THE SEA FISHERIES OF EASTERN NORTH AMERICA.

INTRODUCTORY.

In the present work I propose to give some account, as far as known, of the more important fishes of the Eastern United States north of Delaware Bay, together with an account of the methods by which they are pursued, captured, and utilized, as also of their application, with some statistical tables illustrating the results of the fisheries in the region referred to. For the better elucidation of the subject, I also propose to embrace a reference to corresponding fisheries in Europe and other parts of the world, so far as these throw light upon the American species.

A limitation of the subject to the region north of Delaware Bay is made, partly in view of the fact that the fisheries of that region are much more important in an economical point of view, and can be better monographed at present, and partly because this is the portion of Eastern North America which is embraced in the Washington treaty, and of which the information referred to is needed for the proper consideration of the international, political, and economical treatment of the subject.*

* In confining attention in the present article specially to the subject of the fisheries of the region covered by the treaty of Washington, it is not to be supposed that there are no productive fisheries on a large scale further south, the contrary being quite the fact. No portion of the globe exceeds the Southern and Gulf coasts of the United States in the number and variety of excellent food-fish, their waters teeming with them throughout the year and permitting their capture, especially in the cooler seasons, to almost any imaginable extent. A few hours' labor, either with the line, the cast-net, the gill-net, or the seine, suffices to supply the fisherman with food for days; and the introduction of the wholesale means of capture (pounds and traps not yet attempted) will probably produce no appreciable effect upon the supply.

Among the species which may be mentioned in this connection are the menhaden, bluefish, and mullet, all of which yield important fisheries in North Carolina, Virginia, and farther south. The menhaden is taken in great numbers and salted in barrels, being considered a very desirable article of food.

The bluefish spends several months on the Southern coast after leaving the Northern and Middle States, and is found of very great size—from 12 to 16 pounds. During the late autumn and early winter vast numbers of these are shipped to the Northern markets, where they find a ready demand. I find a memorandum that on the 20th of November, 1872, three thousand bluefish, averaging 12 pounds each, or 36,000 pounds altogether, were shipped from a single fishing station in North Carolina.

It is much to be regretted that there is no machinery employed in the United States for securing the statistics of our fisheries, the example of Canada and of European nations not having yet been adopted. The only sources of knowledge at our command are the reports of the cod and mackerel landed at American seaport towns, as made by the Statistical Bureau of the Treasury Department, the reports of inspections of mackerel by the States of Maine, New Hampshire, and Massachusetts, and other incidental mention of local yields, such as the annual production at Gloucester, &c., as can be picked up.

Of all these fish, however, the mullet is perhaps the most important, as being taken in larger quantities and occupying a greater number of persons in its manipulation. The fish, however, are almost exclusively consumed in the South, a very few being sent to Baltimore, Philadelphia, and New York. At present it may be considered as even more of a staple than the shad and alewife, which have been diminished very materially in later years; the supply of mullet, however, is apparently inexhaustible, and is repeated from year to year, though sometimes, owing to extreme weather and other conditions, the product is less, the condition of the lower classes being affected accordingly. Indeed, it may be said to occupy the same position that the mackerel does in the North; and the increasing yield of this fishery has undoubtedly had much to do with the reduced demand for the mackerel. Although as a fresh fish it may be considered as inferior to the best quality of mackerel, it is by most persons considered superior to it when salted. At Cape Hatteras the mullet fishery is said to begin about the middle of July; about Fort Macon in September, and later further south, continuing for from one to two months at each station. The fish then come in from the sea for the purpose of spawning and enter the fresh water, being similar in this respect to the shad and alewife, although not apparently penetrating any considerable distance from the mouth. Like the herring and cod, they appear to spawn on a falling temperature, or when the waters have acquired a certain minimum. There is but little system adopted in the fishery, several individuals combining for a particular occasion and selecting one of their number as chief. The outfit consists simply of two or three six-oared boats, a seine from 75 to 100 yards long, several splitting tables, some barrels, and salt. The fish are split and cleaned, but without removal of the head, and are slashed in the thickest side for the better penetration of the salt. The fish are all fat and plump, and are graded by size and not by quality. The lower grades are worth from $4 to $5 a barrel; the higher sometimes bring from $8 to $10. Not more than from seventy to a hundred can be packed in a barrel. As many as five hundred barrels of mullets are taken sometimes at a single haul. The entire catch at Fort Macon alone is estimated by Dr. Yarrow at 12,000 barrels. The catch of a single county of North Carolina, Carteret, is given at 70,000 barrels. A large portion of the fish are bartered in the seaboard counties for agricultural products, 2 barrels being usually considered equivalent to 15 bushels of corn. They are sent by the railway lines all through the interior of the State, where they meet with great demand. Mullet roes are also considered a very great delicacy; a portion of them are pickled and the others slightly salted and smoked. They usually bring from 25 to 40 cents a dozen.

With an increased demand and improved methods of capture and preparation, there is no reason why the yield of the mullet fishery should not be fully equaled in bulk and value to that of the mackerel, as the fish itself is in countless abundance and found for many hundreds of miles along the coast.

Dr. H. C. Yarrow, U. S. A., from whose manuscript notes I have obtained the facts referred to above, states that two-thirds of the entire population of the coast of North Carolina is employed in this fishery.

Canada, on the other hand, has a special department of the fisheries, organized for obtaining the necessary data, and from which we can learn with great precision the number of vessels and boats, their tonnage, the men employed, with the yield of the different kinds of fishing, in all the districts of the several provinces constituting the Dominion. The statistics of Newfoundland, which does not belong to the confederation, are scarcely more valuable or reliable than those of the United States. It is much to be hoped that both countries will, in time, initiate and carry on a system more like that of Canada, from which, year by year, tabulated and final results may be obtained.

Having been requested by the Secretary of State to proceed to Halifax and be present during the International Fishery Convention, I have been enabled, from the testimony adduced in regard to American fish and fisheries, and still more by personal inquiries of the witnesses, to obtain a great deal of information of much value, a portion of which will be embodied in the present report, and the remainder in an extension of the subject hereafter.*

The greater portion of the statistics employed in the present report is the result of special correspondence, initiated and maintained with

* The treaty of Washington, made by the joint high commission in 1871, provided that nearly all the restrictions to the unimpeded use of the fisheries by the Americans on the shores of the British provinces on the Atlantic coast, and by the subjects of these provinces in American waters as far south as the parallel of 39°, or Cape May, should be mutually conceded, and either party was to have the privilege of exporting fish other than the products of the Great Lakes to the other country free of duty; and that a commission should meet at Halifax, to consist of a commissioner and agent for each side, to determine what the commercial value respectively of these concessions amounted to, and if it were found that the privileges granted to the Americans were greater than those secured by the same treaty to the Dominion, a money value should be estimated for a twelve years' period and paid by the United States. It was not supposed at the time that the balance might be on the other side.

This convention was organized in obedience to the provisions of the treaty at Halifax on the 15th of June, and was represented by Hon. E. H. Kellogg on the part of the United States, and Sir Alexander T. Galt on the part of Great Britain, the third commissioner, in accordance with the provision of the treaty, being Mr. Maurice Delfosse, the minister from Belgium to the United States. Mr. Dwight Foster, of Boston, was the agent for the American cause, and Mr. F. C. Ford, of London, for the British. Mr. J. H. G. Bergne, of the foreign office, London, was chosen as secretary of the joint convention.

Subsequently the selection of counsel was authorized to assist the agents in their labors, those for the United States being Mr. Richard H. Dana, Jr., of Boston, and Mr. William H. Trescot, of Washington; the British counsel being one for each province, namely: Mr. Joseph Doutre, for Canada; Mr. S. R. Thomson, for New Brunswick; Mr. Wetherbe, for Nova Scotia; Mr. Davies, for Prince Edward Island; and Mr. Whiteway, for Newfoundland.

It is not my province to refer to the history and results of this convention excepting so far as relates to the testimony available for the objects of the present report. Suffice it to say that a vast body of testimony was taken on both sides, much of it contradictory, but leaving a residuum of well-established fact, and that this was supplemented by personal inquiries and special conference with the most intelligent witnesses.

different parts of the country for the purpose, being partly the result of answers to a series of questions issued in printed circulars prepared for the purpose.

The reports of the Massachusetts commissioners of inland fisheries have furnished much valuable information, as well as the report of the commissioner of Maine.

Colonel Lyman, one of the Massachusetts commissioners, has also supplied some manuscript records of the weirs and pounds of Massachusetts, which have contributed greatly in making up these statistical tables. Especially important, too, have been communications from Capt. N. E. Atwood, of Provincetown; Capt. Prince Crowell, of East Dennis; Vinal N. Edwards, of Wood's Holl; Mr. Samuel Powel, of Newport, R. I.; Capt. Benj. Ashby, jr., of Noank, Conn.; Captain Hurlbut, of Gloucester; Captain Babson, collector of the port of Gloucester, and others hereafter enumerated.

To Mr. G. Brown Goode, assistant of the U. S. Fish Commission, I am indebted for very important service in collecting information and preparation of statistical tables, nearly all of which have been made up by him for the purpose. The primary divisions into which an article like the present will naturally fall are as follows:

I. *The natural history or biology.*—This considers the fishes and certain other marine animals as they occur in nature, and without particular reference to their relations to man, except incidentally, or as they existed in North America before its occupation by the white man. Under this head will be included, first, an account of the individual habits and general history of each species included in my subject, and next a general view of our marine fishes as a whole; *e. g.*, their physical and mutual relationships; their migrations and movements; their abundance; their food; their diseases and fatalities; and finally, their reproduction and growth.

II. *Methods of capture.*—After consideration of the inhabitants of the sea, without any special relation to man, we naturally proceed to the history of the various methods by which they are pursued and captured; this involving the subject of fishing grounds, boats and vessels, men, the apparatus of capture, bait, manner of fishing, packing on shipboard, and disposition of offal. Results of the fisheries and their statistics will naturally fall under this head.

III. *Utilization of the products of the fisheries.*—As food, clothing, medicine, fertilizers, industrial applications, etc., or whatever applications are made of the fish after they have been caught. The general statistics of fishery products may come under this head.

IV. *Maintenance and improvement of the fisheries.*—This subject naturally follows those preceding, and does not usually come up for consideration among communities until real or imaginary scarcity or difficulties of capture, etc., begin to press upon their members.

