always stated that this[2] must be compulsory; but at the same time I hope the Board will deal with it, if they do get legislation, gingerly, and so get the people to work into it properly.

"Question 162. Would not such compulsory

[1] *Report of the Inter-dept. Committee on Fisherv Statistics*, p. 7, Evidence.

[2] Returns of fish caught, etc.

legislation be very unpopular: would it not lose the Government a considerable number of seats?—That is for the Government of the time being to consider."

The report of this Committee, then, left the question of the fishery statistics in almost exactly the same state as it was. No new plan was recommended; no further powers have been sought from Parliament; and no further resources have been given the local committees to obtain statistics, either for the Board or for themselves. The old system was maintained, except that additional attention is being paid to two or three large ports on the east coast of England. Whereas, before 1902, about £700 a year was paid to the collectors, after that date about £1400 has been paid. But it was also recommended that an additional £1000 a year be provided, to enable the Board to undertake the supervision of the persons collecting the statistics.

It has been observed that the official fishery statistics—and, I may add, the changes and reforms of the central English administration—are described by the French phrase, "Plus ça change, plus c'est la même chose."

CHAPTER XIV

THE IMPOVERISHMENT OF THE FISHING GROUNDS

THIS is the fundamental problem of sea-fisheries administration, for upon its answer depends the further question of the practical utility of restrictions on methods and seasons of sea-fishing. If the fishing grounds in the seas of the British Islands are, for all practical purposes, capable of much more extensive exploitation than they undergo at present, then it is useless to regulate the forms and dimensions of fishing apparatus, the sizes at which sea-fish may be captured and sold, the times at which they may be taken, etc. If, on the other hand, it is possible by excessive fishing so to impoverish these fishing grounds that they may become unprofitable to the fishermen, then some degree of regulation is necessary. It must clearly be understood, however, that in any case regulations of a police nature are necessary, so as to ensure safety of navigation on crowded fishing grounds, and to prevent unwarrantable interference of one class of fisherman with the operations of another.

Now, it might be expected that a question of this nature is so important, that no pains would be spared to acquire such information as would answer it in such a manner as to leave no reasonable excuse for doubt. But owing to the lack of investigation on a sufficiently large scale, and, above all, to want of accurate and copious fishery statistics, there is still some doubt as to whether the fisheries of the British Islands are deteriorating or otherwise, and opinions are expressed on both sides. Generally speaking, there is a consensus of opinion in this country that the commercial development of the sea-fisheries has reached such a point as to justify legislative restrictions on the methods of the industry. This was not always the view that was held in England and Scotland. Forty years ago very optimistic opinions were expressed, and it was owing largely to the influence of Huxley[1] that these opinions were widely held, and produced a reaction against restrictive fishery legislation which resulted in the freeing of the industry from all laws except such as were absolutely necessary in the interest of the maintenance of order among fishermen at sea. Then, when the great modern development of steam trawling took place,[2] it became apparent that "man was treading too closely upon the supply," and legislative

[1] "Inaugural Address," *Fisheries Literature, International Fisheries Exhibition, London*, 1883.

[2] Between 1885 and 1893.

restrictions were revised. And though some investigators, whose views carry much weight,[1] express a different opinion, this may be said to be the generally accepted position. I am speaking just now of British opinion. On the Continent, particularly in Germany, Denmark, and Norway, fisheries investigators preserve generally a neutral attitude. In Germany, this may be due to the fact that, at the time when British administrators were calling for international regulation of the North Sea fisheries, the German fishing marine was largely undeveloped, and it was felt that international restrictive legislation would hamper this development of the national deep-sea fishing industry.

It is well known that the deterioration of the fishing grounds was a very common cry in the past, and it would be an unprofitable inquiry to trace the numerous representations of a decaying state of the fisheries and the necessity for restrictive or prohibitive legislation that have been made for several centuries. It is most convenient to begin with the great Commission of 1863. This inquiry was held at a time when, owing to the spread of trawl fishing, this complaint of the impoverishment of the fisheries was made very seriously. The Royal Commission of 1863, as we have seen, decided that this complaint was entirely without foundation. The fisheries were not deteriorating, but, on the contrary, were capable of development

[1] See M'Intosh, *Resources of the Sea.*

to an extent which could not be foreseen. Generally speaking, the Commissioners based this opinion on three distinct lines of evidence :—

1. The statistics available at the time. These were not very abundant or enlightening ; but the returns furnished by the leading railway companies for the three years (1862–64) preceding the report of the Commission showed that there was a well-marked increase in the quantity of fish carried from the principal fishing ports. The statistics of the Scottish herring fisheries showed also that for a period of twenty-five years the quantity of herrings cured and exported had, on the whole, increased. There was also an increase in the quantity of the same fish sold in a fresh condition. So far, then, as statistical information went, there was no room for apprehension.

2. The prices of fish in certain public markets during a period of ten years. If the prices maintained the same general level, it was clear that the supply was keeping pace with the demand. On the whole, the prices were fairly constant, and since the demand had steadily increased, owing to a growing population and increasing means of transport, it was evident that the supply, too, was steadily increasing.

3. What we may call an *a priori* argument. This is less clearly expressed in the report of the 1863 Commission than in the report of one held a year or two before that date, but it is to be

traced in the general tenor of the report. It does not follow that the fish population of the sea should diminish to a serious extent, in spite of the enormous quantities of fish captured in fishing operations. For the area of the sea is so vast, its population so enormous, and the destructive agencies at work in nature, irrespective of the fisherman, are so great, that the operations of man in reducing this population are quite insignificant.

All three lines of evidence tended to show that fishing operations, *as they were carried on at the time*, could not result in the deterioration of the fishing grounds.

The report of the Royal Commission of 1863 was reassuring, and the same is also to be said of the report of a commission issued by the Home Secretary (Mr Cross) in 1878. The Trawling Commission of 1885 was the first inquiry in the course of which evidence of deterioration was discovered. The conclusions of this body were not founded on statistical data. "In the absence of a proper system of fishery statistics and scientific observations," the Commissioners reported, "it is impossible to discover the causes, or measure the fluctuations of the fisheries."[1] The Commissioners had the assistance, however, of Professor M'Intosh, and from the observations of this naturalist, as well as the general evidence presented, it was apparent that significant changes had taken place on the

[1] *Report, Trawling Commission*, 1885, p. xliii.

fishing grounds. Trawling, because it was a most effective method of fishing, had had a considerable effect on the inshore fisheries on certain parts of the east coasts of England and Scotland. Much fishing, both by trawls and long-lines, had led to a scarcity of fish in these waters, and it was then necessary to go further to sea in order to get good catches. This change from inshore to offshore fishing was caused by trawl-fishing. It was supposed to be the case even with round fishes like haddocks, which we now believe to be so prone to temporary migrations and changes that it is difficult to make any safe deductions as to their permanent abundance. Flat fishes had not apparently decreased in numbers to a notable extent, but a decrease in their average size had taken place, and this change was indicative of their diminished abundance. All this referred to inshore waters. No change of any importance (except, perhaps, in the case of soles) had taken place on the offshore grounds.[1]

The next inquiry into the question of fisheries impoverishment was made by a Select Committee of the House of Commons in 1893. When the Trawling Commission reported in 1885, there were no statistics in existence which might supplement the observations made by Professor M'Intosh, which, with the recollections and impressions of many witnesses, furnished the only evidence obtainable that commercial trawl-fishing

[1] *Report, Trawling Commission*, 1885, p. xvii.

was making inroads on the resources of the sea. Apparently the question of fisheries impoverishment could be solved by either of two methods: (1) by the collection of accurate statistics of the actual progress of the industry, and (2) by direct experiment. When the Select Committee of 1893 came to hear evidence, both of these methods had been adopted. The Sea-Fisheries (Scotland) Amendment Act of 1885 had given the Scottish Fishery Board powers, and the Treasury had reluctantly given them resources, to make experiments. About the same time the Board of Trade began at last to collect fishery statistics, and had already published a series of statements[1] which professed to give an accurate account of the men and vessels employed in the English and Welsh fisheries, and of the quantities and values of the fish caught each year.

The Experimental Evidence

It was concluded by the Trawling Commission that the excessive use of the beam-trawl as an instrument of fishing could (temporarily, at least) reduce both the numbers and the average sizes of the less migratory fishes on a limited area. The object of the experiments initiated in 1886 by the Scottish Fishery Board was to determine whether or not this was the case, and if it were, whether such an impoverished ground would recover if trawl-fishing were prohibited on it for

[1] The *Statistical Tables and Memoranda*.

a number of years. Two areas off the east coast of Scotland—the Firth of Forth and St Andrews Bay—were therefore "closed" against commercial trawl-fishing, and a number of "stations" were made on each of these areas. Each station was a line of one or more miles in length laid out on the chart. At the same time several stations were chosen outside the closed areas. Once a month the trawling vessel employed by the Board visited each station, and the trawl was dragged from one end of the trawling line to the other. The fishes caught were counted and measured, and the results were recorded.[1] It was expected that, since the stations within the Firth of Forth and St Andrews Bay were prohibited to the trawlers, while those outside were open, there would after a time be an increase of fishes on the inner and protected areas, and no change, or a decrease, on the stations outside, which were open to commercial fishing.

Now, the results of the first year's experiments were apparently such as to justify these expectations. It was found[2] that, both in the Firth of Forth and in St Andrews Bay, the catches of flat and round fishes had increased to a considerable extent. It was almost impossible to avoid the conclusion that the cessation of trawl-fishing on

[1] See the *Annual Reports of the Scottish Fishery Board* (pt. iii.), 1886 to 1903, for these records. At the same time physical observations were also made. "Tow-nettings" were taken, and biological work of a most important nature was carried out.

[2] *Report, Scottish Fishery Board for* 1887, pt. iii. p. 25.

these areas had led to a considerable augmentation of the numbers of fishes inhabiting them.

The results of further experiments, however, showed that these conclusions were premature, and the problem was seen to be much less simple than had been originally supposed. I may anticipate, and give the results of the first ten years of experimental trawling. These results have been discussed very freely,[1] but the following statement[2] shows what had, beyond doubt, taken place. Four species of flat fishes are dealt with, which are: plaice (*Pleuronectes platessa*), lemon sole (*Pleuronectes microcephalus*), dab (*Pleuronectes limanda*), and long rough dab (*Drepanopsetta* (= *Hippoglossoides*) *limanoides*). The whole ten-year period is divided into two quinquennial periods.

	No. of Hauls.	Plaice and Lemon Soles caught.	Dabs and Long Rough Dabs caught.
First period (1886–1890)	325	29,869	19,825
Second period (1891–1895)	466	28,044	29,483

[1] See in particular M'Intosh, *Resources of the Sea*, Cambridge University Press, 1899; *Banffshire Journal*, April–June, 1899, Banff, 1899: a destructive criticism of M'Intosh; and Garstang, *Journal Marine Biological Association*, vol. vi., No. 1, 1900.

[2] Fulton, *Report, Scottish Fishery Board for* 1895 (1896), pt. iii. p. 25; and *Report for* 1898, pt. iii. p. 10 (1899).

These figures apply to the closed areas only. They represent large numbers of hauls spread over a number of stations and over five-yearly periods, and so accidental flunctuations and minor inequalities have no effect on the conclusions. The latter are: (1) During the ten years the numbers of plaice and lemon soles, both valuable food-fishes, had decreased to a considerable extent; and (2) during the same time, and on the same grounds, dabs and long rough dabs, both relatively worthless fishes, had increased to an equally noticeable extent.

Now, these results are unintelligible unless we remember some peculiarities in the life-histories of the two categories of fish. Plaice and lemon soles are fishes which spawn at some distance from land and in deep water. Besides, they are relatively large fishes, and mature individuals, if they get into a trawl-net, are always captured. Therefore the mature individuals were captured on the offshore open grounds by the commercial trawlers. The shallow inshore waters should have been replenished from these offshore grounds, and, because of the increasing exploitation of the latter, they suffered to the extent indicated by the table. The dabs and long rough dabs, on the other hand, spawn to a considerable extent on the shallow inshore waters, and the latter are replenished from their own stock. Even on the offshore grounds many mature dabs escape capture, because they become mature at a relatively small size, and may escape the trawl-nets. The inshore waters are therefore replenished also from the offshore grounds. Probably, also, the dabs benefit to a greater extent from protection than the plaice and lemon soles, because they compete naturally with the latter species.

The Scottish Fishery Board experiments led, then, to conclusions entirely different from those which were anticipated. It was expected that they would indicate that trawling operated in reducing the fish population of the area on which it was practised, and that if it were discontinued, the population on this area would increase again. This is most probably the case, and it is very likely that the immediate increase of flat and round fishes in the Firth of Forth and St Andrews Bay did actually prove it. But what the whole series of trawling experiments did prove was in all probability this: that the continual and growing exploitation of the offshore fishing grounds was producing a certain impoverishment of the inshore fisheries; and that the trawl-fishing of the ten years during which the experiments were carried on had rendered the sea less productive than was formerly the case.

It is as well to point out that this method of experimental trawling had serious limitations. It was thought at one time that, by making periodical hauls with a trawl-net on a portion of a fishing ground, the changes taking place in the abundance of fishes on the latter could be estimated; that is, that the fishes caught in a haul taken on an area of, say, 100 square miles in extent were a sample of all those actually present. Now, such a trawl-net as has been commonly used in these investigations sweeps a portion of the sea-bottom of two or three miles long at the most, and about twenty-five feet wide. This is only a very small fraction of the whole area, and if we are to regard the catch made as a fair sample of the whole, we must assume that the fishes present are uniformly scattered over the whole area. But experiment shows that this is far from being the case.[1] Again, a trawl-net as an instrument of research is far from being perfect. What it does catch does not depend alone on the quantity of the fish actually present on the fishing ground on which it is used, but also to a great extent on the exact construction and "trim" of the net, on the state of wind and tide, on the skill of the fisherman using the net, and on a variety of circumstances well known to fishermen, but generally neglected by those who have adopted the method in the past. Subsequent manipulation of the results obtained by statistical methods will obviously not render them of any more real value, if the data themselves are of such questionable

[1] Johnstone, *Report Lancashire Fisheries Laboratory for* 1902, p. 83.

value.[1] In order to obtain results of real value by the application of such a method, a large trawl-net fished for several hours must be employed, and the results obtained can apply only to a comparatively limited area, and conclusions can only be drawn from the averages yielded by a great number of such trawling experiments spread over several years, and even then the conclusions can only be of the most general character. The useful limits of the method are indicated by the results of the series of trawling experiments of the Scottish Fishery Board to which I have alluded above. Only a small area, such as the Firth of Forth, could successfully be investigated. To attempt to estimate the productivity of such an area as the Irish Sea, or even of one of the fishing banks in the North Sea, by means of trawling experiments made by a single vessel would probably be quite impracticable.