V. *General political considerations.*—Under this head are included the subject of the fisheries in relation to the State, bounties, inspection, international relations, &c.

I propose to consider the subject of the fish and fisheries of Eastern North America substantially as given above, although I shall not be able to follow the various subdivisions in equal detail, indeed omitting some of them entirely for the present. So much yet remains to be known in regard to many of the topics enumerated that I can only hope that the meagerness and incompleteness of what I may say of them will call attention to the fact and secure the co-operation of others in a future more reliable rendering of the whole subject.

GENERAL CONSIDERATIONS IN REGARD TO THE SPECIAL IMPORTANCE AND VALUE OF THE SEA FISHERIES.

It may be safely stated that as a source of animal food to man the sea is the great fountain head, and that without this resource the supply of such food would be comparatively limited and far inferior to the demand of the various populations of the globe.

In the much greater proportion of ocean to land this reservoir of food is practically inexhaustible, and not only do the people living near its shores find a daily supply for consumption in a fresh state, but by proper methods of preparation and preservation the product of the sea can be fitted for long-continued keeping and for transportation to distant markets, where fishing is difficult, or into the interior, where it is impracticable. It is not a little remarkable that abundant as is the supply of fish in the warmer portions of the world it is impossible to preserve them there, and consequently, in Catholic countries especially, where the consumption of fish on certain days is a necessity, the colder countries of the North are drawn upon to furnish cod, haddock, hake, herring, etc., to their own great profit. It is difficult to make a calculation as to the comparative amount of animal food derived from the ocean and the land, but it is stated (Report of the British Sea Fisheries, 1866, I, p. xvi) that the weight of trawled fish supplied to the London market amounts to 300 tons daily, and is nearly equal to the total amount of beef, and that the price paid to the fishermen for this food is only one-eighth of that paid to the first producer of the beef. It is also a gratifying and important consideration that the sources of food in the sea are very far from being all made use of, and that while in regard to the best known and most highly appreciated fish improved methods are constantly being devised for successfully increasing the amount of the catch at less expense, there are a vast number of sea animals which, while highly prized in some portions of the world, and really of superior excellence and wholesomeness as food, are despised elsewhere. In time, however, such prejudices will be overcome and the various species referred to fully appreciated.

Numerous illustrations of the propositions here enunciated will be found in the portions of the present article devoted to the consideration of particular kinds of fish found in American waters. There is practically no difficulty in even a dense population finding its subsistence in the sea, both as regards the food necessary for daily consumption and for the means of securing either necessities or luxuries by means of a trade in the same commodity, this fish supply being furnished and maintained without the necessity of any previous cultivation or care, nature providing for the successions of the crop, and leaving it only to man to gather its full perfection. A spear, the bow and arrow, a hook and line, a boat, even of the simplest and most primitive character, possibly even a floating log, will answer the necessary purpose; while the more extended investments of nets, weirs, and pounds, vessels for going a considerable distance to sea or even sailing to distant waters, are generally within the reach of the successful fisherman or a combination of several of them.

The case is very different on the land, where only a nomadic people can derive support from the wild game or fowl, and this scarcely more than sufficient for daily food and clothing, leaving but little for sale or export. As the population increases, this food becomes scarce and is either exterminated or driven away, so that it offers but a scanty provision for the sustaining of life. It is then necessary to resort to the arts of the agriculturist; the land must be cleared and tilled, the seed sown, and a harvest obtained, sometimes after many months of waiting, and with a chance, unfortunately too often realized, of a partial or total destruction of the whole by storm, rain, hail, drought, blight, or destructive insects. Even at best, too, only a small margin of annual profit is left after the interest on the investment and other deductions are made from the proceeds; and although the farmer who controls a large body of land and works it by labor-saving machinery, or can gather in a large aggregate of the small proceeds of individual laborers, may acquire a competence and even wealth in time, yet comparing the profits of a laborer who has but a small tract of land at his command with those of the fisherman who has the sea for many miles under his control, we shall find the actual results to be very different in the two cases.

Fishing, as an occupation, in fresh waters, is much less remunerative than the same business prosecuted in the sea, as by the limitation of area the supply becomes sooner exhausted, and is under the influence of climatic and physical conditions and the direct agencies of man. So far as the rivers are concerned, it is only where they are in connection with large interior lakes, which take the place to them of oceans, that the most favorable conditions for the fresh-water fisheries are to be met with; and the great lakes themselves, such as those along the northern border of the United States, by their vast extent and great depth, are really, for all practical purposes, simply oceans, and furnish trout, whitefish, sturgeon, and other species in enormous numbers. Even here,

however, the possibility of the exhaustion of the fisheries is to be considered and remedies applied in the way of protection, artificial propagation, &c.

I do not refer in this to the proceeds of rivers connected with the ocean and supplied with anadromous fish, such as salmon, shad, alewives, &c. These are simply pathways for certain forms of sea fish, which enter them for the purpose of spawning and return to the sea again, thus coming within most convenient reach of human energy in their capture.

Apart from the illustrations already presented of such fisheries in the United States, I may refer to the fisheries of the Volga, which is connected with the Caspian Sea. Here, according to Von der Schultz, an enormous number of pounds are annually captured.

For the artificial culture of fish in fresh water it is probable that the carp and tench are most profitable, as furnishing the greatest yield in pounds, and even in values, for a given outlay; and as these are herbivorous fish, thriving in waters not suited to most other species, there is reason to anticipate that a great advantage will result to the United States from the measures now in progress by the U. S. Fish Commission to multiply them, especially as the climate and waters of this country appear eminently adapted to their condition.

The agency of the sea fisheries is also of importance to the welfare of a nation otherwise than merely in the actual yield of food obtained, or of other articles of necessity or luxury. The influence of a sea-fishing life in rendering men bold, self-reliant, hardy adventurers is well known, and the infusion into the general population of such an element is of great importance. The pursuit of sea-fishing has an important and very valuable influence in training men for a sea-faring life generally, there being but little practical difference between the fitting out of a vessel for a distant sea fishery and taking the same or another vessel for an extended voyage to various points of the globe in the interest of commerce. It is from the hardy population of the fishermen that the merchant marine derives essentially its material, while the armed vessels of governments depend more indirectly upon the same source for manning their ships. It is for this reason that in all maritime nations the fishing population is looked to as a source of strength and protection, supplying, as it does, an element absolutely necessary to the well-being of the country, and in many instances bounties and privileges have been extended to increase the inducements to enter upon and prosecute the sea-fisheries. The life of the fisherman is, of course, not one of ease; he is exposed to dangers and hardships which to a landsman would appear appalling, but which are taken by the fisherman in the regular way of his duty. There is, however, no class of community more liable to peril than the fishermen, their dangers being proportioned in a great degree to their enterprise. Of the fishing population of the United States, that of Cape Ann may be considered as eminently typical of the bold and resolute sailor, and every year the

Cape has reason to deplore a large loss of life and property especially as the result of winter-fishing on the George's Bank not inaptly termed the "Gloucester grave-yard."

Proctor's "Fisherman's Memorial and Record Book" gives the names of 1,252 men and 280 vessels lost in the fisheries from the port of Gloucester between the years 1830 and 1873, or during a period of nearly half a century. It is estimated that ten women and twenty children are annually deprived of husband and father by this service, the actual losses averaging twenty-eight lives and six vessels annually. The total amount of property lost in the period mentioned was $1,145,500.

For the better illustration of the present article it would be desirable to present a statement of the product and values of the fisheries of the several maritime nations, so as to show the aggregate; and if reliable data were available for this purpose the result would be an amazing one. Unfortunately, the statistics of most nations are so inaccurate or incomplete as to render such a comparison entirely impossible. We have, however, in an important report from Mr. Richard D. Cutts, "The Fisheries and Fishermen of the North Pacific, and the Commerce in the Products of the Sea, Washington, 1872," a table of the products of certain portions of the fisheries of fifteen countries in the year 1865. They are as follows:

Codfish	$20,730,249
Herring	17,685,408
Whale oil	6,057,967
Mackerel	4,689,687
Sardines	2,600,000
Cod-liver oil	3,419,896
Seal oil	757,838
Pilchards	375,000
Total	59,606,218

This, however, is merely a suggestion, and is probably far below the aggregate of that year, and much less than that at the present time.

The general facts in regard to these subjects may perhaps be best appreciated by some particular statistics in regard to certain countries, especially Norway, for which I give the figures for 1866.

Total product of Norwegian fisheries.

The following statistics of the average product of the Norwegian fisheries is given by Baars in 1866 (Les Pêches de la Norwége, p. 58):

Winter herring, 600,000 barrels, at 18 francs	$2,400,000
Summer herring, 220,000 barrels, at 20 francs	800,000
Salted fish, 22,000,000 kilograms, at 40 francs per 100 kilograms	1,760,000
Dried fish, 12,000,000 kilograms, at 35 francs per 100 kilograms	850,000
Pickled fish, 60,000 barrels, at 20 francs	250,000
Cod-liver oil, 60,000 barrels, at 90 francs	1,080,000
Cod roes, 35,000 barrels, at 50 francs	350,000
Lobsters, 2,000,000, at 6 cents each	120,000
Fish guano, 350,000 kilograms, at 30 francs	5,100,000
Total	12,710,000

According to Schultz (Rep. U. S. F. C.), the annual catch of fish in the Caspian Sea and its tributaries amounts to 68,000,000 pounds, worth about $10,500,000.

The subject of the yield of the fisheries of the United States and the Dominion of Canada is of more special interest in the present report. So far as Canada is concerned an excellent system of supervision by the Government enables us to gather, with more or less accuracy, the returns as to the number of vessels, of men, and the general yield for the different classes of objects in the various portions of the Dominion; and which, although these returns are probably considerably below the actual figures, still answer a useful purpose as a basis for comparison and for obtaining a general average.

Newfoundland, which is not a part of the Dominion, has unfortunately no corresponding record to which reference may be made. The case is equally unsatisfactory in the United States. Here the General Government does not pretend to exercise any supervision in the collection of statistics of the sea fisheries, with the exception of such as are conducted by a certain class of vessels, occupied in foreign waters. Of the great local business of fishing, either by means of small boats that go out to a short distance from the land or the larger coasting vessels, we have no reliable data. It is true that certain States, especially Maine, New Hampshire, and Massachusetts, provide for the inspection of pickled fish, which is branded according to the several degrees of excellence; and this furnishes us, as far as that class of products is concerned, with tolerably reliable information. Other products, however, are unrecorded, and only an approximation to the amount can be made. The State of Massachusetts has, however, lately undertaken to secure reliable facts under this head, and the commissioners of inland fisheries have been empowered to require, under suitable penalties, an annual return of the yield of every weir, pound, and gill-net on the coast.