The Statistical Evidence

So far as it goes, then, the evidence deducible from trawling experiments points to a distinct

[1] Trawling statistics are sometimes corrected without due regard being paid to the method of working of a trawl-net. See *Sixteenth Report of Inspectors of Fisheries for England and Wales*, for 1902. It is there attempted to compare the result of a haul of a trawl-net made over (say) three miles of sea-bottom with one made over one mile. This is the correction: A trawl will catch three times as many fish in a three-miles drag as it will catch in a one-mile drag. This is not the case, however, as any experienced fisherman will know; for as the net becomes full of fish, weeds, etc., it becomes choked up and does not fish nearly so well as it did at first.

falling off in the yield of the British sea-fisheries in respect of the less migratory flat fishes; and the same can be said of the evidence quite unsupported by figures of any kind, and consisting only of the recollections and impressions of persons who had been interested in the sea-fisheries for a considerable time. All this evidence (I am speaking now of that submitted before the two most recent fishery inquiries—the Select Committees of 1893 and 1900) pointed to the same conclusion, that there had been a distinct degree of depletion of the fishing grounds. "All persons interested in the fisheries, whether trawlers or linesmen, whether smack-owners or fishermen, whether scientific experts or statisticians," agreed that "a considerable diminution has occurred amongst the more valuable classes of flat fish, especially among soles and plaice, and this diminution must be attributed to over-fishing by trawlers in certain localities."[1]

Now, taking the information given by statistics, a study of the various official reports shows that the great extent of the change which converted the fishing fleet of the time of Huxley and the 1863 Commission into that of to-day, took place in the interval between 1893 and 1900. Several changes of great significance had taken place, and a detailed study of these is of much importance for a correct appreciation of the present state of the fishing industry.

1. The number of steam vessels employed in

[1] *Report, Select Committee*, 1893, p. iv.

fishing has increased to a very great extent. Not only has steam power been employed as the means of propulsion, but even on many of the sailing smacks steam power has been introduced for the purpose of hauling the nets and hoisting the sails. These changes, and a further one—the greatly extended use of "carriers," vessels which visit the fishing grounds and convey the catch from the fleet back to harbour—have added enormously to the catching power of the British fishing marine. One steam trawler at the present day may be regarded as the equivalent, so far as the power of catching fish goes, of seven or eight sailing smacks.

2. There has been no corresponding increase in the number of sailing vessels. On the contrary, these are steadily decreasing. As they become worn out or obsolete, they are not replaced by vessels of the same class, but by steam trawlers. Where sailing fishing vessels are being built, they are usually of a larger tonnage than the older type of boat.

3. Trawling is taking the place of lining as a method of catching fish. This change is much more perceptible in the Scottish statistics than in those which apply to England.[1]

[These changes indicate the increasing concentration and specialisation which is taking place in the sea-fishing industry. Formerly the small fishing villages were much more important than they are to-day, and the old-time fisherman

[1] See *Report, Scottish Fishery Board for* 1902, pt. i. p. ix.

engaged in each method of fishing as circumstances and seasons made it profitable or convenient. Thus he might reap the harvest of the year in the herring fishery, and for the remainder of the year he would be engaged in line fishing. At the present day the fisherman is usually a specialist. He is either a herring fisherman, a trawler, a liner, or he pursues more or less exclusively one of the other branches of sea-fishing. As for the small villages, these are fast losing their former importance, and fishing is becoming concentrated in the large centres, like Grimsby, Hull, Aberdeen, Milford, or Fleetwood, where harbour and market accommodation are good, and there are abundant means of transport, so that fish can reach the great inland centres in a very short time. Formerly the fishing boat was, in most cases, owned by the men who sailed her. At the present time, though many fishermen own at least a part share in the vessel they sail, many of the sailing vessels and practically all the steamers are owned by large fishing companies. In the course of the last thirty years the fishing industry has undergone the characteristic commercial developments of the age—capitalisation, concentration, and specialisation. Apparently these processes are not at an end. Already there are indications of market "rings," and a great fishing trust is by no means an inconceivable development.]

4. The area exploited by the fishing fleets has widened very greatly. Long ago, fishing was con-

fined practically to a narrow coastal region, not much exceeding, if at all, our present territorial water margin. Then deep-sea fishing was practised, and about the beginning of the sixties the greater part of the North Sea had been fished over. In the interval under consideration fishing vessels have gone much further afield. Every portion of the North Sea has been fished; not a foot of its bottom, it has been said, has not felt the fisherman's sounding lead, trying for suitable trawling ground. At the present day steam vessels go round the Shetland Islands to the westward, as far north as the coast of Iceland and the Færoe Islands, and as far south as the coasts of Portugal.

5. The last and most significant change, or rather want of change, affects the quantity of fish landed. This has increased, of course; but when one remembers the enormous increase in the machinery for capture represented by the great extension of steam fishing, the rapid improvement of steam and sailing vessels, the improvement in fishing apparatus, such as the introduction of the "otter" trawl, it is very surprising that the increase in the quantity of fish caught should be so slight.

The changes in the numbers and composition of the fishing fleet are represented in the following table:—[1]

[1] *Rept. Sel. Comm.*, 1893, p. 378; *Inspectors' Report* (*England and Wales*) *for* 1902, p. 9; *Rept. Sel. Comm. Sea-Fisheries Bill* (*H.L.*), 1904, p. 157.

England and Wales

Period.	No. of Steam Fishing Vessels.	Average Tonnage.	No. of Sailing Fishing Vessels (1st and 2nd class).
1883	181	30·8	8443
1893	564	39·6	7369
1902	1373	56·3	5887

This shows clearly the increase in the numbers and tonnage of the steamers, and the decrease in the numbers of sailing fishing vessels.

It is not possible to obtain statistics of the total quantities of fish landed in England and Wales earlier than for 1886. The changes taking place since then are shown below :—[1]

England and Wales

Period.	Average Quantity of Fish landed (exclusive of shell-fish) per year.
1886–8	6,263,328 cwts.
1890–2	6,184,135 „
1900–2	9,242,425 „

[1] *Rept. Sel. Comm.*, 1893, for the periods 1886–8 and 1890–2, and *Statistical Tables and Memoranda* for 1900–2.

There was, therefore, an actual decrease in the total quantity of fish landed in the interval between 1886–8 and 1890–2. It is true that a great increase took place between 1890–2 and 1901–3, but comparison between these figures and those representing the numbers of fishing vessels employed will show that this increase in the quantity of fish landed is not proportional to the fishing power expended.

The average price of fish landed during the same period is shown in the following statement :—[1]

Period.	Average Price of all Fish per cwt.
1886–8	12s. 2d.
1890–2	14s. 6½d.
1900–2	14s. 3½d.

The several relations between the total quantity of fish caught and the means employed in catching it is best understood by considering the average catch per vessel employed in the fisheries. This is a method first adopted by Fulton, who showed in 1891[2] that a great expansion of the Scottish fisheries had taken place, and that this increase

[1] *Rept. Sel. Comm.*, 1893, for the periods 1886–8 and 1890–2, and *Statistical Tables and Memoranda* for 1901–3.

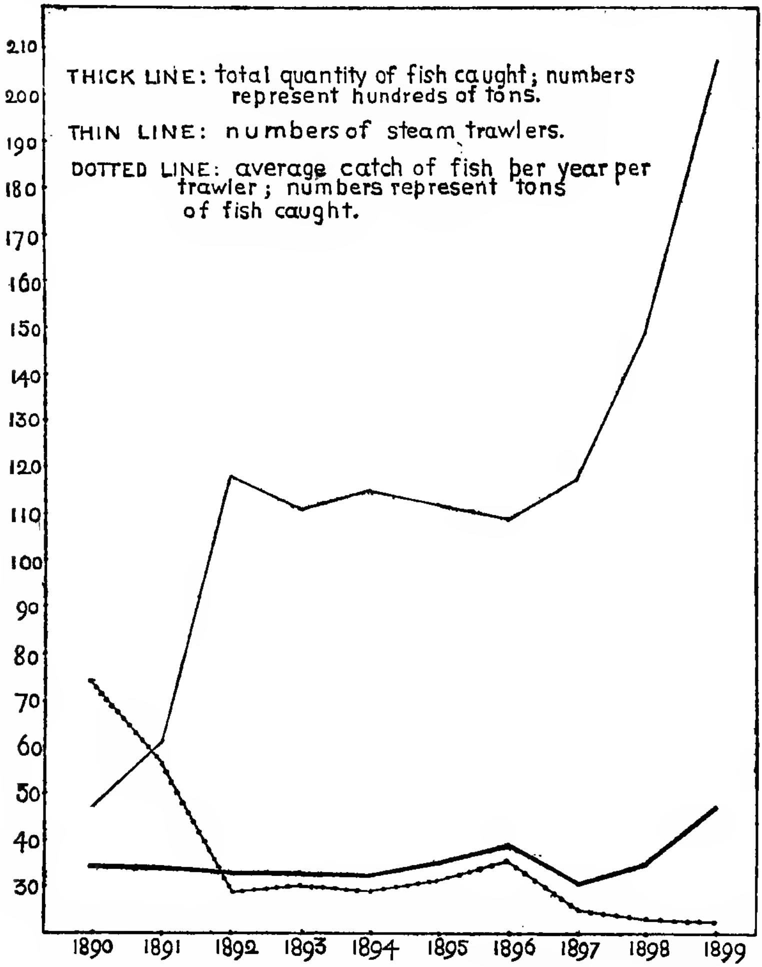
[2] *Rept. Scottish Fishery Board for* 1891, pt. iii. p. 171.

in men and *matériel* was not accompanied by a marked increase in the quantity of fish caught. A much more complete investigation of the same relationship was made by the same writer in 1900, and was submitted in evidence to the Select Committee of 1900.[1] In this calculation the flat fishes, turbot, halibut, lemon sole, flounder, plaice, and brill only were considered. The number of steam trawlers registered out of Scottish ports was known, as well as the total quantity of flat fishes landed annually by them. If, then, these annual total quantities of fish are divided by the number of vessels catching them, results are obtained which express the average quantities of flat fish caught by each vessel employed. This relationship will be easily understood on reference to the chart which I have constructed from Fulton's figures.

Only the total quantities of flat fishes captured are considered in the chart. Much the same results would be obtained, whether we consider turbot, lemon sole, or "flounder, plaice, and brill." The chart shows clearly that the catching power (number of steam trawlers) increased up to 1892, then for four years was practically stationary, and from 1896 to 1899 rose very rapidly. It will be seen, too, that, in spite of this increase in the catching power, the total catch of fish remained much the same, and only increased in a slight degree towards the end of the period. On the other

[1] *Rept. Sel. Comm.*, 1900, p. 148.

hand, the average catch per trawler has, on the whole, fallen, except for the years 1895 and 1896,



Scottish Flat Fish Trawl Fisheries: Chart to show the Relation between the Total Flat Fish caught and the Means of Capture.

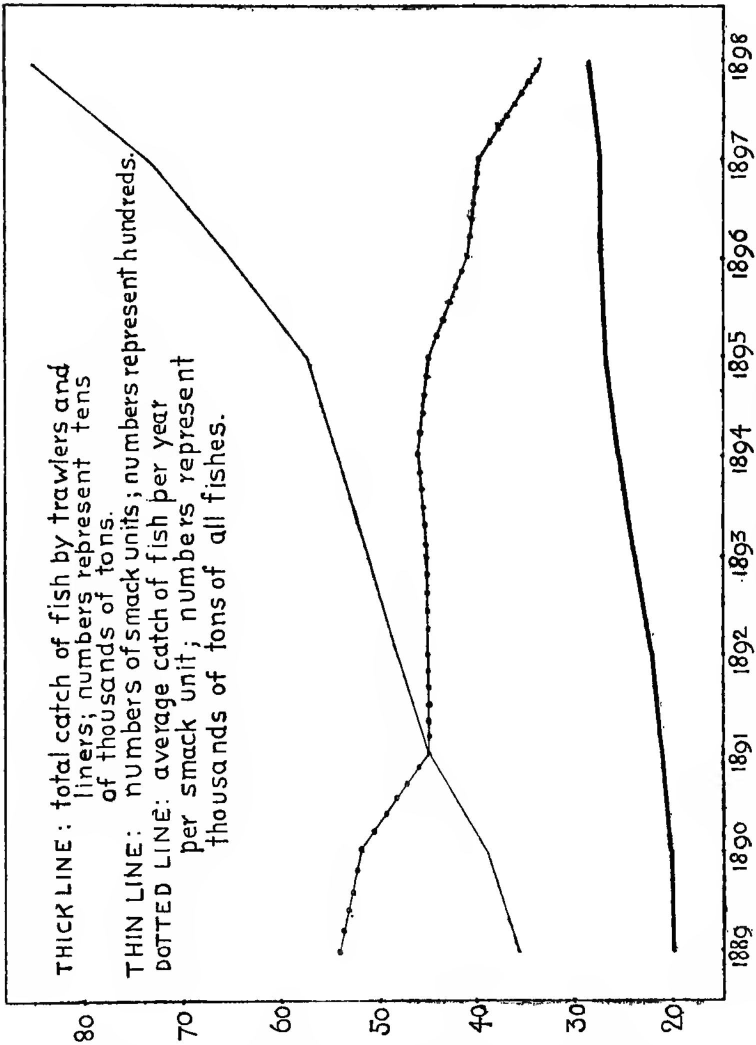
when the otter-trawl came to be generally used, and, by its great superiority over the old beam-trawl, increased the catch of fish for the time. If we consider the catch of halibut for each of these ten years we shall find it to differ strikingly from that of the other fishes; instead of remaining practically the same throughout the period, the total catch of halibut rose from 44 cwt. in 1890 to 2746 cwt. in 1899, and the average annual catch per trawler rose also from 1 cwt. in 1890 to 13 cwt. in 1899. This is accounted for very easily. During the period 1890–99 the steam fishing fleet of Scotland were gradually opening up new ground to the north in colder and deeper water. The halibut is a deep-water fish, so was caught in greater numbers as the fishing fleet came to frequent the water forming its characteristic habitat.

Exactly the same results were obtained by Garstang[1] from a consideration of the statistics of the English bottom sea-fisheries. The total quantities of fish caught annually during the period 1889–98 were divided by the numbers of fishing vessels employed (reduced to a common standard): it was found that one steamer was equal in catching power to from four to seven smacks, according to the year taken into consideration. The whole fishing fleet, steam trawlers and liners included, was then reckoned up as so many "smack-units." Garstang's results are represented graphically on the chart.

In this case also it is seen (1) that the fishing

[1] *Journal, Marine Biological Association*, vol. vi. No. 1, 1900.

power gradually increased during the ten years



Trawl and Line Fisheries of England and Wales: Chart showing the Relation between the Fish caught and the Means of Capture.

considered; (2) that the total quantity of fish caught increased also, though not to a great extent;

and (3) all the time the average catch per vessel gradually fell.

Now, is this a good method? Such a question brings us to the consideration of what is meant by the term "fisheries impoverishment."

The total quantity of fish landed on the shores of the British Islands may remain stationary during a series of years, or it may actually decrease. If the population during that time had increased, and if the demand for fish food had been maintained, we should have "fisheries impoverishment" from the public (the consumer's) point of view. But from the point of view of the fisherman or the fish-merchant there might be no impoverishment, for it might have happened that no more, or even fewer, vessels had been engaged in the industry during the period in question.

The quantity of fish actually present on the fishing grounds of the British Islands is less now than it was thirty or forty years ago. Therefore it is harder to make a good catch. Vessels have to go further afield; they become larger and more powerful; they have to employ heavier and more effective fishing gear. This is what the fishermen understand by "fisheries impoverishment," and it is the proper meaning of the term.

But is the average catch per vessel a test of the existence or degree of such impoverishment? It is necessary to point out, in the first place, that the statistics of English fisheries, both of the number, the classification, and the fishing capacity of fishing vessels, and of the total quantities of fish landed, are so imperfect that all deductions made from them are more or less uncertain. Then the area over which fishing is carried on has changed so much that this introduces a further element of uncertainty.[1] It may be said, too, that it is an imaginary vessel which makes the decreasing average catch. But Garstang [2] gives also the *actual catches* made by four Grimsby trawling smacks from 1875 to 1892, and in each of these cases the annual catch has decreased, with but few fluctuations, during the period under consideration.

It has been contended, however, by the Inspectors of Fisheries [3] that the above treatment of the problem involves a fallacy. "A knowledge merely of the total quantity of fish landed is not sufficient to enable us to arrive at any trustworthy conclusion regarding the condition of the fisheries. On the other hand, care must be taken to avoid the opposite error of thinking that the fisheries are becoming depleted if the increase in the quantity of fish landed does not keep pace with the powers of capture ; . . . for unless the supply of fish in the

[1] If the area widens it is an indication, however, of impoverishment, for it means that the older fishing area is becoming unprofitable; else trawlers would not expend time and stores in going farther to catch fish.

[2] *Journ. Mar. Biol. Association*, vol. vi. No. 1, p. 65, 1900.

[3] *Fifteenth Annual Report, Inspectors of Fisheries* (*England and Wales*), for 1900, p. 5.

sea is unlimited, there must be a point at which the quantity taken by each boat would be affected by the number of boats fishing; and a decrease in the annual average take per boat might, therefore, be due simply to the catch of fish being distributed among a larger number of boats, and not to any depletion of the fishing grounds." With this observation the Inspectors apparently dismiss the subject without further investigation. It seems quite clear that some confusion of thought exists here. The supply of fish in the sea is not unlimited, but bears a proportion, which we are beginning to know, to the means of capture. And if the quantity of fish taken by each boat is affected by the number of other boats fishing, it surely means that between them they have made fish on the sea-bottom less abundant. If a boat (either steam trawler or smack) catches fewer fish in the course of the year,[1] it can mean nothing else than this, that *on the portion of sea-bottom swept by her trawl-net there are fewer fish now than was formerly the case.* That is, the density of fish per unit of area of the North Sea fishing grounds is less now than it was thirty years ago. This is a real impoverishment of the fishing grounds.

Now, how may this impoverishment have occurred? There are three ways:—

[1] Provided her fishing apparatus is as effective and she has made as many voyages as formerly. We know that these conditions have been satisfied.

1. *By the fishing out of an accumulated stock.* At one time the great extent of the North Sea was virgin fishing ground. When it was first fished large catches were made: a great weight of fish were secured, because not only were they more numerous, but they were also larger. When the Iceland fishing grounds were first opened up this was the case. Very large plaice were numerous there.

2. *By simple over-fishing.* It is possible by ordinary methods of agriculture to raise only a limited quantity of produce from a certain area of agricultural land. So with the sea. There is a definite quantity of ultimate food-material in it per square mile (say), and on this depends the number of fish that area can raise.[1] We may fish up to this limit, but if we go beyond it the area becomes impoverished.

3. *By the destruction of fish eggs, larvæ, and immature fishes.* It is well known that large numbers of spawning fishes are annually captured. The spawn which these animals were producing or would shortly have produced represents potential fishes, and is lost. By the capture of immature forms, fishes are destroyed before they have had time to reproduce. Further, they are caught at a time when their weight is small.

All three causes have probably operated in the

[1] I do not mean that a fish necessarily confines itself to one square mile of sea-bottom.

past. It would take far too long to examine the first two at length, but it is the last which is commonly regarded as the great cause of fisheries impoverishment, and I propose considering it later on in some detail.

It is well to remember that we have been discussing fisheries impoverishment in relation to certain species of fish only. Soles, turbot, and plaice have undoubtedly suffered through the operation of the causes to which I have referred; but it is no less clear that there are a number of other species of fish with regard to the supply of which we can trace no continued decrease. Such fish are the herring, the cod, whiting, haddock, and some others. In certain places the abundance of these fishes may undergo large fluctuation, but in such cases experience has usually shown that such changes are temporary. When we speak, then, of the impoverishment of the national fisheries, it should be remembered that we refer only to the reduction in the general fish-supply on the fishing grounds which results from the decreased abundance of the flat fishes only.

CHAPTER XV

THE DESTRUCTION OF IMMATURE FISH: THE FISHERIES BILL OF 1904

THAT the capture and destruction of immature fish should inflict permanent damage on the sea-fisheries is a conclusion which anyone who witnesses, for the first time, a drag with a shrimp trawl on a thickly populated fishing ground, or a haul with a sprat or whitebait net, must almost inevitably arrive at. In each of these methods of fishing (as in many others) an enormous number of young fishes are caught and destroyed. When one realises that all these animals are killed before they have the opportunity of reproducing their kind, and that the same destruction is going on almost continually all round the coast, the above conclusion appears perfectly sound, and indeed is almost irresistible. "Nothing can seem more consonant to reason, or more necessary *a priori*, than that the supply of any kind of fish should be permanently diminished by this great and constant destruction of breeding fish, or of their young fry ; and yet nothing is more certain than that, in many cases, this apparent necessity does not exist."[1]

In some form or another this subject has almost continually been discussed since fisheries administration became a public duty. It has constantly been maintained in many quarters that the destruction of immature fishes was a great evil, and nothing has been a more fertile subject of discussion and legislation. Long before modern administration began, complaints that the capture of fry was damaging the fish-supply were commonly made, and, in many cases, led to regulations. The matter was one of the subjects for inquiry which were referred to the Royal Commission of 1863, and again to the Commission of 1878. Each of these bodies came to the conclusion that the harm done to the fisheries had been greatly exaggerated, and they deprecated any legislation which proposed to minimise or restrict the practice. It was not until the great expansion of the sea-fishing industry in the interval between 1885 and 1893 (when the conditions under which fishing was carried on had changed greatly), that there was a general consensus of opinion as to the harmful effects of the capture of young fish. An undoubted diminution in the supply of certain kinds of sea-fish had taken place, and it became very evident that this was due, partly at least, to the increas-

[1] Royal Commission on Sea-Fisheries of 1863: Report.

ing capture of fish fry and young forms. When this became generally admitted, an agitation for regulations designed to minimise the practice was entered on, and various Bills were promoted, having for their object the imposition of a statutory prohibition on the landing of fishes of certain specified kinds, under certain minimum standards of length. So far none of these Bills have passed into law. When the local regulation of the fisheries began in England, however, a considerable number of regulations were made, all of which had for their object the total prohibition, or the restriction, of certain methods of fishing which were responsible for the destruction of young fish (using the latter term in its widest signification, and taking it to include not only the true fishes, but also molluscs and crustaceans).

The term "immature" has been used in a variety of senses in connection with this subject. In the strict sense, it indicates that the fish or other animal to which it is applied has not yet attained the condition of sexual maturity, that is, that it is incapable of producing ripe eggs, if it is a female, or ripe spermatozoa if it is a male. In the course of its life-history a marine animal generally passes through several distinct phases of development. These are :—

1. The embryonic phase, when it is still undergoing development within an egg-capsule or in the body of the parent ;

2. The larval phase, which lasts from the end of the embryonic period until the time when the "metamorphosis" has been completed;

3. The period of juvenescence, lasting until the reproductive organs have been matured; and

4. The period of sexual maturity.

In most cases the limits of all these phases have been determined. Thus, the embryonic period of the plaice is about 14 to 18 days; the larval period lasts from the time of hatching until the little fish is about six weeks old; and the condition of sexual maturity is only attained during the third or fourth year, when the fish has reached an average length of about 15 inches. Turbot become mature when they are about 18 inches long, brill at about 15 inches, soles at about 12, cod about 30, haddock about 12, and whiting about 9. But these sizes at sexual maturity vary within rather wide limits: thus, mature plaice are smaller in Danish waters (the Cattegat, for instance) than in the English Channel, and smaller again in the latter area than in some parts of the North Sea. Local conditions will influence the sizes at which sexual maturity is attained to a very considerable extent, and the determination of the latter must be carried out for each particular locality.[1]

[1] See Fulton, *Report, Scottish Fishery Board for* 1889, part iii. p. 157, for the first attempt at the determination of the spawning sizes of fishes.

But it generally happens that a fish becomes large enough to be marketable before it has attained sexual maturity. Codling, which are only young cod, are large enough to be sold for food when they are only about 10 inches long, and plaice of 8 to 10 inches in length may very easily command a ready market. Certain trade standards become established in different places, and fish may be classified with reference to these rather than to their biological conditions. In the language of the markets, fish may be "large," "medium" or "sizeable," and "small," commanding, in each case, different prices, and those which are too small to obtain ready sale may be called "undersized" or "immature." Then if legal standards of size exist, as in the cases of the mussel, cockle, or oyster among shell-fish, or are proposed in restrictive legislation, all fish below these legal minimum sizes may again be termed "undersized" or "immature." Thus, if the Bill of 1900, which proposed limits of 10 inches for turbot and brill, and 8 inches for plaice and soles, had become law, all fish of the kinds mentioned under those sizes would have been called "immature," and the popular significance of the term would have related to the legal, rather than to the biological, standard. Marketable and biological size-limits may, but generally do not, coincide. Cockles, mussels, and oysters, for instance, become sexually mature at sizes lower than those which are fixed by law ; but most kinds of sea-fish are marketable before they have attained the biological lower limit of maturity.

Nearly every method of sea-fishing involves the capture and destruction of immature fish, and I can only allude very briefly to those which are more noteworthy. Sprat and whitebait fishing are, no doubt, responsible for the greatest absolute destruction, though it is probable that neither method is so wasteful as several other modes of fishing. Fishing for sprats and whitebait is carried on at different parts of the British coasts, but the fisheries in the Thames, the Firth of Forth, and the Solway are the most important. "Bag-nets" or "stow-nets" of peculiar construction, and often of enormous size, are used in the Thames, while large seine-nets with small meshes are used in the Forth. The catch made with such nets consists of a mixture, in varying proportions, of sprats and herrings, with occasionally other small fishes. These two species, the sprat and the herring,[1] were confused with one another for a long time, for, though it was well known that they were distinct fishes, no attempt was made to analyse what is called "whitebait" until 1861, when a committee[2] of the Scottish Fishery Board made an investigation of the subject. This was repeated at a later date, and the results of the

[1] *Clupea sprattus* and *Clupea harenga* respectively.
[2] Vice-Admiral Dundas and (then) Dr Lyon Playfair.

investigations[1] made showed that the proportion of young herrings present varied from 1 per cent. to about 20 per cent., sprats forming the bulk of the total fishes caught. An estimate was made of the extent of the fishing in the Firth of Forth, the Firth of Tay, and the Moray Firth during a single winter (1882–3), and it was found that over 143 millions of young herrings had been caught, in addition to a much greater quantity of sprats. Most of this bulk of fish was used as manure. It is only in respect of the herrings caught that we can speak of whitebait fishing as destroying immature fishes. The sprat is a fully developed and mature animal, though its average size is not much over three inches. The herrings caught are, of course, all immature.

Trawl-fishing is also a most effectual method for capturing immature fishes, particularly in shallow inshore waters, which in most places are the chosen haunts of these animals. Inshore trawling by small sailing boats is responsible for a great amount of such capture and destruction; but even in what is called deep-sea trawling, which is prosecuted far out at sea, a large proportion of the fish caught are not sexually mature. Attention, in recent years, has been mainly focussed on the destruction of immature flat fish on a certain area of the North Sea off the coasts of Denmark, Germany, and Holland, where the water is

[1] Matthews, *Rept. Scottish Fishery Board for* 1883, p. 60.

relatively shallow, and where great numbers of young plaice, brill, turbot, soles, and other fishes are to be found. The physical conditions of the area—depth, nature of bottom, temperature, prevailing tidal drift, etc.—render it eminently suitable as a habitat for these young fishes. It is, in fact, a fish-nursery on a large scale, and although adult fish are to be found on it, the characteristic fish population is an immature one. For a number of years this area has been exploited by English sailing and steam trawlers, for reasons that are rather obscure. It appears, however, that the skipper of a trawler might be unfortunate in securing a good "voyage of fish" on his ordinary fishing grounds, and though he could rely only on obtaining fish of small size, and therefore of little marketable value, on these "Eastern Grounds," yet it would be preferable to return with a large catch of these, rather than to come back with a relatively empty fish-hold. Then a few large fish would be caught, and these would enhance the value of his catch. It is very difficult, in the absence of reliable statistics, to obtain any definite idea of the amount of destruction of young flat fishes on this area, but the returns from the Billingsgate fish-market give some kind of idea of the magnitude of the practice. In 1896, 368 tons of small fish were seized by the officials of the Fishmongers' Company as unsaleable, and were sold as manure, destroyed, or otherwise disposed of. In 1897, 143, and in 1898, 92 tons were dealt with in a similar manner. When it did sell, very small prices were obtained for this class of fish. In June 1896, an average price of 1s. for ten "trunks" of plaice was obtained, as compared with a price of 28s. per trunk for good-sized fish of the same kind. Such boxes of small fish generally contained a few larger specimens, and it was apparently for the sake of these that the fish were captured and sold, the rest of the contents acting only as a kind of "make-weight." These figures represent only a small proportion of the small fish actually landed in England, to say nothing of those landed at Continental ports.[1]

Even in ordinary trawling, with the object of obtaining fair-sized fish, large numbers of immature fish are landed. Thus Holt gives an estimate of the numbers of mature and immature plaice landed at Grimsby alone in the year April 1893–March 1894. His figures are :—[2]

Mature plaice . . .	7,084,560
Immature plaice . . .	9,166,240

or, classifying the fish in another way—

Plaice over 13 inches long .	9,721,720
„ under „ „ .	6,529,080

Shrimping, however, far more than ordinary fish

[1] See Evidence, Select Committee of the House of Commons on the Sea-Fisheries Bill of 1900, Questions 361–381.

[2] *Journ. Mar. Biol. Association*, vol. iv. No. 4, 1897, p. 414.

trawling, is a most destructive method of fishing, so far as young fishes are concerned. Various kinds of gear are used, the commonest being the shrimp trawl. This apparatus has the same general form as the large beam-trawl, but it is smaller, the beam being about 25 feet long, and its meshes are usually about half an inch square. It is dragged from a sailing boat, and is "shot" and hauled in the same way as the fish trawl. There are various modifications in common use. The "shank" net or "bow-net" is a trawl in which the mouth is formed by a rectangular frame of wood, 10 or more feet long, and about a foot or more high. One edge of this frame drags on the ground, instead of the foot-rope in the proper trawl. Sometimes, as in the Thames estuary, the upper and lower bars of the frame are supported by a central vertical bar, and sometimes a rope or a second bar of wood is stretched a few inches above the bar which drags on the ground, and the lower margin of the mouth of the net is attached to this upper bar or rope. The object of this latter contrivance is to minimise the quantity of fishes captured. When the frame encounters a shrimp, the latter jumps, clearing the top bar or rope, and so entering the net. The fish, on the other hand, often swims through the space below the net, and so escapes capture.[1] On some parts of the coast, the "bow-

[1] See Holdsworth, *Deep-sea Fishing and Fishing Boats*, London, 1870, for an account, with figures, of these nets.

nets," two or more, are dragged in shallow water from a horse and cart. The net may be hauled while the cart is in the water, or it may simply be dragged on shore and emptied there. In other methods of shrimping, a large hand-net may be pushed by a man who wades in the water, or "hose-nets" may be employed: these are long cylindrical nets, kept open by rings and furnished with trap-like pockets. They are set on the sand at low water, so that the tidal stream flows through them, and they are fished at next interval of low water.