While it is probable that the supply of fish on the outer banks and in the deep sea, away from the immediate coast, is as great as that of former years, a lamentable falling off is to be appreciated in the capture of anadromous fish, such as the shad, salmon, and the alewife, as well as of many species belonging immediately to the coast, such as the striped bass, the scup, and other fish.

Fortunately, it is believed they are capable of remedy by proper legislation and protection, artificial propagation, etc., and that we may look forward in the distant future to a very considerable return to the former very desirable state and condition of the fisheries.

In proof of the abundance formerly existing I will only refer to the chapter under that head in the first report of the United States Fish Commission, in which the quotations are supplied from early historical records, extending back to the first peopling of the country by the whites. The capture of thousands of striped bass by means of nets stretched

across the mouths of tidal rivers, the schools of scup so thick that they crowded each other out of the water in their passage, single hauls of from three to five thousand shad, and of from one to nine hundred thousand alewives with the small nets used at that time, the taking of a hundred sturgeon with the hook and line in a day, and other similar facts all going to prove the general statement. A fisherman could, in a few hours and within a short distance from his home, fill his boat with cod, haddock, halibut, and other valuable species, and could take hundreds of pounds where now from one to ten would be considered a satisfactory return under the same circumstances.

As already stated, however, we may look forward, if not to the former state of things, yet to a great improvement on the present condition, and to this the efforts of State governments as well as of the General Government and of the Dominion of Canada are being directed with the utmost zeal, seconded by a growing public sentiment.

It may be remarked that the number of shad and herring (alewives) barreled on the Potomac River as the result of six months' fishing is equal to the entire yield of the Scottish fisheries for the entire year of 1873, one of their most successful years.

In an appendix to the Documents and Proceedings of the Halifax Commission, pp. 3360 *et seq.*, prepared by Mr. Goode, will be found a statement, as approximately accurate as possible, of the yield of the shore fisheries returned in the year 1876, with partial returns for 1877. These, it will be understood, are entirely the results of the inshore fisheries, with scarcely an exception, the capture being made by pounds, traps, or gill-nets, set either on or close in shore, or by line-fishing from open boats, also close to the land.

I have also compiled a table of the sea fisheries of Canada for the year 1876, rearranging the tables of the report of the minister of marine and fisheries, so as to show what are purely sea fisheries, what are fresh water, and what are incidental products. In preparing this table I have converted the estimates of the weight of dry, smoked, and pickled fish into their estimated weight when fresh, so as to supply a more ready comparison. It is extremely difficult to obtain any estimate of the yield of the distant fisheries, prosecuted in vessels and from the ports of the United States. The report of the Washington Bureau of Statistics for the fiscal year ending June 30, 1877, enumerates:

	Pounds.
Codfish	71,373,900
Mackerel	30,542,500
Herring	22,328,700
Other fish	11,503,540
Fresh fish, not cured	99,677,911

A second column gives the estimated weight of these fish when fresh, and is obtained in making up the table of Canadian statistics by multiplying the weight of the codfish by three; and adding one-fifth, or 20

per cent., to the weights of the herring and mackerel. We have thus an aggregate which we are sure is very far below the proper figures.

Within the last two years a very great increase in the demand for fish fresh from the sea has sprung up in the United States, most portions of the interior being now regularly supplied. To this end the improved methods of preservation and transportation have greatly conduced. The use of ice in its various applications,* the employment of refrigerating chests and refrigerator steamboats and cars and other devices, permits the transportation of fish many miles in a brief space of time. During the present year salmon have been loaded in cars on the Restigouche River and delivered in New York in thirty hours. The fish are packed in boxes with snow and placed in a refrigerator car supplied with a quantity of ice, so that on arriving in New York the snow is generally entirely unmelted. Fish are packed in chests in Florida and delivered in New York by steamer in the same manner. Fish taken in pounds or gill-nets or with lines along the coast are concentrated at shipping points and forwarded by rail or in smacks, properly iced. They are then repacked and sent by various lines of conveyance to their distant markets.

Such is now the method and system adopted in this business that it becomes very difficult to obtain fresh fish in seaport towns, the machinery of collecting and transporting being so arranged as to prevent, to a very great extent, the diversion of any portion of the stock to the local consumption. Indeed, it is not at all uncommon for fish to be sent directly away from a village on or near the coast to New York or Boston in a general shipment to market, and afterwards returned to its starting point for consumption. One supposed evidence of an increasing scarcity of fish is the increase in price at such stations. This is, however, a fallacious argument, as the market is regulated by the rates obtainable in the centers of supply rather than elsewhere, and the local prices necessarily must correspond. The proprietor of a weir or pound generally has his entire catch pre-engaged to the wholesale dealer in New York or Boston, and he cannot keep his accounts satisfactorily if he permits any portion to be diverted by the way. Formerly, before the introduction of the use of ice and the improved system of transportation, whenever a great catch of fish was made, the principal market would be found at a point on or near the landing, the fish being taken in wagons and peddled in the interior, but always over a limited area, the result being that prices were usually or frequently very low, and not remunerative, in cases of a glut in the market. It is to the interest of fishermen, of course, that there should be no danger of such a glut, and that all the catch be disposed at a fair price.

* In 1874 there were 25,000 tons of ice brought from Norway to Hull, for the preservation of fish taken by trawl nets.

I.—NATURAL HISTORY.

GENERAL CONSIDERATIONS IN REGARD TO THE SPECIES OF FOOD-FISHES OF THE EASTERN COAST OF THE UNITED STATES AND OF THE DOMINION OF CANADA.

The peculiar difficulties of investigating the natural history and general character of the inhabitants of the sea, excepting so far as they can be observed in aquaria, have tended very greatly to prevent the acquisition of satisfactory information in relation to their habits and characteristics; and it is therefore not surprising that our knowledge of this portion of the animal kingdom is far inferior to that of species belonging to the land. This proposition applies almost equally to the fish of all countries, there being very few species, even on the coast of Europe, the biology of which has been worked out in a satisfactory manner. Of a few species we know more than we do of others, especially of the salmon, several kinds of herring, and the cod. All these, as constituting an important source of wealth, have been investigated by scientific commissions, organized by Governments, and embracing men trained to research, and competent to do the work assigned them.

With an enlightened appreciation of the importance of this subject, the Norwegian Government has, for a number of years, employed some of its best naturalists, such as Professor Sars, Prof. A. Bœck, Mr. Robert Collett, and others, in these inquiries, providing them with all the necessary facilities. The inherent difficulties in the way will be readily appreciated, in view of the fact that even under such circumstances the investigators have not succeeded as yet in entirely working out the problems submitted to them for solution, but year by year further discoveries have been made, the sum of which constitutes the most if not the only reliable data at the service of inquirers elsewhere.

In view of these considerations, therefore, I trust that I shall be excused, if the accounts I give of the present state of our well-established knowledge of the habits and distribution of the American sea fish be more or less meager, especially as the limitation of the present report will forbid going into very minute detail. By distributing questions, as is now being done to a considerable extent, to the most intelligent observers throughout the country, and submitting particular questions and inquiries, and then by collating the results, it is hoped that a large body of facts will shortly be available.

The fishes of any region may be considered either in a purely zoological point of view, or as they would be treated in a natural history monograph, or in their relations to particular industries or to some special relation they may have to the land or water. For the purposes I have in view the subject of the biology or natural history of our fishes may be treated under the following heads:

A. A systematic list of the species embraced in the subject, including also the fishes and marine invertebrates serving as food and bait.

B. Biographical notices of the most important species. After treating them separately they may be considered collectively, or at least by groups of species.

C. The relationships of fishes in general to each other and to the shores and sea-bottom, as also to physical condition, their migration and movements, and the influence of men upon the same.

D. Their numbers and abundance formerly and at the present time.

E. Their fatalities, diseases, and destruction by natural causes and other than by ordinary human agency (which belong to the subject of the fisheries).

F. Their food, animal and vegetable.

G. Their reproduction, including their fecundity, their habits during that season, their rate of growth, and their conditions of maturity.

A.—List of the principal food and bait marine fishes of the eastern United States and British provinces.*

1. Principal food and bait fishes.

LOPHIIDÆ.

1. *Lophius piscatorius* (Linn.). Goosefish; Monkfish; Molligut.
   Nova Scotia and Chesapeake.

PLEURONECTIDÆ.

2. *Pseudopleuronectes americanus* (Walb.) Gill. Common Flounder; Winter Flounder; Mud Dab (Massachusetts Bay); Sole (New York).
   Nova Scotia to Cape Hatteras.
3. *Limanda ferruginea* (Storer) Goode & Bean. Rusty Dab; Sand Dab (Maine).
   Nova Scotia to Long Island.
4. *Glyptocephalus cynoglossus* (Linn.) Gill. Pole Flounder.
   North Atlantic, south to Block Island.
5. *Pomatopsetta dentata* (Storer) Gill. Smooth Plaice; Smooth-back.
   Massachusetts to Maine.
6. *Hippoglossoides platessoides* (Fabr.) Gill. Arctic Dab.
   Polar regions to Cape Cod.
7. *Pseudorhombus dentatus* (Linn.) Günther. Common Flounder.
   Cape Ann to Brazil.
8. *Hippoglossus vulgaris* (Fleming). Halibut.
   Greenland and Newfoundland to Cape Hatteras.
9. *Platysomatichthys hippoglossoides* (Walb.) Goode & Bean. Greenland Turbot.
   Greenland to Eastern Banks.

* This list is intended to present the principal species of food and bait fishes found north of the Delaware or the thirty-ninth degree of latitude.

GADIDÆ.

10. *Pollachius carbonarius* (Linn.) Bon. Pollock; Coal-fish (England).
Greenland to Cape Hatteras.

11. *Gadus morrhua* Linn. Common Codfish; Sarandlik and Sarandlisksoak (Greenland).
Polar regions to Cape Hatteras.

12. *Microgadus tomcodus* (Walb.) Gill. Tomcod; Frost-fish.
Newfoundland to Cape Hatteras.