Wherever shrimps are found, young fishes are also present on the same grounds, often in immense numbers, and no method of catching shrimps, except, perhaps, the one last mentioned, and the French method of traps (one which is not practised in this country), can avoid capturing fish. The young food-fishes associated with shrimps are usually dabs, plaice, flounders, soles, whiting, haddock, sprats, herrings, etc., and the quantities and proportions of these vary with the locality and the season of the year. Along with these fishes and shrimps, the net, when "fished," usually contains a miscellaneous mass of crabs, star-fishes, inedible fishes of various kinds, jelly-fish, sand, mud, and weeds. Everything except the shrimps and the few larger fishes often caught are described as "muck" by the fishermen. The net is hauled for a variable time (one-half to two hours), and at the end of the drag its contents are dumped out on the narrow deck of the boat.[1] The net may then be "shot" again, and the fisherman then begins to sort the catch. Small fish, crabs, etc., are quickly thrown overboard, an operation not free from most serious inconvenience, on account of the presence of "sting-fish" (*Trachinus vipera*), which can inflict most painful wounds. The shrimps are put into a riddle, the smaller ones are shaken out and returned to the sea, and the larger ones, which are destined for the market, are usually boiled at once. The operation of sorting the catch is performed in a surprisingly short time, and in cool weather a large proportion of the fish caught are returned to the sea alive. But in hot weather the latter die very quickly, and the whole contents of the net are sometimes stowed away for the time in baskets and sorted at leisure. In the latter case the fishes caught die, of course, and usually also when, by reason of the presence of mud in the net, they are smothered. Cart "shankers," too, may sort their catches on going up the beach, and young fishes thrown overboard on the dry sand are obviously in an unfortunate predicament.

[1] Shrimping boats are usually half-decked, and are about 36 feet long. They are worked by two men, a man and a boy, or by one man. It speaks volumes for the skill of English fishermen, and is almost incredible to the ordinary landsman, that *one* man may manage such a boat (with perhaps a mainsail, topsail, foresail, and jib all set), work two "bow-nets," shoot them, haul them, and sort his catch, unaided.

In many places, of course, but little destruction of young fishes may accompany shrimp trawling, but the usual state of matters is that large quantities of these animals, all too small to be of use for food, are taken, and often destroyed. This is particularly the case on the coast of Lancashire, where a large shrimping industry is carried on. As many as 10,407 young plaice have been taken there in a single drag with a shrimp trawl. I will quote, as an example of the contents of a shrimp trawl, one of many such experiments witnessed by myself. In a two miles' drag there were caught 20 quarts of shrimps, 896 dabs, 265 plaice, 257 soles, 285 whiting, and 18 skate, besides a large number of inedible fishes, and the usual quantity of star-fish, crabs, and other invertebrates. The majority of the young flat fishes were from 1½ to 2 inches long, and the whiting were about 5 inches. The results of some hundreds of such experimental trawls on the Lancashire coast, extending over a period of seven years, gave an average of 567 plaice caught per haul of the shrimp trawl.[1] When the large numbers of boats and men engaged in this locality are considered, it is evident that the quantity of young fishes of value, caught and destroyed incidentally in shrimp fishing, must be enormous, and is probably to be measured by the hundred million annually.

[1] *Report for* 1901 *of the Lancashire Sea-Fisheries Laboratory*, Appendix, p. 229.

It is perfectly obvious, then, that a great amount of destruction of many kinds of young fishes is involved in ordinary fishing operations as carried on at the present time. The practical questions now arise: Is this capture and destruction wasteful to the general fishing industry? that is, does it tend to diminish the total quantity of fish landed on the British coasts? And if it could be avoided by legislative restrictions on methods of fishing, would the total value of *all* the fisheries increase? There is yet another consideration which ought not to be lost sight of: would the disturbance of employment caused by this legislation—the probable shifting of a great amount of fishing from the inshore to the offshore waters, from fishermen using small boats and possessing little capital to largely capitalised fishing firms and companies—not produce social-economic effects which it would be much better to avoid?

The destruction of immature fish *per se* is not necessarily an evil. Sardines are immature fishes which are much more valuable in the form in which they reach the consumer than as adult pilchards, and whitebait are just as much a legitimate object of fishing as herrings or sprats. To borrow an illustration from agriculture, we need not give up using lamb or veal because by doing so we destroy immature sheep and cattle, or eggs because thereby we are destroying potential fowls. In these cases, as in the cases of sardines and whitebait, the immature products have a directly commercial value, and are sought after without regard to the adult animals into which they develop. But the latter must also be preserved in sufficient numbers to keep up the stock of the immature stages; and when both immature and adult animals are of marketable value, regulations must take account of the relative value of each, and of the relative demand for them.

Even admitting that the destruction of immature fishes is economically wasteful, it remains to consider the further question whether restrictions on their capture would lead to the increase of the adult and (generally) most marketable stages. This is not necessarily the case. In a mussel-bed on the foreshore, for instance, which extends from some distance below high-tide mark down to the extreme low-water line, we may generally find that, the higher up the beach we go, the smaller and more stunted are the animals. By legal standards these are immature shell-fish, and in many localities they may not be taken for food nor any other commercial purpose. But no amount of protection will enable such small mussels to grow to the statutory size (say 2 inches in length), because they are in an unsuitable environment. It has to be considered, then, whether the same may not be the case in many other forms of fishing in which there is an apparently wasteful destruction of immature fishes. Every such case must be studied with reference to the particular conditions involved, and regarded as a special problem.

Whitebait, sprat, and sardine fishing may be dismissed at once, for there is no evidence that the destruction of immature herrings or pilchards has any prejudicial effect on the fisheries for these creatures, whether in their immature or adult stages. The immature fish question, so far as it has become "practical politics," resolves itself into two main sub-inquiries, which concern the destruction of small fish by deep-sea and inshore trawlers, and by the shrimpers. I shall take the former question first. We have seen that there is a very considerable fishery for small flat fish on the eastern side of the North Sea. At the very outset, however, we are confronted by the invariable difficulty encountered in all fishery inquiries—the lack of accurate statistics. There are no figures in existence which give (1) the relative numbers of adult and immature flat fishes of the different species on the grounds in question, and (2) the quantity of fish landed from these grounds annually by British and Continental fishermen. It is certain, however, that a large amount of small and nearly worthless fish *are* landed in England, and that a great quantity are never packed and brought home at all, but are at once thrown back into the sea. It has nearly always been assumed that all this destruction is wasteful, and that it is the cause of the admitted decrease of certain kinds of flat fish in the North Sea. At first sight there appear to be three remedies: (1) to prohibit fishing on these "small-fish grounds"; (2) to regulate the methods which may be practised, by restricting the length of the drags, and by increasing the size of the meshes of the trawl-nets used; and (3) by a prohibition of the landing of fish under certain specified sizes. Now, (1) is impossible without international agreement; (2) would require an international police on so large a scale as to be quite impracticable, while the efficacy of the regulations suggested is not generally admitted. The third remedy is the only one left to consider. If the sale of small flat fish were made illegal, then trawlers would cease to work on grounds where these are generally found. This was the remedy suggested by the trawling trade, and embodied in the Sea-Fisheries Bill of 1900. I have already alluded to the fate of this measure. It failed most probably because of the general lack of statistical and scientific data, and also because it seems to have been felt that its operation was too wide, and that its application all round the coast would have involved very considerable interference with the methods of inshore fishing, and most probably a good deal of hardship to men fishing in a small way, and possibly depending to a great extent on just those small fishes which it was the object of the Bill to prevent them catching.

In such cases the Legislature is naturally (and very properly) slow to impose legal restrictions, unless it could be shown very clearly (which is not the case at present) that the remedy proposed would be productive of so much benefit as more than to compensate for the disturbance and hardship brought about.

In the case of shrimp trawling there are considerable restrictions in force already. So long as the capture of shrimps is a legitimate form of fishing, the destruction of young fishes cannot be avoided. But though this is the case, it has been found that, when short drags are made on clean ground, a great proportion of the fishes caught are alive and uninjured when the net is hauled and its contents emptied on deck. Therefore drags are made short (half-hour to one hour) in some districts, and the fishermen are expected to sort out the fish rapidly and restore them to the sea. The dimensions and form of the net may be regulated, and in some cases, where certain shrimping grounds harbour great numbers of young fishes, trawling may be prohibited absolutely. It is also the case that young fishes are much more abundant at some seasons of the year than at others, and it has been proposed to close the grounds for these latter seasons, either absolutely, or to allow fishing subject to the employment of certain forms of gear.

Now, what would be the effect of such restrictions as are proposed or have actually been adopted with regard to deep-sea trawling or shrimping? Obviously, such a question can only be answered in a thoroughly satisfactory manner by trying, and then noting what are the results, as displayed by abundant statistics. But inasmuch as all such legislation involves more or less interference with employment, hardship to poor or unadaptable fishermen, and expense in changing or laying up fishing gear; and as it creates new offences, requires a special police, and generally causes bad feeling and friction between the fishing population and those whose duty it is to administer the law, it is only reasonable to ask those who propose such steps what grounds they have for the belief that the restrictions suggested would yield benefits at least commensurate with the disturbance and loss caused by their operation. Now, a knowledge of the present state of fishery science forces one to the conclusion that the case for the imposition of such restrictions is purely an *a priori* one, and though it is probably a good enough case, yet it rests on incomplete scientific results.

I will put this case as strongly as possible. If we return to our imaginary mussel-bed, we can easily convince ourselves that no restriction on the capture of the small animals on the higher parts of the beach can possibly be of any use. They are inadequately nourished and cannot attain a greater size, and for all practical use they are, they may as well be carted away for manure. It is true that they produce spat, which may lead to the formation of new mussel-beds in better localities, but there is no scarcity of mussel spat in most localities. The mussel, however, is a sedentary animal. It is fixed on the place where it grows, and has a most limited range of movement. It is quite different with the small flat fishes on the shrimping grounds or on the "Eastern Grounds" of the North Sea. The investigations made on the life-history of the most abundant of these fishes—the plaice—show that it lives during the first two years of its life on shallow, sandy flats, grows there till it is about 6 to 9 inches in length, and then begins to migrate outwards into deeper water. These shallow inshore areas are therefore "fish-nurseries" which "feed" the fishing grounds offshore where the larger fish are found. On the other hand, the mature plaice on the latter areas spawn, and the eggs drift inshore, where the little fish, when it is hatched, passes through its post-larval and immature stages. In the "Eastern Grounds" of the North Sea we have such a fish-nursery on a large scale—a nursery which owes its position to physical causes. The general drift of the surface water in the North Sea is such as to cause small objects floating on the surface to move down the north-east coast of Great Britain as far as Norfolk, while at the same time there appears to be a northerly drift from the Straits of Dover along the Dutch coast. The general result of such a drift is to carry the eggs of any fish, such as plaice, spawned almost anywhere in the North Sea, towards, and into, the Bight of Helgoland and the shallow waters off the coasts of Denmark and Holland. These eggs undergo development and the little fishes pass their first year of life close inshore, and then move out towards deeper water—such water and such a sea-bottom as are found on the "Eastern Grounds."[1] The same general movement of eggs and larvæ towards the coast, and an opposite movement of the fishes as they grow from the coast towards deeper water, exists on a smaller scale on the east coast of Britain in some places, and on the west coast of England. Whether we consider these latter places, in many of which shrimping grounds are situated, or the larger area in the North Sea, the apparent result is the same. We are not dealing with small or stunted fishes in these inshore areas, but with migratory fishes which are on their way outshore, where they will grow into much larger and more valuable animals. If we capture and destroy them, we impoverish to that extent those off-shore fishing grounds. The capture of these fishes is therefore unfortunate :—

[1] Cunningham, *Marketable Marine Fishes of the British Islands*, 1896, pp. 221–2.

1. Because it is economically wasteful, inasmuch as they are of little or no value when caught by the inshore trawler or shrimper, and the price which they would have brought, if caught a year or two later, would be comparatively high ; and

2. Because in catching them we are destroying animals which have never spawned, and are so reducing the stock of eggs destined to keep up the plaice population of the sea.

Now, this argument will probably turn out to be quite a sound one, and if we knew no more, it would be enough to justify legislation, in a provisional sense at least. It is necessary, however, to point out that it is by no means so firmly established by investigation as might be desired. Theories in biological matters, when they have been stated and have come to be repeated in books and memoirs, often become so generally believed that the need for verification by and by becomes less apparent. Now, however desirable it may be to verify any theories of migration, spawning, distribution, and the like, from a purely scientific point of view alone, this is all the more desirable when they are to form the bases of restrictions on methods of fishing. No one familiar with the literature of sea-fishery science will say that those theories with which we are now concerned have been sufficiently verified by observation and experiment. Only one thorough investigation has been made with the object of determining the surface drift of the water of the North Sea,[1] and it is very desirable that this should be repeated with this particular question in view. Then, though it is probably the case that floating fish eggs are carried by this drift towards the Helgoland Bight, this is rather a deduction from Fulton's experiments than an actually observed fact. Hensen's work on pelagic fish eggs is the only piece of experimental evidence of which I am aware that is relevant to this question, and his distribution maps[2] do not lend very decided support to the contention in question. Again, it is probably the case that young flat fishes do migrate from the small-fish "Eastern Grounds" towards the deeper water fishing grounds of the North Sea; but here too direct experimental evidence is wanting.

So also with regard to the effects of shrimping on shallow inshore waters, though in this case the question is rather more complex. If we wish to be assured that the cessation or diminution of the capture of young fishes on any shrimping ground is to be of material benefit to the fisheries, it must be proved, *for the particular area in question*, that the young fish (say plaice) are only present there during a particular stage in their life-history, and that on the completion of this they migrate

[1] Fulton, *Report, Fishery Board for Scotland*, 1894, pt. iii. p. 153.

[2] Hensen, *Wissenschaftliche Meeresuntersuchungen*, Kiel Kommission, Bd. ii. (N.F.), Heft 2, 1897.

towards the fishing grounds offshore. The generally accepted theory of the migratory movements of the plaice is that the young fish spends its early life in shallow water, and migrates into deeper water as it becomes older. This theory has been deduced from observations on the distribution of plaice of different sizes in water of varying depths. Generally speaking, large plaice are more abundant in deep water, and small plaice in shallow water. But, again, the evidence for this is not very complete. Plaice may be found in certain shallow inshore areas, *where trawl-fishing has been prohibited for a number of years*, and we must remember that the apparent natural distribution of the plaice may be due to the fact that the shallow-water areas have been more thoroughly fished than the deeper water offshore, and that it is generally agreed that the principal effect of extensive fishing is to reduce the average size of the fish on the areas fished on, for the larger fishes are fewer and are more easily caught than the smaller ones. Most theories of the distribution and migratory movements of fishes have been constructed during the time when modern fishing has been so largely developed, and subsequent to the initiation of the above changes in the distribution of large and small fishes.

Further, it is very difficult to forecast the probable changes in the fish fauna of a particular area, such as a shrimping ground, which would result from the cessation of fishing there; and it is by no means certain, however probable it may appear on *a priori* grounds, that the prohibition of shrimping would lead to the increase of young fish (say plaice) on the area in question, and, in consequence of the offshore migration, to an increase in the number of large plaice further out at sea.

It would appear, then, that we are not yet prepared to give thoroughly convincing reasons for the adoption of legislative restrictions on those modes of fishing in which small fishes are destroyed to a notable extent. At the same time, there can be no doubt that what we do know of the life-histories of fishes does justify us in recommending the adoption, *as a tentative measure*, of some of the remedies proposed—say, the imposition of size-limits on the fishes landed in certain districts, or the restriction of shrimp trawling during certain seasons and in certain localities. Such tentative restrictions or prohibitions might be abandoned later, if it became evident that no beneficial result followed from their imposition. But when we consider—

1. That the imposition of such legislative restrictions would, in many cases at least, provoke much resentment, create new offences demanding an increased police superintendence, and might be the cause of (at least) temporary hardships; and
2. That it is certainly quite practicable, by well-

> planned fishery investigations, to obtain much more information than we at present possess : information which would certainly show with great probability whether or not such legislative restrictions were likely to be beneficial—

then it is better, on the whole, to press for investigation on a much more adequate scale than has hitherto been contemplated, before recommending any drastic change in the fishery laws.

The Sea-Fisheries Bill of 1904

I may bring the discussion of this portion of our subject up to date by referring briefly to the fate of this measure. It will be remembered that the Select Committee of the House of Commons which considered the Fisheries Bill of 1900 came to the conclusion that, largely because of the lack of information of a statistical nature, it was not advisable to pass the Bill into law. They recommended that no effort should be spared to secure international treatment of the subject of the destruction of immature fish in the North Sea ; and that the Government Department of Fisheries should be adequately equipped for the investigation of the question. In the interval between the discussion of the two measures much was done. The control of the fishing industry was transferred from the Board of Trade to the Board of Agriculture, and the Department became better organised.

The prospects of international treatment of the question became appreciably better, one reason for this being the growing recognition in Germany of the fact of the depletion (so far as certain classes of fish are concerned) of the North Sea area,[1] and the other being that the international investigation of the North European fishing grounds was directing very general attention abroad to the condition of the fishing industry. Finally, the Board of Agriculture and Fisheries had obtained statistics bearing closely on the question of the destruction of undersized fishes in the North Sea. It was shown that a very considerable fishery for small plaice was going on in the seas round Helgoland; that the bulk of this fish was caught principally from March to October. In the year 1903 extensive statistics were collected by the officers of the Board. These were obtained from steam "carriers" which took the fish from certain fleets fishing in the North Sea and landed them at Billingsgate Market. These figures showed that—

In 1902–3, 229,076 cwts. of plaice were landed in London, and that 173,693 cwts. of these were caught in the seas round Helgoland.

In 1902, 82 per cent. by weight were "small," and 71 per cent. in value were small.

In 1903, 67 per cent. by weight were small, and 56 per cent. in value were small.

[1] Henking, *Mittheilungen deutschen See-Fischerei-Vereins*, No. 1, 1901 (extracted in *Report of Select Committee on Sea-Fisheries Bill*, 1904, p. 191).

By "small" plaice is to be understood plaice of less than 11 inches in total length.[1] Further, the pathetic state of matters was revealed that the fried-fish trade of London found it was increasingly difficult to get plaice of a size sufficient to meet the demand, and that they were compelled to use turbot, brill, witches, and even skate and dog-fishes in the fried-fish business; and that, because of the popular preference for plaice, the trade was compelled to sell all fish under that designation.[2]

The Bill introduced was an "enabling" one. It proposed to give the Board power to make Orders prohibiting the landing of fish, of kinds and sizes to be specified, and in such localities as were found necessary. This elasticity was claimed as the great merit of the Bill, for, as investigation revealed the necessity for action, Orders could be made or modified accordingly. The Bill was introduced in the House of Lords by Lord Onslow, the President of the Board of Agriculture and Fisheries, and passed through the various stages there. Finally, it was made to apply only to steam trawlers and sailing smacks over seventy tons burden. It appears to have met with general approval, but in the end it was rejected in the House of Commons.

[1] *Rept. Sel. Comm.*, 1904, pp. vi.–vii.
[2] *Ibid.*, p. vi.

CHAPTER XVI

MARINE PISCICULTURE

When it became evident that over-fishing of the sea was taking place, and that, as a consequence, certain species of fish were less abundant on the great fishing grounds than was formerly the case, two remedies were suggested and discussed. These were: (1) to impose restrictions on the capture of the young and comparatively valueless stages of certain species; and (2) to attempt to make fish more abundant by means of artificial culture. Both remedies have, as a matter of fact, been adopted. In the general discussion of the efficacy of these measures, it was agreed that the first would be likely to prove effective, but that there were grave practical difficulties in the way of its general adoption. Restrictive legislation has always been very unwillingly adopted in this country, not only on account of the expense of enforcing it, but also because of the prejudice and ill-feeling which measures of this kind always arouse. Then it could practically be applied to territorial waters only; and legislation with regard to the high seas (which was just as necessary as within the three-mile limit) was only possible by international agreement, and was almost impracticable. Restriction on the capture of young fishes, then, was regarded as only one of the possible means of restoring the productivity of the fishing grounds. The prospect of achieving valuable results by our second remedy was, on the other hand, a very alluring one. It avoided the necessity of vexatious interference with the fishermen—a view which was held in the United States, where it was regarded as cheaper to make fish plentiful by culture than by restriction. Further, the *a priori* argument in favour of it was apparently a rather strong one. Fishes are enormously prolific; a cod, for instance, produces annually between five and ten millions of eggs. The destruction of these eggs and their resulting larvæ in the sea *must* be very great. But this destruction would be avoided if the eggs were incubated under artificial conditions, and the saving would represent an enormous gain to the fishing industry. It was "Nature's offer and man's opportunity." Again, fish-culture with respect to fresh-water fish was a very old and well-understood industry, and had been practised with great success in Germany, where it was minutely studied. It was concluded, then, that the artificial culture of sea-fishes could not fail to be of enormous benefit to a decadent fishing industry, and that it would, in the long run, be cheaper, and moreover would not cause friction between the administration and the fishermen.

As I have said, restrictions were also applied; but, where artificial culture was practised by public bodies, such, no doubt, was the line of argument adopted, though not always clearly expressed. The credit of having first practised fish-hatching on a large scale belongs to the United States. We have seen that the Fish Commission of that country made it a most important department of their work, and public fish-culture has been carried on in North America, both by the United States and Canada, to a greater extent than by any European country. The method has continually been developed on the other side of the Atlantic, and, judging from the reports of the authorities, with conspicuous success. Great encouragement was afforded by the striking results which attended an experiment started in 1871. The shad (*Clupea* (or *Alosa*) *sapidissima*) was an important food-fish on the Atlantic seaboard of North America, and it occurred to the officers of the Fish Commission to attempt its introduction on the Pacific side. Shad eggs were accordingly obtained, were artificially fertilised and incubated, and the larvæ were introduced into suitable waters on the eastern seaboard. In a few years, this fish, which was previously unknown, became, next to the salmon, the most abundant fish in the rivers of the Pacific slope, and became cheaper than on the Atlantic side. When first taken, its price was $1.20 per pound,[1] but after a time this fell to about 2 cents in many places. In 1892 the catch of this fish, which, however, was not the sole object of a fishery, was 700,000 lbs. These results were held to be highly gratifying, and encouraged the Americans to develop the system of fish-culture to the extent at present represented by their official reports.[2]

At the present time, then, fish-culture is extensively practised on the other side of the Atlantic. According to the last report of the Commissioner, there were hatched in 1902 1,495,543,374 fish eggs, all the resulting fry of which were distributed throughout the rivers and fishing grounds of the United States by means of the very complete system of transport developed by the Fish Commission. Of this enormous number of fish fry, the majority consisted of fresh-water species, and were principally salmon, trout, bass, etc. About fifteen millions were game fish, but all the rest belonged to species forming the object of the commercial fisheries. The principal salt-water species dealt with were :—

[1] One suspects, however, that this was a "fancy price."

[2] See *Commissioner's Report*, *U.S. Fish Commission*, for 1893 (1895), p. 72, for an account of the results of shad culture and acclimatisation.

Cod	338,120,000
Flounders (*Pseudopleuronectes americanus*)	194,000,000
Lobsters	81,000,000

The fresh-water species were hatched at a number of stations situated at convenient places on the rivers and great lakes, and the marine forms were dealt with at the two marine stations at Wood's Hole, Boston, and Gloucester.

Fish hatching was also taken up in Canada and Newfoundland. The Dominion Government undertook the hatching of lobster eggs. There is an extensive fishery for this crustacean in Canada, and the lobsters caught are, for the most part, sent to the "canneries" to be canned for export. But "berried" females—that is, animals carrying developing ova attached to the abdomen—are previously "stripped," that is, the eggs, which would otherwise have been lost, are removed from the parents and incubated in suitable apparatus. The Dominion lobster hatcheries hatched, in this way, 742,000,000 lobster fry in the period 1891–97. In Newfoundland, cod hatching is principally practised, and the average annual number of fry of that fish treated in the period 1890–96 was 145,435,555.

Sea-fish hatching in Europe was first started in Norway by Captain G. M. Dannevig, at whose suggestion the Flodevigen hatchery for salt-water fish, at Arendal, on the south-east coast, was started, at a time when the decrease in the local cod fisheries was severely felt. The institution was a private one at first, and the expenses were met by a local society in Arendal. All the details of the hatching apparatus were elaborated by Captain Dannevig, and it was here that cod eggs were first incubated on a large scale. In 1889 the Government took over the work, and voted money for the erection of a hatchery on a larger scale, and during the period 1890–96 1,203,000,000 cod fry were incubated and were liberated on the south coast of Norway, between Christiansand and the Swedish frontier. According to Dannevig, the result of this work has been that cod are rapidly increasing on the south coast of Norway, and especially at the places where fry have been "planted."

Sea-fish hatching was begun in Scotland by the Fishery Board in 1893. The report for that year[1] contains a statement by the members, which gives the reasons which induced them to begin this kind of work. The great diminution among the more valuable classes of flat fish, which had taken place during the decade preceding the issue of the report, is referred to, and it is pointed out that the regulative measures with regard to beam-trawling — the mode of fishing by which flat fishes are principally obtained—adopted in Scotland were more extensive and were longer in force than in any other country. Not only

[1] Part iii. p. 8.

the territorial waters had been closed, but also extensive areas lying outside these, such as the Firth of Clyde and Moray Firth. Nevertheless, statistics showed a continued falling off in the supplies of flat fishes, and the trawling investigations of the Board showed a general diminution in the average abundance within these protected areas.

The artificial culture of these flat fishes was felt, then, to be a remedy worthy of adoption, and in 1893 the fish-hatching establishment at Dunbar, on the east coast of Scotland, was erected.[1] Plaice and cod were the fishes first dealt with, but attempts were made to cultivate turbot and soles. The latter form is very scarce on the east coast of Scotland, and the breeding fishes were obtained from Lancashire waters. The fry produced in the hatchery at Dunbar were first liberated on the fishing grounds in the neighbourhood of the station; but in 1895 the Board, although convinced of the economic value of the practice, yet thought it would be desirable to prove experimentally whether the planting of large numbers of plaice fry in a portion of the sea did increase the abundance of adult fish on the same area. "It is, however, of importance," they say, "that the economic results of marine pisciculture should be as speedily as possible

[1] There is an excellent account of this establishment in the Board's Report for 1893, pt. iii. p. 196.

ascertained. Its utility as a means of benefiting the sea-fisheries depends on the extent to which it is likely to increase the abundance of the fishes propagated. There is at present no means of judging what proportion of the fry distributed on the fishing grounds survive to a marketable size; and it has been thought desirable, as the most likely way to discover this, to place the fry in one or more selected lochs on the west coast, which are to a large extent shut off from free communication with the open sea, and carefully to watch the results on the abundance of the same species within its waters. Accordingly, the fry are now, for the most part, being transported in special apparatus by rail to the west coast, and distributed in confined lochs."[1] Upper Loch Fyne was selected as the most suitable place to experiment in, and from 1893 practically all the fry produced at the Dunbar hatchery, and at the station at the Bay of Nigg, Aberdeen, to which the whole work was removed in 1899, have been carried across the country and planted in that loch. Investigations were also made to show, for the year 1898, what was the condition of Upper Loch Fyne as regards the abundance of pelagic fish eggs.

The numbers of eggs of sea-fish hatched at the Scottish Fishery Board stations so far have been, up to the year 1903:—

[1] *Report of the Fishery Board for Scotland for* 1895, pt. iii. p. 10.

Plaice	340,455,000
Lemon soles	5,727,000
Turbot.	5,160,000
Cod	4,010,000
Other fishes	2,000,000

Since 1897, sea-fish hatcheries have also been established in England, at Piel, in Lancashire, by the Fisheries Committee of that county; and at Port Erin, Isle of Man, by the insular government.

The methods adopted in the artificial culture of sea-fish differ somewhat in the various establishments. This is particularly the case in the manner in which the eggs are obtained. Commonly sea-fish eggs for incubation in hatcheries are obtained direct from fishes kept on the establishment. Several months before the onset of the breeding season a sufficient number of fish are obtained, of such sizes that they may be expected to yield spawn at the next spawning season. Generally one male produces sufficient spermatozoa to fertilise the eggs of several females, so in obtaining the fish this is taken into account—a somewhat difficult matter, as it is not always possible to distinguish between immature females and mature males. The stock of breeding fish are either specially fished for, short drags with a fish trawl-net being made, so as to obtain the fish in as healthy a condition as possible, or they are purchased from the vessels engaged in the commercial fishery.

Once obtained, they are put into the "spawning pond," which is a large and somewhat deep pond excavated or built, and kept supplied with a current of pure sea-water pumped into it by means of engines and pumps, or perhaps let into it at intervals, if the pond be situated at a lower level than that of high-water mark. The fish are kept supplied with suitable food, and in the course of time they spawn naturally in the pond; and as there are generally some males in a ripe condition while spawning is going on, the eggs are fertilised. The latter then rise to the surface of the water in the pond, and this surface layer of water may be constantly running off, passing through a large horse-hair sieve as it does so. The eggs are therefore retained by this sieve. Or perhaps the surface of the pond may be swept daily by a large net made of fine material, so as to gather the eggs. There are other methods of obtaining the eggs. Ripe fishes may be caught, and the eggs and spermatozoa obtained by stripping them, that is, by gentle pressure on the abdomen in the region of the reproductive organs. These stripped fish may then be put back into the sea. Or the commercial trawlers may be visited, and such ripe fish as are taken in the trawl-net may be stripped, and the fertilised eggs then brought back to the hatchery. But when it is desired to obtain a large number of eggs, the method of the spawning pond is always adopted.