13. *Melanogrammus æglefinus* (Linn.) Gill. Haddock.
Newfoundland to Cape Hatteras.

14. *Phycis chuss* (Walb.) Gill. Codling (New York); Old English Hake; Squirrel Hake (Massachusetts); Ling; Chuss (formerly at New York); Codling (Newport); Fork-beard (England).
Newfoundland to Cape Hatteras.

15. *Phycis tenuis* (Mitch.) DeKay. Codling (New York); White Hake (Massachusetts); Squirrel Hake (Maine).
Newfoundland to Cape Hatteras.

16. *Brosmius brosme* (Müller) White (d. @ s.) Cusk (Massachusetts); Torsk or Tusk.
North Atlantic, south to Cape Cod.

MERLUCIIDÆ.

17. *Merlucius bilinearis* (Mitch.) Gill. American Hake; Silver Hake (Maine); Whiting (Massachusetts); Stock-fish.
Nova Scotia to Cape Hatteras.

SCORPÆNIDÆ.

18. *Sebastes marinus*; Linn. (d. @ s.). Norway Haddock; Hemdurgan; Red-fish; Bream (Maine); Rose-fish; Snapper (Massachusetts Bay, Storer); Red Sea-perch (New York); Red Perch (Eastport).
Polar regions to Block Island.

LABRIDÆ.

19. *Tautoga onitis* (Linn.) Gthr. Black-fish; Tautog.
Bay of Fundy to South Carolina; New York.

20. *Tautogolabrus adspersus* (Walbaum) Gill. Burgall or Bergall (New York); Cunner or Conner; Chogset (New England); Bluefish or Blue Perch.
Newfoundland to Cape Hatteras.

XIPHIIDÆ.

22. *Xiphias gladius* Linn. Common Swordfish.
Nova Scotia to West Indies.

23. *Tetrapturus albidus* Poey. Billfish; Spearfish.
Cape Cod to West Indies.

24. *Histiophorus americanus* Lac. Sailfish.
Cape Cod to West Indies.

SCOMBRIDÆ.

25. *Scomber scombrus* Linn. Mackerel; Wawwhunne-kesuog (Narragansett Indians, Trumbull); Caballa (Cuba).
Greenland to Cape Hatteras.

26. *Scomber grex* Mitchell (= *S. pneumatophorus* De la Roche). Chub Mackerel.
Nova Scotia to Cape Hatteras.

27. *Sarda mediterranea* (Schn.) Jordan. Bonito; Skip-jack (Boston market).
Cape Cod to Florida.

28. *Orcynus thynnus* (Linn.) Goode (d. & s.). Horse-mackerel (Massachusetts, &c.); Albicore (Rhode Island); American Tunny.
Newfoundland to Florida.

29. *Orcynus alliteratus* (Raf.) Gill. Little Tunny; Albicore; Alliterato; (Naples); Mackerel (Bermuda).
Pelagic, occasional on coast (found in large numbers at Wood's Holl, Mass., August, 1871).

30. *Scomberomorus maculatus* (Mitch.) Jordan. Spanish Mackerel; Spotted Mackerel; Bay Mackerel (rare in Massachusetts Bay).
Cape Cod to Florida.

31. *Scomberomorus regalis* (Bloch) Jordan. Cero; Black-spotted Spanish Mackerel; King-fish.
Cape Cod to Florida.

CARANGIDÆ.

32. *Carangus hippos* (Linn.) Gill. Horse-crevallé; Jiguagua (Cuba).
Cape Cod to Florida.

33. *Trachynotus carolinus* (Linn.) Gill. Pompano (Southern coast); Cavallé or Crevallé (South Carolina); Pompynose (New Orleans).
Cape Cod to Florida.

34. *Trachynotus ovatus* (Linn.) Gthr. Short Pompano.
Cape Cod southward.

STROMATEIDÆ.

35. *Poronotus triacanthus* (Peck) Gill. Harvest-fish (New Jersey); Butter-fish (Massachusetts); Dollar-fish (Maine).
Maine to Cape Hatteras.

SCIÆNIDÆ.

36. *Cynoscion carolinensis* (Cuv. & Val.) Gill. Salmon-trout; Spotted Sea-trout (South coast); Spotted Silversides (Scott).
Cape Hatteras to Florida.

37. *Cynoscion regalis* (Bloch) Gill. Squeteague or Squit (New England); Shecutts or Checutts (Mohegan Indians); Chickwick (Connecticut); Weakfish (New York); Bluefish (Beesley's Point, New Jersey); Trout (Southern coast); Salt-water Trout; Gray Trout (Southern coast).
Cape Cod to Florida.

38. *Pogonias chromis* Lacépède. Drum.
Cape Cod to Florida.

39. *Liostomus obliquus* (Mitch.) DeKay. Lafayette (New York); Goody (Cape May); Chub (Norfolk); Roach (Northampton County, Virginia).
Cape Cod to Florida.

40. *Sciænops ocellatus* (Linn.) Gill. Bass; Red Bass; Sea Bass; Spotted Bass (South Carolina); Redfish (Gulf of Mexico).
Cape Cod to Florida.

41. *Menticirrus nebulosus* (Mitch.) Gill. Kingfish; Whiting; Hake (New Jersey); Barb (New Jersey).
Cape Cod to Florida.

42. *Micropogon undulatus* (Linn.) Cuv. & Val. Croaker; Verrugato (Cuba).

SPARIDÆ.

43. *Archosargus probatocephalus* (Walb.) Gill. Sheepshead.
Cape Cod to Florida.

44. *Stenotomus argyrops* (Linn.) Gill. Scup (Vineyard Sound); Scup. paug; Porgy (New York); Bream (Rhode Island, formerly); Fairmaid (East shore of Virginia).
Cape Cod to Florida.

PRISTIPOMATIDÆ.

45. *Hæmulon arcuatum* Cuv. & Val. Grunt.
South Atlantic coast of United States.

SERRANIDÆ.

46. *Centropristis atrarius* (Linn.) Barn. Black Sea Bass; Sea Bass (New York); Black Perch (Mass.); Black Bass; Blackfish (New Jersey); Bluefish (Newport); Black-harry; Hannahills (New York, DeKay); Black-will (Eastern shore of Virginia).
Cape Cod to Florida.

LABRACIDÆ.

47. *Roccus lineatus* (Bl. Schn.) Gill. Striped Bass (Eastern States); Rockfish (Pennsylvania, &c.); Missuckeke-kequock (Narragansett Indians).
Nova Scotia to Florida.

48. *Morone americana* (Gmelin) Gill. White Perch.
Nova Scotia to Florida.

EPHIPPIIDÆ.

49. *Ephippus faber* (Cuv.). Moonfish; Angel-fish (South Carolina); Three-banded Sheepshead; Three-tailed Porgy; Porgy (Chesapeake Bay).
Cape Cod to Florida.

LOBOTIDÆ.

50. *Lobotes surinamensis* Cuv. Flasher (New York market).
Cape Cod to Florida.

POMATOMIDÆ.

51. *Pomatomus saltatrix* (Linn.) Gill. Bluefish (New York and New England, except Rhode Island); Horse-mackerel (Newport and Beesley's Point, N. J.); Skip-jack (North Carolina); Green-fish (Virginia, DeKay); Tailor (Maryland and Virginia); Whitefish and Snap-mackerel (young).

ELACATIDÆ.

52. *Elacate canadus* (Linn.) Gill. Crab-eater.
Cape Cod to West Indies.

AMMODYTIDÆ.

53. *Ammodytes americanus* DeKay. Sand-launce; Sand-eel (New England).
Newfoundland to Cape Hatteras.

MUGILIDÆ.

54. *Mugil albula* Linn. Striped mullet.
Cape Cod to Florida.

55. *Mugil brasiliensis* Agassiz. White mullet.

ATHERINIDÆ.

56. *Chirostoma notata* (Mitch.) Gill. Silversides; Friar (New England).
Maine to Florida.

BELONIDÆ.

57. *Belone longirostris* (Mitch.) Gill. Silver gar; Bill-fish.
Cape Cod to Florida.

SCOMBERESOCIDÆ.

58. *Scomberesox saurus* (Walb.) Fleming. Skipper; Saury; Skip-jack.
Nova Scotia to Florida.

CYPRINODONTIDÆ.

59. *Cyprinodon variegatus* Lac.
Cape Cod to Florida.

MICROSTOMIDÆ.

60. *Mallotus villosus* (Müller) Cuv. Capelin.
Polar regions to Nova Scotia.

61. *Osmerus mordax* (Mitch.) Gill. Smelt.
Nova Scotia to Cape Hatteras.

SALMONIDÆ.

62. *Salmo salar* (Linn.) Günther. Salmon; Mishquammauquock (Narragansett Indians).
Polar regions to Cape Cod.

ELOPIDÆ.

63. *Megalops thrissoides* (Bl. Sch.) Günther. Jew-fish; Tarpum (Bermuda).
Cape Cod to Florida.

DUSSUMIERIDÆ.

64. *Etrumeus teres* (DeKay) Brevoort. Round herring.
Cape Cod to Cape Hatteras.

CLUPEIDÆ.

65. *Brevoortia tyrannus* (Latrobe) Goode & Bean. Menhaden (Vineyard Sound); Munnawhatteaug (Narragansett Indians); Pogy, Poghaden (East coast of New England); Mossbunker (New York); Panhaden, Panhagen (New England); Hard-head, Bony-fish (Massachusetts Bay); Skippaug or Bunker (East end of Long Island); Bony-fish (Saybrook); Whitefish (Saybrook to Milford, Connecticut); Fat-back and Yellow-tail (coast of North Carolina); Bug-fish (Carolina).
Nova Scotia to Brazil.

66. *Alosa sapidissima* (Wilson) Storer. Shad.
Newfoundland to Florida.

67. *Opisthonema thrissa* Gill. Thread-herring; Menhaden (Portland); Shad-herring (New York).
Newfoundland to Florida.

68. *Pomolobus æstivalis* (Mitch.) Goode & Bean; and *Pomolobus vernalis* (Mitchell) Goode & Bean. Herring (Southern States); Alewife (New England); Gaspereau (British Provinces); Spring-herring (New England); Aumsuog (Narragansett Indians); Kyack, Blueback, Alewife, Sawbelly, Cat-thresher (Portland, Me.).
Newfoundland to Florida.

69. *Pomolobus mediocris* (Mitch.) Gill. Tailor-herring (Potomac); Fall-shad.
Newfoundland to Florida.

70. *Clupea harengus* Linn. English Herring.
Polar regions to Cape Cod.

DOROSOMIDÆ.

71. *Dorosoma Cepedianum* (Lac.) Gill. Toothed Herring.
Cape Cod to Cape Hatteras.

ENGRAULIDÆ.

72. *Stolephorus vittatus* (Mitch.) Jordan & Gerard. Anchovy.
Cape Cod to Cape Hatteras.

ANGUILLIDÆ.

73. *Anguilla bostoniensis* (Les.) DeKay. Common Eel.
Newfoundland to Cape Hatteras.

ACIPENSERIDÆ.

74. *Acipenser oxyrhynchus* Mitch. (d. s.) Sharp-nosed Sturgeon.
Cape Cod to Florida.

75. *Acipenser brevirostris* Lesueur. Short-nosed Sturgeon.
Cape Cod to Florida.

PETROMYZONTIDÆ.

76. *Petromyzon americanus* Lesueur (d. s.) Lamprey; Lamper eel.
Cape Cod to Cape Hatteras.

2.—Invertebrates actually used as food and bait on a large scale.

MOLLUSCA.

Architeuthis Harveyi Verrill.
The giant squid, and other species of giant squids when they can be obtained.

Ommastrephes illecebrosa Ver.

The squid generally north of Cape Cod, and the only squid of the Gulf of Maine, Bay of Fundy, &c.

Loligo Pealii Lesueur. Squid.

South of Cape Cod, and also occurring in Massachusetts Bay.

Mya arenaria Linn. Long Clam.

Ranging from South Carolina to the Arctic Ocean.

Venus mercenaria Linn. Round Clam; Quahog.

Massachusetts Bay to Florida; Quahog Bay, Me.; Gulf of Saint Lawrence (Local).

Spisula solidissima Gray. Sea Clam; Surf Clam.

Labrador to Gulf of Mexico.

Gnathodon cuneatus. Louisiana.

Mytilus edulis Linn. Common Mussel (or muscle).

Modiola plicatula Lamarck. Ribbed Mussel.

These two species are both said to be used as bait off Sandy Hook, N. Y. I know nothing very positive about them.

CRUSTACEA.

Panopeus Herbstii Edwards. A crab, but know of no common name.

Range, Long Island Sound to Brazil; used for blackfish, Southern States.

Crangon vulgaris Fabr. Sand Shrimp.

North Carolina to Labrador.

Mysis, sp.

Used by boys in Eastport Harbor for catching pollock and red perch.

Thysanopoda, sp.

Used by boys in Eastport Harbor for catching pollock and red perch.

Homarus americanus Edw. Lobster.

Ranges from Labrador to New Jersey.

Callinectes hastatus Ordway. Common edible Crab, or Blue Crab.

Ranges from Cape Cod to Florida, and is occasionally found in Massachusetts Bay.

3.—Invertebrates which might possibly answer as bait.

It would seem as though nearly all the species of invertebrates which are found in the stomachs of fish, as food, might serve as bait for the same species at least; and the character of the food of some fishes is very varied. The following species are among the more common ones on the New England coasts and are easily obtained and of about the right size for bait, or could be rendered so by very little cutting. Of course there is the question as to whether they would all or even many of them prove attractive to fish when on a hook, but forms closely related to some of them are now standard articles of bait.

CRUSTACEA.

Gelasimus minax, pugnax, and *pugilator.*

The three species of Fiddler Crabs found on the Southern New England coast.

Cancer irroratus. Rock Crab.

Labrador to South Carolina.

Panopeus.

Several species of this genus are found on the Southern New England coast and to the south of New England, one of which, *Herbstii*, is already used as bait for blackfish.

Carcinus mœnas. Green Crab.

Cape Cod to New Jersey.

Eupagurus.

There are several species of "Hermit Crabs" common to the New England coasts, two or three of which, living not far from land, could easily be obtained as bait. One common species (*pollicaris*) is abundant on the oyster-beds of Southern New England (Long Island Sound) and could, therefore, be obtained of the oystermen.

Pandalus annulicornis. The Deep-water Prawn or Shrimp.

Common in the Gulf of Maine and Massachusetts Bay, in moderate to considerable depths, where it can be taken in large quantities by the beam-trawl.

Palæmonetes vulgaris. Common Prawn.

Massachusetts to South Carolina. Abundant in places, in shallow water.

ANNELIDA.

Nereis virens, and other "marine worms" which occur, buried in muddy and sandy beaches; nearly everywhere.

MOLLUSCA.

There are six species of Gasteropods of medium size which might possibly answer.

Buccinum undatum. Whelk.

Entire New England coast, but most abundant north.

Urosalpinx cinerea. Drill.

Massachusetts Bay to Florida. Very thick shell, for which reason might not answer.

Purpura lapillus. Purple.

Long Island to arctic. Also very thick shell.

Lunatia heros. Sea Snail.

Georgia to Gulf of Saint Lawrence.

Crepidula fornicata. Double-decker.

Casco Bay, Me., to Florida.

Littorina littorea.

New Haven to Nova Scotia. Imported from Europe. Very abundant on the shores northward of Newport, R. I. Is very good eating for man.

Two other Gasteropods are common south of Cape Cod, but they are of large size.

Fulgur carica. Winkle.

Sycotypus canaliculatus. Winkle.

Of Lamellibranchs there are the following:

Mulinia lateralis. No common name, but related to the Sea or Surf Clam, smaller size.

Massachusetts to Florida.

Callista convexa. Related to the Quahog, but of smaller size.

New Jersey to Gulf of Saint Lawrence.

Astarte undata.

Scapharca transversa. Bloody Clams.

Argina pexata. Bloody Clams.

Florida to Cape Cod.

Pecten irradians. Scallop.

Florida to Cape Cod.

If ascidians could be used as bait, the best three species would be the following, but I have not heard of their ever having been found in the stomachs of fish:

Molgula Manhattensis.

North Carolina to Maine; sometimes thrown up on the beaches in immense quantities; lives in shallow water.

Cynthia pyriformis. Sea Peach; abundant in Bay of Fundy, in moderate depths.

Boltenia Bolteni. Sea Lemon.

Cape Cod northward, with last above in Bay of Fundy.

RADIATA.

Brittle-stars (Ophiurans) are often found in fishes' stomachs, and might answer as bait. The commonest species is—

Ophiopholis aculeata.

New Jersey to the Arctic Ocean; low water to 100 fathoms and deeper.

Some species of common starfishes and sea-cucumbers might possibly also do.

4.—Lists of species, annual estimate for 1871–'72, found in the stomachs of fishes—food of fishes.

In the following lists have been brought together the principal results of the various recorded examinations of stomachs of fishes in

this region up to the present time, whether done in connection with the U. S. Fish Commission or independently. The special dates and localities are given in each case.*

Lophius Americanus DeKay. Goosefish; Angler.

A specimen caught in Vineyard Sound, in June, contained crabs, *Cancer irroratus;* and squids, *Loligo Pealii.* Another contained a medium-sized skate. Still another a large common flounder; bluefish (*Pomatomus saltatrix*); fragments of clam shells (*Mya arenaria*); crabs; and eel-grass. Wood's Holl, 1871; E. Palmer.

Specimens taken in the rivers with herring had their stomachs filled with that fish. A. E. Verrill, Eastport, Me., 1871.

Alutera Schœpfii. (Walb.) Goode & Bean. File-fish.

A specimen taken at Wood's Holl, in August, contained a quantity of the finely-divided stems and branches of a Hydroid, *Pennaria tiarella.*

Pseudopleuronectes Americanus Gill. Winter Flounder.

A specimen caught at Wood's Holl, in August, contained large numbers of *Bulla solitaria.*

Specimens taken, in 1871, in the rivers about Eastport, were filled with herring. A. E. Verrill, 1871.

Lophopsetta maculata Gill. Spotted Flounder.

Numerous specimens caught in seines at Great Egg Harbor, April, 1871, contained large quantities of shrimp, especially *Mysis Americana* and *Crangon vulgaris;* the prawn, *Palæmonetes vulgaris;* numerous Amphipods, *Gammarus mucronatus;* one contained a *Gobia affinis.*

Chænopsetta ocellaris Gill. Ocellated Flounder; Summer Flounder.

Several specimens taken in the seines at Great Egg Harbor, New Jersey, in April, contained large quantities of shrimp, *Crangon vulgaris* and *Mysis Americana;* one contained a full-grown *Gobia affinis.*

One caught at Wood's Holl, June 6, contained twenty-six specimens of *Yoldia limatula;* and numerous shells of *Nucula proxima, Angulus tener,* and *Tritia trivittata;* and Amphipod Crustacea belonging to the genus *Ampelisca.*

Specimens caught at Wood's Holl, in July, contained rock-crabs, *Cancer irroratus; Pinnixa cylindrica; Crangon vulgaris;* squids, *Loligo Pealii; Angulus tener; Nucula proxima;* and many "sand-dollars," *Echinarachnius parma.*

August 16. One specimen contained a scup and one squid (*Loligo*); Sept. 1. Another specimen had two small crabs and two minnows. Wood's Holl; E. Palmer, 1871.

* This article is essentially the same as the one contributed by Prof. A. E. Verrill to the report of U. S. Fish Commission of 1871–'72. I am indebted to Mr. R. Rathbun for rearranging it and adding notes by Professor Verrill made at Eastport, Me., either in 1871 or previous years, and notes of the fishes found as food in the stomachs of other fishes at Wood's Holl in 1871 by Dr. E. Palmer, Professor Verrill having enumerated in his report only the invertebrate contents.

Gadus morrhua var. Cod.

The codfishes devour a great variety of Crustaceans, Annelids, Mollusks, starfishes, &c. They swallow large bivalve shells, and after digesting the contents spit out the shells, which are often almost uninjured. They are also very fond of shrimps, and of crabs, which they frequently swallow whole, even when of large size. The brittle-starfishes (Ophiurans) are also much relished by them. I have taken large masses of the *Ophiopholis aculeata* from their stomachs on the coasts of Maine and Labrador; and in some cases the stomach would be distended with this one kind, unmixed with any other food.