The fertilised eggs, by whatever method they are obtained, are cleaned by washing in pure sea-water, and they are then put into the "hatching-boxes." These apparatus are generally small boxes about a foot square, open at the top, and having a bottom made of a fine but strong sieve of horse-hair. They are arranged in sets, and float in connected compartments in a large wooden tank, also filled with water. Water enters into each hatching-box at the top, and passes out through the sieve forming the bottom. By an automatic arrangement of some kind or other the hatching-boxes are jerked up and down at regular intervals, and in this way the eggs, which normally float at the surface of the water, are kept from collecting there as a layer, and receive sufficient aeration by the motion of water caused by the jerking of the boxes. The sea-water which is made to circulate through the hatching-boxes is selected for its freedom from sediment and its high specific gravity. If there should be much sediment in the water, this is apt to settle down on the eggs, and so impede their oxygenation. If the specific gravity is low, then the eggs may sink to the bottom. It is often necessary to filter the water used in the hatching-boxes, though a high degree of freedom from sediment is not so essential as is often supposed.

The average volume of the eggs dealt with is known, so that, by measuring the total bulk put into the hatching-boxes, and applying a factor obtained by experiment for each kind of egg used, the total number incubated is ascertained. About two or three days after the beginning of incubation, a certain proportion (roughly, 10 per cent) of the eggs die and sink to the bottom. These are removed by allowing the floating living eggs to run off with the current. The quantity of dead eggs is measured, and the numbers ascertained by calculation. Then the proportion of living eggs, and, consequently, the mortality, are obtained. At the end of a variable incubation period, depending (1) on the species of egg dealt with, and (2) on the average temperature of the water in the boxes during the incubation period, the embryos hatch out.

Now, so far the work has not been difficult. There are many things which are trying to the fish-culturist, of course; but, compared with most ordinary industrial processes, the operations of sea-fish hatching are simple, easy, and straightforward. But when the embryos have hatched out the really difficult part of the work begins. If sea-fish culture on a large scale is ever to be successful, then it must be emphasised that the rearing of the embryos through the period of the metamorphosis is most essential. In most hatching establishments this rearing is attempted, but in all cases with very doubtful success. The embryos are retained in the hatching-boxes for a time which is, roughly speaking, a week to a fortnight, and they are then transferred to rearing-tanks or ponds. During this period the little fish is feeding on the supply of food contained in its own yolk-sac. When this food-yolk is exhausted, then the troubles of the fish-culturist begin.

It has been suggested that a kind of inherited anæmia afflicts the embryo hatched in artificial conditions, and probably also in the sea in a state of nature. It is extremely difficult to induce a considerable proportion of the larvæ to feed on any kind of food-material supplied to them. All kinds of food have been tried, both natural and artificial; but it has always been found that by far the greater number of the larvæ hatched out from the eggs die in the hatching-boxes, or in the rearing-tanks or ponds. It is true that considerable success has been achieved by various investigators in rearing sea-fishes hatched artificially—H. Dannevig did this, with regard to plaice, on at least two occasions. In 1896 [1] he reared a number through the metamorphosis. No figures are given, however, showing what proportion of those started with were successfully reared. In 1900 Dannevig again reared "a few specimens" for about nine months, by which time they were about $3\frac{1}{4}$ inches long.[2] These results are very interesting, and are of very considerable theoretical importance. The

[1] *Report, Fishery Board for Scotland for* 1896, pt. iii. p. 175.

[2] *Ibid.*, 1900, pt. iii. p. 229.

same is to be said of experiments made by Garstang[1] and by Cunningham,[2] the former of whom reared young blennies successfully, while the latter was successful with flounders. But in these cases also the experiments were not carried out successfully on the large or economic scale. Finally, M. Fabre-Domergue[3] made a most encouraging experiment with soles at Concarneau, on the coast of France, and was able to rear a considerable number of these fish through the critical stage of metamorphosis. Unfortunately, the French investigator did not experiment with large numbers, and we are unable to regard his work as a satisfactory solution of the rearing problem. In hatching operations we deal with numbers like ten to two hundred millions of fry, and if rearing operations are to be successful, we must be able to deal with as large numbers, rearing, say, fifty millions of plaice larvæ through their metamorphosis, and with a loss corresponding to that incurred in hatching, viz. little more than 10 per cent. Hitherto this has not been possible, and there are few indications that it will become practicable in the near future.

In actual practice, then, the fry are liberated within a few days after hatching, or, at the latest, just before the yolk-sac has been completely absorbed.

[1] *Journ. Mar. Biol. Ass.*, vol. vi. 1900, p. 70.
[2] *Ibid.*, vol. iii. 1893–5, p. 206.
[3] *Comptes Rendus Acad. Franc.*, Section Sci., 6th May 1901.

The great mortality which occurs when the mode of nutrition of the larva is changing is thus avoided *in the hatchery* simply because the fry are liberated before this mortality begins. Now, with regard to the part of the sea in which the fry are set free, two considerations have to be borne in mind. The reader will remember that the pelagic eggs of most fishes are spawned well out at sea, and that those which come within the influence of a favourable drift of the surface water ultimately find themselves in shallow waters near the land, on those sandy bottoms which seem to be necessary for their further development. Further, this drift inshore must be completed about the time when the little fish is abandoning its pelagic mode of life, and is assuming the bottom-living habit characteristic of its after-existence. If the larvæ drift on to a rocky, deep-water coast, then, from what we do know of the life-histories of such fish as the plaice, it is probable that they do not meet with the conditions favourable to the development of further stages. Again, if they drift into shallow water some time before the metamorphosis begins, there is a probability that they may be stranded by the receding tides and destroyed. And if they do not accomplish this drift in the proper time, it may also happen that the metamorphosis may take place in relatively deep water, and that the larvæ may go to the sea-bottom in too great a depth and on unsuitable ground. Therefore, in correct practice they should be set free (1) in such a place that the surface drift will carry them to the nursery grounds, and (2) so that the duration of this inshore drift will coincide with the duration of the period between the stage at which they are liberated and the stage of the metamorphosis.

In all economic sea-fish cultural operations, the intention is to benefit some particular local area. To be certain of doing this, it is further necessary that we should know that the migratory course pursued by the young fishes added to the inshore nursery is such as will carry those fishes, when they become marketable, from the latter to the fishing grounds offshore.

Now, a consideration of the literature of sea-fishery science will show that, so far as this country, at least, is concerned, we do not know enough of the migrations and distribution of fishes *at all stages*, to be sure that all these conditions may be satisfied. In actual practice, moreover, questions of expense must be considered, and it is not generally practicable to liberate the larvæ on the offshore spawning grounds, at the times when winds and currents contribute to secure the most favourable inshore drift for the fry liberated. The best has to be done, and this is not always the theoretically correct (so far as we know) procedure.

There are two main arguments for the utility of sea-fish culture: (1) the argument *a priori*, from what we know of the life-histories of fishes; and (2) the argument *a posteriori*, from what we have been able to discover of the actual results of the method. The first line of argument may be stated in the following manner:—[1]

Sea-fishes producing pelagic eggs are enormously prolific, but the destruction in nature of the eggs produced is just as enormous. This destruction is due to three main causes—

1. The physical causes. The eggs may drift out to sea and be lost to the fisheries, or they may be stranded or drifted on to an unfavourable shore, or they may drift into an estuary, where the low specific gravity of the water may destroy them. But in artificial cultural work they are liberated at such a place and time as to avoid these causes of destruction.

2. Many eggs spawned in natural conditions on the fishing grounds fail to be fertilised by the males of the same species, and are thus destroyed. But in the hatchery we can be sure that practically all are fertilised.

3. There is an enormous destruction of pelagic eggs in natural conditions, because they are eaten as food by other pelagic animals. But in the hatchery we can exclude these natural enemies, and so avoid this destruction.

4. There is most probably a great mortality at

[1] The case of such a fish as the plaice is considered here.

the time of the absorption of the yolk-sac, and further during the metamorphosis. In the hatchery we seek to avoid this mortality by providing the larvæ with suitable food.

In an "over-fished" area, we assume that there are fewer mature fish this year than last (or this year than formerly). Therefore fewer fry reach the nurseries. This loss of fry must be compensated. If we take a number of spawning fish from the sea and let them breed in the hatchery, and take all imaginable care of the resulting larvæ, and then turn out the parent fish and the larvæ under the theoretically correct conditions, there is a distinct gain. We have saved the larvæ which would have been destroyed in nature. Now, this gain in the number of larvæ must be equal to that number of larvæ which would have been produced (and attained the nursery grounds) by the excess of fish caught this year over those caught last year (or formerly). In this way we compensate, by artificial culture, for over-fishing.

This is the rationale of sea-fish culture. Is the above argument sound? Apparently it would be, if the premises were sound. But, on examining the latter, it is not certain that this is the case.

1. We do not know, even approximately, what proportion of the eggs and fry produced naturally are lost through the physical causes mentioned. We suspect, with reason, that great loss occurs, but we do not know to what extent this takes place.

2. It is a pure assumption that pelagic eggs escape fertilisation in the sea. In all the records of plankton examination I do not know of any in which the presence of unfertilised pelagic fish eggs has been observed. An unfertilised pelagic egg lives and floats for some days, and if such did occur among the plankton, it is hardly likely that they would have escaped record.

3. We do know that an enormous destruction of *demersal* fish eggs occurs in nature. Haddock, for instance, have been taken with their stomachs full of herring spawn. But we do not think it necessary to cultivate herring. There are instances on record of pelagic animals like copepods, or the Chætognathous worm, *Sagitta*, doing the same with regard to pelagic eggs. But these cases have not often been observed, and we cannot say that the incidence of destruction in the life-history of a pelagic fish is greatest during embryonic and larval development. It is indeed possible that the greatest degree of mortality may occur at a later stage.[1]

4. The destruction which is assumed to take place at the time of the total absorption of the yolk-sac has not, so far, been avoided in the hatchery. Indeed, it is from experience gained in the hatchery (and from theoretical considera-

[1] This question might be resolved by the application of quantitative plankton methods—by observing the relation between the numbers of eggs at each different stage of development.

tions) that we postulate the existence of this destruction in nature. Again, it has been found impossible to rear large numbers of artificially hatched fry up to the stage of the metamorphosis. It would, of course, be quite wrong to say that we shall never be able to avoid these two causes of mortality in artificial conditions. If we could do so, then sea-fish culture would have made an enormous advance. Conversely, until we can do so, the utility of the method must remain an open question.

Another line of argument, of much the same logical order, which has frequently been advanced, is at once ingenuous and plausible. In a specific case[1] the cost of running a sea-fish hatchery for one year was £600, and during that year some 300 millions of cod larvæ were hatched and liberated. The cost of 2000 larvæ was therefore 1d. Suppose that one larva in 2000 attains maturity, or even grows to such an age as to be worth 1s. There is, therefore, a very clear gain in the process of hatching the fish.

It is not difficult to discern the fallacious reasoning here. It has been pointed out that from this assumed gain we must deduct the cost of catching the fish. This, however, is not the case, because the process of putting more fry, and, to a less extent, more marketable fish, in the sea renders an impoverished fishing ground more pro-

[1] That of the Arendal (Norwegian) hatchery in 1895.

ductive, and the same fishing operations which formerly caught a reduced number of fish will now catch more *at the same expense*. We must remember, however, that the whole number of fry turned out from the hatchery does not represent clear gain, but the gain is the difference between the assumed (greater) number of fry produced in the hatchery and the (lesser) number which would have been produced from the same parent fishes if they had been allowed to remain in the sea, and this difference must be the basis of the profit and loss calculation. There would be a difference, (1) because of the advantages gained in hatching under artificial conditions, and (2) because some of the parent fish would, presumably, have been caught if allowed to remain in the sea; but the gain resulting from (2) is to be discounted, because if some of the parent fish had been caught fishing operations would have been more lucrative than if there had been no hatching. Again, it is tolerably certain that *all* the marketable fishes added to the sea by hatching would not have been caught, any more than all the fishes of the same stage present in the sea apart from those artificially added. The argument, indeed, cannot be considered to be a sound one, but I mention it because it has occasionally been used.

The argument *a posteriori* is much more difficult to discuss, and it is very probable that the materials for its proper consideration do not exist in the case of any sea-fish culture operations. One instance of the apparently beneficial results of fish-culture is made use of frequently, viz. the success which attended the operations of the American Fish Commission in introducing shad into the waters of the Pacific coast of North America.[1] Two distinct results have been confused here: (1) the effect of artificial hatching in increasing the number of fish already present on a fishing ground; and (2) the result of the introduction and acclimatisation of fish in an area where the species dealt with did not previously exist. There were no shad in the rivers of the American Pacific seaboard, and what the U.S. Fish Commission did was to introduce them there—an eminently useful piece of public work, and highly creditable to a scientific organisation, but a piece of work which does not bear the interpretation frequently put on it. The Americans proved (1) that it is possible to introduce fishes into an area where suitable conditions exist—not an extremely difficult thing to prove, by the way; and (2) that the larvæ of fishes planted in a suitable habitat may grow up to maturity—a result which has an important bearing on the discussion of fish-culture. It did not prove, however, that it is possible, by artificial culture, to increase the number of marketable fishes of a species already present on the fishing grounds, to such

[1] *Report Comm. U.S. Fish Commission* for 1893, p. 72 (1895).

an extent as to provide a direct remedy for over-fishing.

All the success which has attended the artificial culture of fresh-water fishes, or of anadromous fishes,[1] can hardly be urged as an argument for the utility of the similar treatment of purely marine species. The conditions in the two cases are very different. Fishes in a river or lake have a distribution which is extremely limited, when compared with that of marine species, even of such "semi-sedentary" forms as the plaice. And the ova and fry of fresh-water fishes like the trout or carp are, when compared with those of marine fishes, easy to hatch and rear to maturity. The large amount of food-yolk in these eggs, and other properties which we do not understand, greatly facilitate their culture. Then the planting and distribution of such fry can be controlled with great ease. There can be no shadow of doubt as to the success of trout-hatching and distribution in this country, and still more of carp-rearing as it has been practised in Germany. In the latter country the art of carp-rearing is perfectly understood, and a literature, both philosophical and technical, exists with regard to this subject.[2] Pisciculture with regard to the carp in Germany is quite an industry, just as

[1] Fishes like the salmon or shad, which migrate regularly from the sea into rivers, and *vice versa*.