In this region I have not been able to make any new observations on the food of the cod. This deficiency is partially supplied, however, by the observations made by me on the coast of Maine, &c., coupled with the very numerous observations made at Stonington, Conn., many years ago, by Mr. J. H. Trumbull, who examined large numbers of the stomachs of cod and haddock, caught within a few miles of that place, for the sake of the rare shells that they contained. This collection of shells, thus made, was put into the hands of the Rev. J. H. Linsley, who incorporated the results into his "Catalogue of the Shells of Connecticut," which was published after his death, in a somewhat unfinished state, in the American Journal of Science, Series I, vol. xlviii, p. 271, 1845. In that list a large number of species are particularly mentioned as from the stomachs of cod and haddock, at Stonington, all of which were collected by Mr. Trumbull, as he has informed me, from fishes caught on the fishing-grounds near by, on the reefs off Watch Hill, &c. Many other northern shells, recorded by Mr. Linsley as from Stonington, but without particulars, were doubtless also taken from the fish-stomachs by Mr. Trumbull. There was no record made of the Crustacea, &c., found by him at the same time.

The following list includes the species mentioned by Mr. Linsley as from the cod. For greater convenience the original names given by him are added in parentheses, when differing from those used in this report:

List of mollusks, &c., obtained by Mr. J. H. Trumbull, from codfish caught near Stonington, Conn.

GASTROPODS.

Sipho Islandicus (?), young, (Fusus corneus).
Ptychatractus ligatus (Fasciolaria ligata).
Turbonilla interrupta (Turritella interrupta).
Turritella erosa.
Rissoa exarata (?) (Cingula arenaria).
Lunatia immaculata (Natica immaculata).
Amphisphyra pellucida (Bulla debilis).
Chiton marmoreus (?) (Chiton fulminatus).

LAMELLIBRANCHS.

Martesia cuneiformis (Pholas cuneiformis).
Periploma papyracea (Anatina papyracea).
Thracia truncata.
Tagelus divisus (Solecurtus fragilis).
Semele equalis (?) (Amphidesma æqualis).
Ceronia arctata (Mesodesma arctata).
Montacuta elevata (Montacuta bidentata).
Callista convexa, young, (Cytherea morrhuana).
Cardium pinnulatum.
Cyprina Islandica.
Gouldia mactracea (Astarte mactracea).
Yoldia sapotilla (Nucula sapotilla).
Yoldia limatula (Nucula limatula).
Nucula proxima.
Nucula tenuis.
Modiolaria nigra (Modiola nexa).
Crenella glandula (Modiola glandula).
Pecten tenuicostatus, young, (Pecten fuscus).

ECHINODERMS.

Echinarachnius parma.

Microgadus tomcodus Gill. Tomcod; Frost-fish.

Several specimens from New Haven Harbor, January 30, contained numerous Amphipods, among which were *Mœra levis; Gammarus*, sp.; *Ampelisca*, sp.; an undetermined Macrouran; numerous Entomostraca; the larva of *Chironomus oceanicus.*

A lot taken in a small pond at Wood's Holl, in March, by Mr. Vinal N. Edwards, contained the common Shrimp, *Crangon vulgaris;* large numbers of the green Shrimp, *Virbius zostericola;* the Prawn, *Palæmonetes vulgaris;* large quantities of Amphipods, especially of *Gammarus annulatus, G. natator, Calliopius lævisculus*, and *Microdeutopus minax;* and smaller numbers of *Gammarus ornatus* and *G. mucronatus.*

Another lot of twelve, taken in April at the same place, contained most of the above, and in addition several other Amphipods, viz: *Mœra levis, Pontogeneia inermis, Ptilocheirus pinguis*, and *Caprella;* also *Nereis virens*, and various small fishes.

Melanogrammus æglifinus Gill. Haddock.

The haddock is not much unlike the cod in the character of its food. It is, perhaps, still more omnivorous, or, at least, it generally contains a greater variety of species of shells, &c.; many of the shells that it habitually feeds upon are burrowing species, and it probably roots them out of the mud and sand.

A complete list of the animals devoured by the haddock would doubtless include nearly all the species belonging to this fauna. We have

had few opportunities for making observations on the food of the haddock south of Cape Cod, but have examined many from farther north.

A specimen taken at Wood's Holl, November 6, 1872, contained a large quantity of *Gammarus natator* and a few specimens of *Crangon vulgaris*. Another from Nantucket contained the same species.

The following species of shells were mentioned by Mr. Linsley, in his catalogue, as from the haddock:

List of mollusks obtained from stomachs of haddock, at Stonington, Conn., by Mr. J. H. Trumbull.

Neptunea pygmæa (Fusus Trumbulli).
Astyris zonalis (Buccinum zonale).
Bulbus flavus (?) (Natica flava).
Margarita obscura.
Actæon puncto-striata (Tornatella puncto-striata).
Cylichna alba (Bulla triticea).
Serripes Grœnlandicus (?) (Cardium Grœnlandicum).

The above list doubtless contains only a small portion of the species collected by Mr. Trumbull, but they are all that are specially recorded. As an illustration of the character and diversity of the haddock's food, I add a list of the species taken from the stomach of a single specimen, from the Boston market, and doubtless caught in Massachussetts Bay, September, 1871.

GASTEROPODS.

Natica clausa.
Margarita Grœnlandica.

LAMELLIBRANCHS.

Leda tenuisulcata.
Nucula proxima.
Nucula tenuis.
Crenella glandula.

ECHINODERMS.

Psolus phantapus.
Lophothuria Fabricii.

In addition to these there were fragments of shrimp, probably *Pandalus annulicornis*, and numerous Annelids, too much digested for identification.

Pollachius carbonarius Bon. Pollock.

A species of *Thysanapoda* and one or two species of *Mysis* serve as food for the pollock about Eastport, Me. These crustaceans go under the general name of "shrimp" among the fishermen, and swim together in large schools. A. E. Verrill, 1871.

Phycis tenuis DeKay. Hake.

Feeds largely on worms, crustaceans (*Pandali*, &c.), and mollusks, frequenting muddy bottoms. A. E. Verrill, Eastport, Me., 1871.

Anarrhichas lupus Linn. Wolf-fish.

This species is said to feed on the sea herring (*Clupea elongata*), but in two specimens examined at Eastport, Me., in 1871, no traces of herrings were found. The stomach of one specimen contained about four quarts of sea-urchins (*Strongylocentrotus Dröbachiensis*), a part of them entire, and all with the spines on. The other contained a mixture of the same sea-urchin and *Buccinum undatum*. A. E. Verrill, 1871.

Batrachus tau Linn. Toadfish.

Several specimens examined at Great Egg Harbor, New Jersey, April, 1871, contained young edible crabs, *Callinectes hastatus* of various sizes up to those with the carapax two inches broad; shrimp, *Crangon vulgaris;* prawn, *Palæmonetes vulgaris; Ilyanassa obsoleta;* various fishes, especially the pipe-fish, *Syngnathus Peckianus;* and the anchovy, *Engraulis vittatus.*

A specimen caught at Wood's Holl, in July, contained the common rock-crab, *Cancer irroratus.*

Cyclopterus lumpus Linn. Lumpfish.

In the rivers near Eastport, Me., specimens taken in connection with herring had been feeding upon the latter fish. A. E. Verrill, 1871.

Prionotus Carolinus Cuv. & Val. Sea Robin.

A specimen caught at Wood's Holl, May 27, contained shrimp, *Crangon vulgaris;* and a small flounder.

Another caught May 29, contained Amphipod Crustacea, *Anonyx* (?), sp.; and *Crangon vulgaris.*

Specimens dredged in Vineyard Sound, in August, contained mud-crabs, *Panopeus Sayi;* rock-crabs, *Cancer irroratus;* and several small fishes.

Sebastes marinus Lütken. Redfish; Red Perch.

At Eastport, Me., the red perch feeds upon a species of *Thysanopoda*, and one or two species of *Mysis*, which swim together in large schools, and are called "shrimp" by the fishermen. A. E. Verrill, 1871.

Tautoga onitis Gthr. Tautog; Blackfish.

Specimens caught at Wood's Holl, May 23, contained the common rock-crab, *Cancer irroratus;* hermit-crabs, *Eupagurus longicarpus;* shells, *Tritia trivittata*, all crushed.

Others caught May 26 contained *Eupagurus pollicaris; E. longicarpus;* the barnacle, *Balanus crenatus;* the squid, *Loligo Pealii; Tritia trivittata.* Others taken May 29 had *Cancer irroratas;* mud-crabs, *Panopeus depressus;* lady-crabs, *Platyonichus ocellatus;* shells, *Tritia trivittata, Crepidula fornicata, Argina pexata*, and the scollop, *Pecten irradians;* barnacles, *Balanus crenatus*, all well broken up.

Another taken May 31 contained *Platyonichus ocellatus; Tritia trivittata.*

Others taken June 3 contained the mud-crab, *Panopeus depressus;* triangular crab, *Pelia mutica; Crepidula unguiformis; Triforis nigrocinctus;* the common mussel, *Mytilus edulis;* and the "horse-mussel," *Modiola modiolus.*

Another, on June 10, contained the common rock-crab, *Cancer irroratus;* mud-crab, *Panopeus Sayi; Nucula proxima;* several ascidians, *Cynthia partita* and *Leptoclinum albidum.*

Two caught July 8 and 15 contained small lobsters, *Homarus Americanus; Crepidula fornicata; Bittium nigrum;* a bryozoan, *Crisia eburnea;* sand-dollars, *Echinarachnius parma.*

A specimen caught in August contained long-clams, *Mya arenaria;* muscles, *Mytilus edulis; Petricola pholadiformis.*

Xiphias gladius Linn. Swordfish.

One specimen contained mackerel (*Scomber scombrus*), and butterfish (*Paronotus triacanthus*). Wood's Holl, Mass., 1871; E. Palmer.

Sarda pelamys Cuv. Bonito.

Specimens taken at Wood's Holl, in August, contained an abundance of shrimp, *Crangon vulgaris*, scup, and occasionally fragments of fish and bones. Out of eighty-two individuals examined at one time, nearly every one was empty. Shiners seemed to form their common food. Wood's Holl, 1871; E. Palmer.

Scomber scombrus Linn. Mackerel.

Specimens taken July 18, 20 miles south of No Man's Land, contained shrimps, *Thysanopoda*, sp.; larval crabs in the zoëa and megalops stages of development; young of hermit-crabs; young of lady-crabs, *Platyonichus ocellatus;* young of two undetermined Macroura; numerous small Copepod Crustacea; numerous shells of a Pteropod, *Spirialis Gouldii.*

Orcynus thunnina. Small Tunny.

One specimen caught at Wood's Holl, in August, contained eleven squids, *Loligo Pealii.*

Often contained small fragments of fish and sea-grass (*Zostera*). Wood's Holl, 1871; E. Palmer.

Cybium regale Cuv. & Val. Cerò.

Stomachs often contained fine particles of fish. Wood's Holl, 1871; E. Palmer.

Palinurichthys perciformis Gill. Rudderfish.

A specimen caught at Wood's Holl, in August, contained a small *Squilla empusa;* young squids, *Loligo Pealii;* Butterfish, and several other young slender fish. Wood's Holl, 1871; E. Palmer.

Cynoscion regalis Gill. Weakfish; Squeteague.

Several caught in seines at Great Egg Harbor, New Jersey, April, 1871, with menhaden, &c., contained large quantities of shrimp, *Crangon vulgaris*, unmixed with other food.

Specimens taken at Wood's Holl, in July, often contained sand-crabs, *Platyonichus ocellatus;* and very frequently squids, *Loligo Pealii.*

August 8.—Nearly every one of ten specimens opened contained six scup (*Stenotomus argyrops*); one had a herring (*Clupea elongata*).

August 11.—Twenty specimens contained on an average about five scup each. Some were empty, while others had as many as nine. One or two squid were found.

August 12.—Twenty-five specimens examined contained on an average about four scup each; a few shiners, butterfish (*Poronotus triacanthus*), and squid were also found.

August 14.—Twenty specimens opened; of these one or two were empty, and the remainder had on an average about three scup each, without other kinds of food.

August 15.—Of fifteen squeteague examined, three had empty stomachs, and the remainder were more or less full of scup; a butterfish was found in one stomach.

August 16.—Out of ten specimens examined two were empty, and eight had a total of twenty-five scup.

August 19.—Ten squeteague opened contained a total of thirty-nine scup and six butterfish. One had nine scup in his stomach.

August 21.—Of forty specimens opened nearly all had more or less scup, with a few butterfish and squid.

September 2.—One squeteague had six butterfish; another a scup, with eel-grass (*Zostera*); another eel-grass only.

September 6.—One specimen contained three butterfish, two scup, and two dotted scad (*Decapterus punctatus*).

September 15.—One specimen contained a sand-crab and a bluefish (*Pomatomus saltatrix*).

September 18.—Ten stomachs opened contained three specimens of *Tracurops crumenopthalmus*, three butterfish, three scup, and one squid.

September 26.—One stomach contained three butterfish, one herring, one eel (*Anguilla Bostoniensis*), and three *pisquetos* (*Paratractus?*).

Menticirrus nebulosrus Gill. Kingfish.

Four specimens taken in seines at Great Egg Harbor, April, 1871, contained only shrimp, *Crangon vulgaris.*

Others taken at Wood's Holl, May 29, were filled with *Crangon vulgaris.*

Specimens taken in July contained rock-crabs, *Cancer irroratus;* and squids, *Loligo Pealii.*

Stenotomus argyrops Gill. Scup; Porgee.

Forty young specimens, one year old, taken at Wood's Holl in August, contained large numbers of Amphipod Crustacea, among which were *Unciola irrorata, Ampelisca*, sp., &c.; several small mud-crabs, *Panopeus depressus; Idotea irrorata; Nereis virens*, and numerous other Annelids of several species, too much digested for identification.

Other specimens, opened at various times, show that this fish is a very general feeder, eating all kinds of small Crustacea, Annelids, bivalve and univalve mollusks, &c.

Centropristis fuscus. Black Bass; Sea Bass.

Specimens caught in Vineyard Sound, June 10, contained the common crab, *Cancer irroratus;* the mud-crab, *Panopeus Sayi;* three species of fishes.

Another, caught May 25, contained a squid, *Loligo pallida.*

July 27.—Ten specimens were opened and found to contain scup (*Stenotomus argyrops*) and squeteague (*Cynoscion regalis*).

September 5.—One specimen contained two butterfish (*Poronotus triacanthus*) and two chogsets (*Tautogolabrus adspersus*).

Roccus lineatus Gill. Striped Bass; Rockfish, or "Rock."

At Great Egg Harbor, New Jersey, April, 1871, several specimens, freshly caught in seines, with menhaden, &c., contained *Crangon vulgaris* (shrimp) in large quantities.

A specimen caught at Wood's Holl, July 22, 1872, contained a large mass of "sea-cabbage," *Ulva latissima*, and the remains of a small fish.

Specimens taken at Wood's Holl, August, 1871, contained crabs, *Cancer irroratus;* and lobsters, *Homarus americanus.*

Morone americana Gill. White Perch.

Numerous specimens caught with the preceding at Great Egg Harbor, New Jersey, contained *Crangon vulgaris.*

Pomatomus saltatrix Gill. Bluefish; Horse-mackerel.

Specimens caught at Wood's Holl, in August, frequently contained squids, *Loligo Pealii;* also various fishes.

Off Fire Island, Long Island, August, 1870, Mr. S. I. Smith saw bluefishes feeding eagerly on the free-swimming males (heteronereis) of *Nereis limbata*, (p. 318,) which was then very abundant.

Fundulus pisculentus Cuv. & Val. Minnow.

Specimens caught in July, at Wood's Holl, contained large numbers of *Melampus bidentatus*, unmixed with other food.

Clupea elongata LeS. Sea Herring.

Specimens taken in Vineyard Sound, May 20, contained several shrimp, *Crangon vulgaris*, about 1.5 inches long; *Mysis americana*, and large numbers of an Amphipod, *Gammarus natator;* also small fishes.

At Eastport, Me., and Grand Manan, the principal, if not the only, food of the herring in summer is a species of *Thysanopoda*, and one or two species of *Mysis.* These species are associated together, and move in large schools; they are known among the fishermen as shrimp. The food of the herring caught out in the bay by means of seines, and of those trapped in the weirs in the harbor, was of the same character for both. A. E. Verrill, 1871.

Alosa sapidissima Storer. Shad.

Several specimens taken in the seines, at Great Egg Harbor, April, 1871, contained finely-divided fragments of numerous Crustacea, among which were shrimp, *Mysis americana.*

Several from the mouth of the Connecticut River, May, 1872, contained fragments of small Crustacea, (*Mysis*, &c.).

Pomolobus mediocris Gill. Hickory Shad.

Several specimens taken in the seines at Great Egg Harbor, April, 1872, contained large quantities of fragmentary Crustacea; one contained recognizable fragments of shrimp, *Crangon vulgaris.*

Brevoortia tyrannus (Latrobe) Goode. Menhaden.

A large number of specimens freshly caught in seines at Great Egg Harbor, April, 1871, were examined, and all were found to have their stomachs filled with *large quantities of dark mud.* They undoubtedly swallow this mud for the sake of the microscopic animal and vegetable organisms that it contains. Their complicated and capacious digestive apparatus seems well adapted for this crude and bulky food.

Raia diaphana Mitch. Common Skate; "Summer Skate."

A specimen taken at Wood's Holl, May 14, contained rock-crabs, *Cancer irroratus;* a young skate; a long slender fish (*Ammodytes?*). Another, caught in July, contained *Cancer irroratus.*

Raia lævis (?) Mitch. Peaked-nose Skate.

Specimens caught in Vineyard Sound, May 14, contained numerous shrimps, *Crangon vulgaris;* several *Conilera concharum;* several Annelids, among them *Nephthys ingens; Meckelia ingens;* two specimens of *Phascolosoma Gouldii;* razor-shells, *Ensatella Americana* (the "foot" only, of many specimens); a small fish, *Ctenolabrus burgall.* Specimens taken at Menemsha, in July, contained large numbers of crabs, *Cancer irroratus;* and of lobsters, *Homarus americanus.*

Trygon centrura Gill. Sting-ray.

Specimens caught at Wood's Holl, in July and August, contained large numbers of crabs, *Cancer irroratus;* squids, *Loligo Pealii;* clams, *Mya arenaria; Lunatia heros.*

Myliobatis Freminvillei Les. Long-tailed Sting-ray.

Specimens taken in Vineyard Sound, in July, contained an abundance of lobsters, *Homarus americanus;* crabs, *Cancer irroratus;* also clams, *Mya arenaria;* and *Lunatia heros.*

Pteroplatea maclura Müll. & Henle. Butterfly Ray.

One specimen examined contained menhaden (*Brevoortia tyrannus* Goode). Wood's Holl, 1871. E. Palmer.

Eulamia obscura Gill. Dusky Shark.

Several specimens caught at Wood's Holl, in July and August, contained lobsters, *Homarus americanus;* rock-crabs, *Cancer irroratus.*

One specimen contained a flat-fish, in the stomach of which were star-fish and clam-shells. The common ray is often the food of this species

as is also the bonito, as many as three of the latter being sometimes found in the stomach of a single individual. Other animals that serve as food are the herring, horse-mackerel, skate's eggs, crabs, and lobsters. Wood's Holl, Mass., 1871. E. Palmer.

Eulamia Milberti Gill. Blue Shark.

A large specimen caught at Wood's Holl, in August, contained a quantity of small bivalve shells, *Yoldia sapotilla.*

The common food of this species was the squeteague (*Cynoscion regalis*), and the bonito (*Sarda pelamys*). One individual contained a five-pound mackerel; another had a large codfish hook and piece of line. Scup, the common skate, sea bass, and a small shell (*Yoldia sapotilla*), also served as food. Three bonitos were often found in a single specimen. Wood's Holl, 1871. E. Palmer.

Galeocerdo tigrinus Müll. & Henle. Tiger Shark.

Specimens caught at Wood's Holl, in August, contained large univalve shells, *Buccinum undatum* and *Lunatia heros.*

One contained a quantity of pork in large pieces, while others had fed upon sea turtle, the common ray, sting-ray, bluefish, dogfish; quantities of feathers and eel-grass were also found in the stomachs of this species. Wood's Holl, 1871. E. Palmer.

Mustelus canis De Kay. Dogfish.

Several specimens caught at Wood's Holl, in August, contained lobsters, *Homarus americanus;* spider-crabs, *Libinia canaliculata;* rock-crabs, *Cancer irroratus;* Tautog (*Tautoga onitis*); and butterfish (*Poronotus triacanthus*). Wood's Holl, 1871. E. Palmer.