[2] See *U.S. Fish Commission Report* for 1884 (1886), pp. 467–655.

it is likely to become in the United States with respect to many fresh-water fishes. In the latter country the culture of these species appears to be highly successful, and it can even be compared with the introduction of the rabbit into Australia, for in some cases fish-culture has been attended with pernicious results.[1] But it must be repeated that we cannot justifiably utilise the unequivocal success which has attended fresh-water pisciculture as an argument in favour of the utility of what is a very different and a much more difficult thing, viz. marine pisciculture. Indeed, we can hardly say that the utility of the artificial culture of a British anadromous fish like the salmon is beyond question.[2]

Marine fish-culture, as a means of restoring the productivity of an impoverished fishing ground, cannot be said to have emerged from the purely experimental stage in Great Britain. The only marine fish hatcheries at present in existence in our country are those of the Scottish Fishery Board at Aberdeen, the Lancashire and Western Sea-Fisheries Committee at Piel, and the Manx Fishery Board at Port Erin. None of these institutions has received the financial support necessary for developing them to the extent

[1] See *Reports of the Inspectors of Salmon Fisheries for England and Wales* for 1897 and 1898, pp. 14 and 6 respectively.

[2] See *Report of the Royal Commission on the Salmon Fisheries*, 1902, p. 55 [Cd. 1188].

necessary for giving the method—as an economic process—a fair and adequate trial, and all are to a large extent purely scientific organisations. It is therefore unnecessary to argue as to the results achieved—except experimentally—in Great Britain. With regard to America, there are great difficulties in the way of arriving at a correct estimate of the benefit conferred on the sea-fisheries there by the sea-fish hatcheries at Wood's Hole and Gloucester, and the same is to be said of the Newfoundland hatchery at Dildo. No American investigator thoroughly conversant with local conditions has attempted a critical analysis of the methods and results. This has been done by Mr C. E. Fryer, one of the English Inspectors of Sea-Fisheries,[1] and so far Mr Fryer's argument, that no useful results have been obtained, has not satisfactorily been answered. But American fishery statistics throw very little light on the problem. It ought to be stated, however, that the Americans themselves, so far as one can judge from the official publications, are thoroughly impressed with the value of their methods, and regard them as having yielded notable results.

In Norway, results of much value have been claimed by Captain Dannevig, the pioneer of sea-fish hatching. In that country, however, the conditions are different from those with which we

[1] *Reports of the Inspectors of Sea-Fisheries* (*England and Wales*) for 1895 and 1897, pp. 22 and 29 respectively.

are familiar on this side of the North Sea. Outside the coast of Norway, and at a distance of only a few miles from land, there is a great submarine depression where the depth is never less than 100 fathoms, and, quite near to the site of the Flodevigen hatchery, is in one place as much as 450 fathoms. This Norwegian depression isolates a narrow strip of fishing ground from the relatively shallow-water fishing grounds of the Skagerack and North Sea, and may possibly form a barrier across which the more stationary fishes like the cod and plaice find it difficult to pass. Although restricted in area, this coastal region, because of the numerous fjords, bays, and inlets on the mainland, and the islands which fringe the latter, and the character of the sea-bottom, forms an excellent fishing ground, and one having the great practical advantage of being accessible to the fishermen in all weathers. Strong tides and currents are absent, and fry planted in these waters are not likely to be carried out to sea. But, on account of its very limited extent, this fishing ground is very easily over-fished, and, according to Dannevig, this is what has happened during the last fifty years or so. It therefore presented an area where the prosecution of sea-fish culture was likely to be attended with success, and, according to Dannevig, this success is beyond question. The planting of cod fry for many years was associated by him, and by a number of fishermen, with the increase of cod of the smaller sizes. Not only so, but the fishes in question were claimed to belong to a variety differing slightly from those normally present on the fishing grounds dealt with, and were claimed to have been those resulting from the growth of the fry produced in the hatchery.

It is difficult to discuss this question of the success of the Norwegian cod-hatching operations here, and I will only point out that the utility of the practice, so far as it refers to the Norwegian fisheries, has been very severely criticised by Dr J. Hjort, the official chief of the Norwegian fisheries administration, who has maintained that the useful results are imperceptible. Dr Hjort's views have obtained wide currency among those interested in these questions in this country, and it is rather unfortunate that Captain Dannevig's defence is not so well known.[1] The whole matter is very technical, and can hardly be discussed here. But it ought to be remembered that, even if it is certain that Dannevig's cod-hatching operations have had an economic success commensurate with the money spent on them, this can hardly be used as an argument in favour of sea-fish culture in this country, where, so far as we know, conditions similar to those outlined above do not exist.[2]

[1] Dannevig's defence of his work is published in a Norwegian fishery journal. It is, unfortunately, written in Norwegian, and is therefore practically inaccessible to the majority of English readers.

[2] The nearest approach to them is in such an area as Upper Loch Fyne. But there is no plaice fishery there.

Successfully to deal, by artificial culture, with such areas as the North Sea or the Irish Sea would be quite impossible. This is evident when we come to consider the scale on which fish-cultural operations would have to be conducted. Hensen[1] and Apstein found that in the North Sea in 1895 there were *over 31 billions of plaice eggs and embryos*, and this estimate was most probably under the mark. Even in such a small area as Loch Fyne, Williamson found 483 millions of plaice eggs to have been present during one season.[2] Even if we try to consider the number of mature plaice landed in England from the fishing grounds, and attempt to form an estimate of the loss of fry which has, presumably, to be made good, the impossibility of hatching operations becomes very evident. Holt[3] estimated that over 17 millions of mature female plaice were landed at Grimsby alone in one year (ending March 1894). It is quite impossible to determine what is the total number of such fish landed from the North Sea fishing grounds by all the fishing boats working there, and still more, what is the annual reduction of this fish population which has to be made good by taking advantage of the immunity which the hatchery confers on the fish and eggs dealt with. But the figures I have quoted above will suffice

1 *Wissensch. Meeresunt.*, Kiel Komm., Bd. ii. Heft 2, p. 71, 1897.
2 *Report, Fishery Board for Scotland*, for 1898, pt. iii. p. 79.
3 *Journ. Mar. Biol. Ass.*, vol. iv. No. 4, p. 414, 1897.

to show on what an enormous scale economic hatching operations would have to be conducted.

Finally, it may be observed that our relative ignorance, both scientific and statistical, of the condition of the fisheries, and of many portions of the life-histories of economic fishes, is so great as to prevent us from undertaking sea-fish culture in what may be called an intelligent manner. It has been assumed, in this discussion of the matter, that impoverishment of the fisheries with regard to any one species can be made good by adding to the number of fry (fishes at the stage of the metamorphosis) of that species already present in the sea. But it is not even certain that by doing so we should be making any sensible increase in the number of fishes of marketable size on the fishing grounds ; for we do not know that the mortality at about this stage is of so much significance as that between it and the stage at which the fish becomes of value to the fishermen. (It is much more probable that protection of the immature, but just marketable, fish is the step most likely to be of direct economic value.) There are so many things to be considered before we can undertake fish-culture in any particular locality, with any degree of confidence of success, and we know so little of them, that lengthy scientific investigation must, in each case, precede the purely economic work.

APPENDICES

APPENDIX I

REPORTS OF THE PRINCIPAL PUBLIC INQUIRIES INTO THE CONDITION OF THE FISHERIES HELD IN MODERN TIMES

ONLY the more important Reports are mentioned, but all those of interest to the general student of the sea-fishing industry are included. Many other documents of special interest may be traced in the classified indices of Parliamentary Papers. The short titles are those by which the Reports are usually known.

1837. Royal Commission on Irish Fisheries.—"Report of the Commissioners of Inquiry into the State of the Irish Fisheries." Reports I. and II.; pp. xxiv + 452 and pp. v + 71.

1863. Royal Commission on Herring Trawling.—"Report of the Royal Commission on the Operation of the Acts relating to Trawling for Herrings on the Coasts of Scotland." Report and Appendix, pp. 37; Evidence, pp. 34. (This is the Report by Dr Lyon Playfair, Prof. Huxley, and Col. Maxwell which led to the repeal of the repressive herring trawling legislation. It contains Prof. Allman's account of the natural history of the herring.)

1866. Royal Commission of 1863.—"Report of the Commissioners appointed to inquire into the Sea-Fisheries of the United Kingdom." Report and Appendix, pp. cvii + 72; Evidence, pp. 1409. (Historically the most important inquiry of modern times. The appendix contains Holdsworth's article on fishing methods and implements.)

1870. Report on Coast and Deep-sea Fisheries of Ireland.—"Report on the Coast and Deep-sea Fisheries of Ireland by the Royal Commissioners on Irish Oyster Fisheries." pp. 42. [C. 226.] (Includes an historical summary of the decadence of the Irish sea-fisheries.)

1878. Report on the Herring Fisheries of Scotland. — "Report on the Herring Fisheries of Scotland, by F. Buckland, Esq., and Spencer Walpole, Esq. (Inspectors of Salmon Fisheries for England and Wales); and A. Young, Advocate (Commissioner of Scottish Salmon Fisheries)." pp. lvi + 246. [C. 1979.]

1879. Sea-Fisheries Commission of 1879.—"Report by Frank Buckland, Esq., and Spencer Walpole, Esq., Inspectors of Fisheries for England and Wales, and Commissioners for Sea-Fisheries, on the Sea-Fisheries of England and Wales." pp. xl + 282. [C. 2449.] (Includes appendix by Buckland, giving an account of the natural history of fishes.)

1881. Outrages committed by Foreign Fishermen in the North Sea.—"Report by W. H. Higgin, Esq., Q.C., on the Outrages committed by Foreign upon English Fishermen in the North Sea." pp. 68. [C. 2878.]

1883. Sea-Fishing Trade Committee.—"Report of a Committee appointed under a Minute of the Board of Trade to inquire into, and report whether any, and what, legislation is desirable with a view to placing the relations between the masters and crews of fishing vessels on a more satisfactory basis." pp. xlii + 665. [C. 3432.] (Deals, *inter alia*, with "coopering" in the North Sea.)

1885. Royal Commission on Trawling.—"Report of the Commissioners appointed to inquire and report upon the complaints that have been made by line and drift-net fishermen of injuries sustained by them in their calling owing to the use of the trawl-net and beam-trawl in the territorial waters of the United Kingdom." pp. xliv + 517. [C. 4324.] (Appendix contains M'Intosh's report on trawling observations and scientific results.)

1888. Liquor Traffic in the North Sea. — "Correspondence respecting the Liquor Traffic in the North Sea." pp. xcviii. [C. 5263.]

1893. Select Committee of 1893.—"Report from the Select Committee on Sea-Fisheries." pp. xxiv + 472. 1893, 377. (Deals with the whole condition of the fisheries, but with special reference to the immature fish question, and the question of fisheries impoverishment. The appendices contain statistical tables.)

1900. Select Committee of 1900. — "Special Report from the Select Committee on the Sea-Fisheries Bill." pp. xvi + 180. 1900, 287. (Deals with the Immature Fish Bill of 1900: brings questions discussed in 1893 up to date.)

1901. Sea-Fisheries Restrictive Legislation in Foreign Countries.—"Return to an Address of the Hon. the House of Commons, dated 13th December 1900, for 'Return of the precise position of foreign law affecting sea-fisheries,' 19th July 1901." pp. 155. 1901, 271. (The response to the complaint of the Select Committee of 1900 that the Board of Trade had no information regarding fishery laws in other countries. Professes to give an account of foreign restrictive fishery laws.)

1902. Committee on Fishery Statistics. — "Report of the Interdepartmental Committee appointed to inquire into the system of collecting Fisheries Statistics in England and Wales, and to report how it could be improved and extended." pp. xiii + 74.

1903. Committee on Ichthyological Research. —"Report of the Committee appointed to inquire and report as to the best means by which the State or Local Authorities can assist scientific research as applied to problems affecting the Fisheries of Great Britain and Ireland." pp. xxv + 168.

1904. Royal Commission on Sewage Disposal. —"Fourth Report of the Commissioners appointed in 1898 to inquire and report what methods of treating and disposing of sewage (including any liquid from any factory or manufacturing process) may properly be adopted." Vol. i., Report, pp. xliv. [Cd. 1883]; vol. ii., Evidence, pp. 283 [Cd. 1884]; vol. iii., Reports by Dr Houston on bacteriological methods, etc., pp. viii + 316 [Cd. 1885]. (These reports deal with the contamination of the fisheries.)

1904. Select Committee of 1904.—"Report from the Select Committee of the House of Lords on the Sea-Fisheries Bill (H.L.)." pp. xvi + 192, 4 charts. 1904, 36. (Report on the Immature Fish Bill of 1904.)

APPENDIX II

OFFICIAL PUBLICATIONS OF BRITISH FISHERIES AUTHORITIES

Scotland

1. "Annual Report of the Fishery Board for Scotland." Pt. I., General Report (administration and statistics); Pt. II., Salmon Fisheries (administration and research); Pt. III., Scientific Investigations. Occasional papers are also published.

England

2. "Sea-Fisheries (England and Wales). Annual Reports of the Inspectors" (administrative).
3. "Salmon and Fresh-water Fisheries (England and Wales). Annual Reports of the Inspectors of Fisheries" (administrative).
4. "Copy of Statistical Tables and Memorandum relating to the Sea-Fisheries of the United Kingdom, etc."

(statistics). (Monthly reports are also issued to fishery authorities.) See also "Annual Statements of Trade of the United Kingdom" for details of fish imported and exported.

5. "Journal of the Marine Biological Association" (scientific research; published at irregular intervals. Not strictly an official report; but, as the Association receives Treasury aid, it is to be regarded as "semi-official.")

6. Lancashire and Western Sea-Fisheries Joint Committee. "Superintendent's Report" (administrative; published quarterly). "Report of the Lancashire Sea-Fisheries Laboratory" (scientific; published annually).

7. "Report on the Scientific Investigations carried on under the Northumberland Sea-Fisheries Committee" (published annually).

Ireland

8. "Report on the Sea and Inland Fisheries of Ireland." Pt. I., General Report (administration and statistics); Pt. II., Scientific Investigations. Both published annually.

9. "Report of the Congested Districts Board." (Deals with Government assistance to the sea-fishing industry; published annually.)

Isle of Man

10. "Annual Report of the Committee, Isle of Man Fish Hatchery."

Denmark

11. "Conseil Permanent International pour l'Exploration de la Mer: Bulletin des Résultats."

12. "Conseil Permanent International pour l'Exploration de la Mer: Publications de Circonstance."

(11 and 12 are the official publications of the North European international fishery investigation organisation.

11 is published in English and German in parallel columns. 12 is published in various European languages. 11 appears quarterly ; 12 at irregular intervals.)

APPENDIX III

THE FISHERIES STATUTES

ONLY the more important enactments are mentioned here. In addition to the Statutes, there are a number of Provisional Orders made under various Acts, and Orders in Council of like origin. The Merchant Shipping Acts contain provisions dealing with fishing vessels. Enactments dealing solely with the fresh-water fisheries are not included.[1]

1. THE SEA-FISHERIES ACTS, ENGLAND AND GENERAL

Sea-Fisheries Act, 1868 (31 and 32 Vict. c. 45)—Confirms Convention between Great Britain and France, and gives Crown power to make Orders in Council regulating conduct of fishing boats at sea. Deals with registry of fishing vessels, and oyster fisheries. Repeals a number of obsolete Acts. (General.)

Sea-Fisheries Act, 1875 (38 Vict. c. 15).—Amends 31 and 32 Vict. c. 45.

Fisheries (Oysters, Crabs, and Lobsters) Act, 1877 (40 and 41 Vict. c. 42).—Establishes "close time" for oysters. Gives Board of Trade power temporarily to prohibit or restrict oyster fishing. Regulates crab and lobster fishing. Revives Convention of 1843. (General.)

Fisheries Act, 1883 (46 and 47 Vict. c. 22).—Confirms Convention between Great Britain, Germany,

[1] See, however, a list of these by C. E. Fryer.

Belgium, France, Denmark, and Holland, and gives Crown power to make Orders in Council regulating fishing at sea in interest of the maintenance of good order. (General.)

Sea-Fisheries Act, 1884 (47 and 48 Vict. c. 27).—Amends Sea-Fisheries Act, 1868. (General.)

Fisheries Act, 1891 (54 and 55 Vict. c. 37).—Confirms Declaration between Great Britain and Belgium providing for simpler legal procedure in fishery disputes. (General.)

North Sea Fisheries Act, 1893 (56 and 57 Vict. c. 17).—Confirms Hague Convention of 1887 between Great Britain, Germany, Belgium, Denmark, and Holland, prohibiting the liquor traffic in the North Sea. (General.)

2. The Sea-Fisheries Regulation Acts

Sea-Fisheries Regulation Act, 1888 (51 and 52 Vict. c. 54).—Provides for local regulation of the sea-fisheries by District Committees.

Fisheries Act, 1891 (54 and 55 Vict. c. 37).—Part II. confers additional powers on District Fisheries Committees.

Sea-Fisheries (Shell-fish) Act, 1894 (57 and 58 Vict. c. 26).—Extends powers of District Committees with respect to shell-fish and scientific investigations.

3. The Central Authority, England and Wales

Salmon Fishery Act, 1861 (24 and 25 Vict. c. 109).—Provides for superintendence by Home Office Inspectors of the salmon fisheries.

Salmon and Fresh-water Fisheries Act, 1886 (49 and 50 Vict. c. 39).—Transfers superintendence of salmon fisheries to Board of Trade, and extends s. 32

of Salmon Fishery Act, 1861, so as to include sea-fisheries.

Board of Agriculture and Fisheries Act, 1903 (3 Edw. VII. c. 31).—Transfers superintendence of fisheries to Board of Agriculture.

4. The Scottish Fishery Board[1]

Act for the Encouragement of the British White Herring Fishery, 1808 (48 Geo. III. c. 110).—Established the "Board of British White Herring Fishery."

Fishery Board (Scotland) Act, 1882 (45 and 46 Vict. c. 78).—Dissolved the White Herring Board and constituted the Fishery Board for Scotland.

Secretary for Scotland Act, 1885 (48 and 49 Vict. c. 61).—Appointed a Secretary for Scotland, and transferred to him the powers previously vested in the Home Office with respect to the Scottish sea-fisheries.

Sea-Fisheries (Scotland) Amendment Act, 1885 (48 and 49 Vict. c. 70).—Empowered Fishery Board to prohibit or restrict trawling; provides for lettering and numbering steam trawlers; gives Board power to demand statistical information from fishermen, etc.; regulates procedure in case of damages to fishing boats, etc.; gives Board powers under Sea-Fisheries Acts and under Fisheries (Oyster, Crab, and Lobster) Act, 1877.

Sea-Fisheries Regulation (Scotland) Act, 1895 (58 and 59 Vict. c. 42).—Reconstituted Fishery Board; appointed scientific superintendent; empowers Board to establish district committees as in England; gives Board power, with certain limitations, to prohibit trawling within thirteen miles of low-water mark; gives Board power to regulate, lease, etc., mussel fisheries.

[1] There are altogether fifty-nine statutes regulating the Scottish fisheries. See *Manual of Sea-Fisheries (Scotland) Acts and Statutory Bye-laws in force at 31st December* 1900, pp. 285 [Cd. 428], 1901. Complete text of Acts and by-laws.

5. Scottish Herring Fishery Acts

Herring Fisheries (Scotland) Act, 1865 (28 Vict. c. 22).—This amended several existing Acts, and made herring fishing illegal on the west coast of Scotland, south of Ardnamurchan Point, between February 1 and May 31.

Herring Fisheries (Scotland) Act, 1867 (30 and 31 Vict. c. 52).—Removed certain restrictions on herring fishing.

Herring Fishery (Scotland) Act, 1889 (52 and 53 Vict. c. 23).—This Act is far more important than its title indicates. It legalised certain measures for use in the trade ; it made herring fishing illegal on Sundays and on week-days from sunrise to sunset, on the west coast south of Ardnamurchan Point ; it made trawling illegal in Scottish territorial waters and in a number of scheduled areas, including the Moray Firth and the Firth of Clyde ; and it made the landing of fish caught in contravention of the by-laws illegal on the Scottish coasts.

Herring Fishery (Scotland) Amendment Act, 1890 (53 and 54 Vict. c. 10).—Increased the penalty for trawling in Scottish prohibited waters.

6. Irish Sea-Fisheries

Irish fishery legislation is extremely complex. There are altogether about forty enactments applying to the industry.[1] The foundation of the existing code is—

Fisheries (Ireland) Act, 1842 (5 and 6 Vict. c. 106). Subsequent Acts may be regarded as amending or extending this one. Statutory by-laws are very numerous. A great number of enactments impose judicial duties on, and vest powers in, the inspectors. Other Acts provide for the encouragement of the industry, by loans to fishermen, and, as in the case of Scotland, by

[1] See *Manual of Fisheries (Ireland) Acts*, pp. 397 + xxvi, 1904 [Cd. 2277], for the text of the purely Irish Acts.

grants for building and repairing piers and harbours. A new departure was made in 1899 by the

Agriculture and Technical Instruction (Ireland) Act, 1899, which created a new department with largely increased powers and with a fairly ample vote for the expenses of administration. Besides control of the industry, piscicultural operations, technical instruction, and scientific investigation became the duties of this department.

APPENDIX IV

LOCAL REGULATIONS

REGULATIONS made by District Committees vary from county to county. Those in force in the Lancashire and Western Sea-Fisheries District (all the English and Welsh coast from Cumberland to Milford Haven) are abstracted below: they will serve as an example of the general code of local regulations.[1]

ABSTRACT OF LANCASHIRE AND WESTERN COUNTIES FISHERIES BY-LAWS

Trawling for sea-fishes (except shell-fish, mackerel, herrings, sparling, or garfish).—The mesh of the trawl-net must not be less than $1\frac{3}{4}$ inches from knot to knot, except during part of the year in certain specified inshore areas, where it is legal to use a mesh of $1\frac{1}{2}$ inches from knot to knot.

Dimensions of the trawl-nets to be used.—For an 18-feet beam, the circumference of the net must not be less than 50 meshes; for a beam over 18 and less than 25, the net must not have less than 60 meshes in its

[1] See *Annual Reports of Inspectors of Sea-Fisheries* (*England and Wales*), for the full text of all the English District Committees' by-laws.

circumference; and if the length of the beam is over 25 feet, the circumference of the net must not be less than 80 meshes.

Mackerel, herring, sparling, and garfish nets must not be less than 1 inch from knot to knot.

Drift-nets must not be deeper than 200 meshes.

Shrimp and prawn trawl-nets.—The mesh must not be less than $\frac{3}{8}$ inch from knot to knot. The minimum circumference is: for a 20-feet beam, 120 meshes; over 20-feet beam, 140 meshes. The length of the beam must not exceed 25 feet. (Other local forms of nets have their dimensions defined.)

Steam trawl vessels are prohibited absolutely from fishing in territorial waters.

Stake-nets must be marked with the owner's name, and must be marked by poles or buoys, so that they are visible at high water. They must not be set in navigable shallow channels. They must have meshes of not less than $1\frac{3}{4}$ inches from knot to knot. Different stake-nets must be at least 150 yards apart. Stake-nets must not be longer than 300 yards.

Cockles must not be "removed from a fishery" if they are so small that they will pass through a gauge having a square opening of $\frac{13}{16}$ths of an inch. Fishing implements in local use have their dimensions regulated.

Mussels must not be taken if they are less than 2 inches long. The dimensions of local fishing implements are regulated.

Oysters must not be taken if they are less than $2\frac{1}{2}$ inches in diameter.

Crabs must not be taken if they are "berried," that is, if they are females carrying spawn. They must not be less than 5 inches across the broadest part of the back.

Lobsters must not be taken if they are "berried," nor if they are less than 9 inches in total length.

Methods of fishing are only permissible if they are permitted in the by-laws; or if they are hooks and lines, or "pots, hooks, or baskets for taking eels, prawns, crabs, or whelks"; or if they are "hedge-baulks" in use previous to August 9, 1893, and in accordance with certain regulations.

Deposit of sewage or refuse in the sea.—This is prohibited, but because of the saving provisions of the various enactments concerned, this prohibition is purely nominal, and cannot be enforced.

"**Close seasons.**"—Sparling must not be taken from April 1 to October 31 following. Mussels must not be taken from April 1 to August 31 following.

Closed areas.—An area of about 10 square miles off Blackpool is "closed" against all kinds of trawling.

"**Removal from a fishery.**"—Fishes or shell-fishes must not be "removed from a fishery" if the capture of such is in any way or in any circumstances illegal. But the meaning of "removal from a fishery" is not always clear.

Bona-fide fishing.—In fishing for any food-animal with an apparatus permissible for the capture of that animal, it is imperative that a fisherman should not take any other animal, the capture of which is illegal with the apparatus he is using. But if a fisherman is *bona fide* fishing for (say) shrimps with a trawl-net of $\frac{3}{8}$-inch mesh, he may take fishes over certain specified sizes, even though the use of a shrimp-net for the capture of these fishes is illegal with the apparatus he is using.

Scientific investigations, etc.—The regulations in force do not apply to persons fishing for scientific purposes, or for stocking or breeding purposes, provided that the written authority of the Committee, through their clerks, has been obtained.

Penalties.—A maximum fine of £20, and a maximum continuing penalty of £10 per day, may be enforced for breach of the by-laws. Illegal fishing implements may be forfeited.

Powers of officers.—Include stoppage and search of vessels and vehicles employed in fishing or in conveying fish. Fisheries officers have the powers and privileges of, and are subject to the liabilities of, constables in their constablewicks, under common and statute law.

APPENDIX V

COST OF FISHERY ADMINISTRATION IN THE UNITED KINGDOM, 1901–2

It is difficult to give an exact estimate of the total sum expended in fishery administration. This is particularly the case with respect to the English Central Authority. The public accounts do not appear to give any information as to the proportion of the whole vote for the Board of Trade which was expended by the Fisheries Department. The estimate of £2500 is founded on the statement of salaries given in *Whitaker's Almanac.*

England and Wales

Fisheries Department, Board of Trade (about)	£2,500 [1]	
Vote for fisheries statistics	1,600	
Incidental expenses under Sea-Fisheries Acts	100	
Grant to Marine Biological Association .	1,000 [2]	
Expenditure by Local Fisheries Committees	17,218 [3]	
		£22,418
Carry forward		£22,418

[1] Since the transfer of the fisheries staff to the Board of Agriculture and Fisheries this expenditure must have increased.

[2] The English share of the international fishery investigations was carried on by the Marine Biological Association, which received the proportion of the grant on these investigations allocated to England.

[3] Nearly £11,000 of this total sum was expended by the Lancashire and Western Sea-Fisheries Committee alone.

Brought forward		£22,418

Scotland

Vote for Fishery Board	£18,097	
Provision for Fishery Board expenses in other estimates	2,903	
Vote for scientific investigations[1] . . .	770	
Treasury allowance to fishery correspondents collecting fishery statistics . . .	730	
		22,500

Ireland

Vote for fishery purposes to the Department of Agriculture and Technical Instruction .	10,000

Isle of Man

Annual grant of £200 for the fish hatchery .	200

Great Britain

One year's expenditure on International Fishery Investigations	16,000
Total, ...	£71,118

[1] Reduced this year by £2000, because of the grant for the international fishery investigations. A large proportion of this was given to the Scottish Fishery Board, and the naturalists on the scientific staff were thereupon engaged on these investigations.

APPENDIX VI

IMPORTS, EXPORTS, AND RE-EXPORTS OF FISH[1]

1. *Imports of Fish into the United Kingdom in the Year* 1902

Kind of Fish.	From British Possessions.	From other Foreign Countries.	Total.
	Quantities in Cwts.		
Fresh herrings .	952	414,046 (Norway, chiefly[2])	414,998
Other fresh fish .	59,659	174,316 (Europe, generally)	233,975
Shell-fish (all kinds)	3,482	241,213 (Holland, U.S.A.)	244,695
Sardines . .	273	252,174 (France, Portugal)	252,447
Canned salmon .	368,938	452,486 (U.S.A.)	821,424
Canned lobsters .	37,325	13,353 (U.S.A.)	50,678
Other canned fish .	209	30,198 (Norway, U.S.A.)	30,407
Other fish cured or salted, but not canned . .	149,754	383,681 (Norway, Denmark)	533,435
Totals . .	620,592	1,961,467	2,582,059
	Values in £s.		
Fresh herrings .	486	150,912	151,398
Other fresh fish .	64,700	326,211	390,911
Shell-fish (all kinds)	11,862	183,289	195,151
Sardines . .	444	638,247	638,691
Canned salmon .	890,631	908,156	1,798,787
Canned lobsters .	190,532	70,423	260,955
Other canned fish .	235	71,988	72,223
Other fish cured or salted, but not canned . .	157,404	443,266	600,672
Totals . .	1,316,294	2,792,492	4,108,786

[1] See *Annual Statement of Trade of the United Kingdom in* 1902 (1903) [Cd. 1582].
[2] The countries' names are those from which the bulk of the fish is imported.

2. *Exports of Fish, the Produce of the Fisheries of the United Kingdom, in* 1902 [1]

	To British Possessions.	To Foreign Countries.	Total.
Herrings (in barrels)	7,140	2,243,032	2,250,172
Salmon (in cwts.)	40	5,633	5,673
Pilchards (in hogsheads)	0	15,365	15,365
Unenumerated fish (quantities are not given)			
	Value in £s.		
Herrings	8,502	2,925,416	2,933,918
Salmon	421	39,579	40,000
Pilchards	0	45,674	45,674
Unenumerated fish	254,725	432,275	687,000
Total	263,648	3,442,944	3,706,592

3. *Re-exports of Fish (i.e. exports of fish previously imported), Foreign and Colonial Produce*, 1902 [2]

	Quantity. Cwts.	Value. £.
Fresh fish	1,889	4,496
Cured or salted	437,884	804,826
Total	439,773	809,322

[1] *Annual Statement of Trade.*
[2] *Statistical Tables and Memorandum* for 1902 (1903, 112).

Notes.—The bulk of the fish exported from the British Islands consists of cured herrings; thus, of the total export in 1902 of £3,706,592, nearly £3,000,000 represents the value of this fish. The greater portion of cured herrings exported are fish caught and cured in Scotland. The total number of barrels exported in 1902 was just over two and a quarter millions, and of this enormous quantity about one and a half million were shipped from Scottish ports. Germany is the principal customer, receiving well over a million barrels. Then come Russia, Norway and Sweden. The principal ports to which cured herrings are exported are Stettin, Königsberg, Hamburg, Danzig, St Petersburg, and Riga.

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