Eugomphodus littoralis Gill. Sand Shark.

Many specimens taken at Wood's Holl, in July and August, contained lobsters, *Homarus americanus*, in abundance; *Cancer irroratus;* and squids, *Loligo Pealii.*

Also menhaden, *Brevoortia tyrannus;* eels; and common flounder. E. Palmer, 1871.

Squalus americanus.

Specimens taken in the rivers near Eastport, Me., in 1871, associated with herring, were full of the latter fish. A. E. Verrill, 1871.

A Gephyrean worm is often used for bait by the fishermen on some parts of the coast of Maine. It has not been well described but it is apparently the *Holothuria chrysacanthophora* of Couthouy and the *Echiurus chrysacanthophorus* of Pourtales. It has been generally considered a rare species, and specimens of it are uncommon in museums. At Harpswell the fishermen sometimes dig it in immense quantities. It lives in the mud, just above the low-water mark, and is as readily obtained as clams. It is used in catching several species of fishes, but is specially desirable for hake. Its irregularity of occurrence seems to be the only reason why it should not be more extensively employed.

B.—Biographical notices of the most important species.

As already explained, our knowledge of the habits of the sea-fishes of America is very imperfect for various reasons, chief among which is, of course, their concealment from notice during the greater portion of their existence. We are even far from the knowledge of what species actually occur on our shores; many kinds coming to notice only at rare intervals, or under circumstances when the intelligent observer and naturalist fail to encounter them. Comparatively few species are readily, if ever, taken with the hook, or even the seine, and it is only since the more recent introduction of traps, pounds, and weirs, with their wholesale captures, that a fair idea of the geographical distribution of the sea-fishes along the coast has been attained. Even this apparatus fails to reach the outlying deep-sea species; and the beam-trawl and long-line, while constantly adding to the list, will never in all probability entirely complete it. During the summer of 1877 the parties of the U. S. Fish Commission trawled up at various distances off the coast of Massachusetts several species, some new to science, never before known in American waters, and it is probable that additions will be made continually, without exhausting the list.

It is not a little remarkable that fishermen who are continually in contact with fish throughout the year know actually so little about them. To questions as to the food of the various species, the peculiarities of spawning, the size and character of the eggs, the period of development, the history of the young, &c., a negative answer is usually returned, and it is only occasionally that one more intelligent, or at least more observant, than the rest can be found from whom any satisfactory information can be obtained. It is, however, to be hoped, and indeed to be expected, that the publication of a résumé of our actual knowledge of the habits and peculiarities of our fishes will call their attention to the subject, and secure their assistance in solving the many remaining problems.

As already explained, the facts, or probably it will be safer to call them statements until confirmed, here given are to a considerable degree the result of personal observation of members of the U. S. Fish Commission, supplemented and extended by the answers to questions distributed by the Commission. Personal inquiry of witnesses summoned before the Joint Fisheries Commission held at Halifax from June 15 to December 15, 1877, in addition to the testimony elicited on their examination by the counsel and printed with the other evidence, have also added not a little to the mass of facts. Great care, however, requires to be exercised in admitting the statements made on this occasion, as one witness, apparently honest and claiming to have been a practical fisherman for many years, stated under oath, that the eggs of the mackerel were as large as pease or BB shot, and that they could be hauled up on a hook in large masses.

Not much information is to be found in the various publications hitherto made relative to the fish and fisheries of Eastern North America, although some facts of value are contained in the writings of Gilpin, Perley, Ambrose, Storer, and others.*

C.—Relationships and surroundings.

Fishes considered collectively or by groups.—Although each species of fish on our coasts may be considered as possessing some peculiar habit or combination of habits by which it is distinguished from its fellows, they may be, for convenience of consideration, divided into groups, all the members of which possess certain common peculiarities, having an important bearing upon the methods and times of their pursuit and capture. These relationships are, to some extent interrupted by the reproductive instinct, which causes them to change their ordinary location and to assume new conditions. They are also affected by the exigencies of feeding, of pursuit by other animals or by man, or by the variations in their physical surroundings.

Deferring to a subsequent part of the chapter any consideration of the migrations and movements of the various species, we may arrange marine fish in certain groups, as follows:

a. The inshore fish, or those found within a short distance (sometimes miles) from the shores. These embrace a great variety of species, generally of small size and finding their harbor and shelter among rocks and stones, sea-weeds, eel-grass, &c. They are fish that can be taken from beaches, rocks, and wharves, or small boats from the shore, and furnish more occupation and amusement than actual profit in their capture. They are also among those most frequently taken in weirs, pounds, and fykes. Among them may be mentioned various Cyprinodonts, the cunner, the spearing or friar, the young Clupeids, the sea bass, the tautog, the scup, and many other species of less note.

These fish furnish an important article of food, but obtainable only by considerable effort; and being generally of small size, do not yield a very generous return. Some of the species, as the scup, in former years were, however, in such abundance on the south coast of New England that hundreds of pounds could easily be taken in a short time.

b. The offshore fish.—These are species which usually occupy greater depths, and are found at remoter distances from the shore than those first mentioned, being generally found on the banks or elevations in deeper water.

The greater portion of the *Gadidæ* or cod family, such as the cod, haddock, hake, &c., belong here; as also the halibut. This group is the most important of our coast-fishes, being usually of large size and occur-

* This section of the report as prepared at Halifax I have concluded to omit until a new digest of our knowledge of the subject can be prepared, so much information having been obtained in reference to the habits of our fishes since 1877 as to render it obsolete.

ring in great numbers, so that a few men, with proper apparatus, can capture a large number of pounds in a day. The salmon and shad may perhaps be included in this group.

c. Pelagic fish.—These consist largely of species belonging or allied to the mackerel family, and, next to the group just mentioned, furnish the most important supply of food. The prominent members of this group are the common mackerel, the bluefish, the menhaden, the swordfish, the bonito, and other kinds. Sometimes members of this group are found hundreds of miles from the land; at others they come close inshore, either in pursuit of food or for purposes of reproduction, when they can be taken from the shores or in nets. They, however, appear to be continually on the move, showing more or less at the surface, remaining in proximity to the shore during the warm season, then disappearing during the winter.

d. Deep-sea fish.—This constitutes a group, of which until within a few years very little was known, occasionally being found floating at the surface either dead or dying, or caught at great depth on cod or halibut lines. It is only within a few years, or since the labors of the Challenger and other vessels, provided with apparatus for fishing at great depths, that the number of species has been realized. While some of the fishes belonging to the second section occur not unfrequently at depths of many hundreds of fathoms, such as the cod, halibut, hake, &c., very few of this fourth group are taken in waters of less than 100 fathoms, and thence to 1,000 and even to 2,900 fathoms, by the Challenger. This group is of little ecomomical value, especially on account of their small size and apparently scant numbers, even apart from the practical difficulty of their capture, although it is not at all impossible that there may be edible species sufficiently large and abundant to be worth pursuing if they were more within reach.

The status of fish in the sea is very largely determined by the question of temperature. This, however, will be considered more definitely under the next head of the migrations and movements of fish as influenced by various causes.

MIGRATIONS AND MOVEMENTS.

The human race is more concerned in the movements and migrations of fish than in the question of their permanent abode. It is when they are aggregated in large bodies, and moving from place to place, either under the stimulus of search for food or other causes, that they furnish the best opportunity to man for their capture and utilization.

Little is known of the salmon, the shad, the herring, the menhaden, the mackerel, and the bluefish during a large portion of the year; but at certain periods these species collect in large bodies, and by a change of place come within the reach of their relentless pursuer—man. On the other hand, the *Gadidæ*, the cod, especially, and the halibut, are within reach throughout the greater part of the year, either on the offshore banks while feeding or inshore when spawning.

The movements and migrations of fish are of two classes; the one irregular and occasional, the other regular. The irregular migrations are such as occur only at long intervals, sometimes altering very materially the industrial and social conditions of maritime countries.

Among the most notable illustrations of irregular migrations, we may cite the case of the bluefish, which during the past century was a well-known inhabitant of the eastern coast of the United States, occurring in great abundance and of large size. This species appears regularly on our eastern coast in the spring and leaves in autumn; but some time after the middle of the last century it disappeared entirely, according to the histories of the time, and was not seen during the present century until much of it had passed by, having been absent for a period of about fifty years. Of course it is possible that it may have occurred in small numbers, but not sufficient to make any impression; at any rate, on its reappearance in 1825 or 1830 it was entirely new to all the fishermen.

Another case is that of the chub mackerel (*Scomber pneumatophorus*). This, twenty years ago, was extremely abundant and was taken in large numbers at the same time with the common mackerel; but of which in later years only occasionally individuals have been captured. I have succeeded in securing only one or two specimens since the commencement of the operations of the United States Fish Commission, although every effort has been made to obtain them.

A European member of the mackerel family is extremely capricious in its movements. It is the *Caranx trachurus*, or the scad, a well-known fish of the Mediterranean and of the European coast generally. This sometimes sweeps down in immense numbers upon the shores of regions where it was previously unknown, or where it has not been seen for many years; a notable instance of this occurring in 1862, when immense numbers made their appearance on the coast of Bergen and in the Shrange Fiord, furnishing occupation in their capture and preparation to a large population; but scarcely was it at all known except in straggling specimens before or since.*

The causes of these variations in distribution are entirely unknown; whether the fish have been exterminated by some disease or pestilence (as suggested in the case of the bluefish), &c., cannot be ascertained. Various changes in the number of herring on the coast of Northern Europe have been of a similar character. These have been more especially important as influencing the condition of the population of Norway and Sweden and other northern countries. On the coast of Sweden herring were formerly in enormous abundance, sustaining a large population along the shores, but have disappeared for decades. It is with the regular migrations of the fishes of our coast that we have at present most to do, and I shall proceed to consider them under several headings.

* Baars, Des Fischerein Industrie de la Norwége, 1873; p. 158.

The regular migrations of fishes are for the most part dependent, 1st, on the instinct of reproduction which causes them to seek grounds and regions more suitable to the purpose, especially so far as relates to a safe abode for the young during the earlier months of their life; 2d, the search for food; 3d, the influence of temperature, a most potent factor. A fourth agency is the pursuit of predaceous fishes, although this is generally much more restricted in its operations than the others The pursuit of fish by man has doubtless some effect, but this is exhibited more in a reduction of numbers by actual destruction of parent fish or their eggs and young than by causing a definite change of place.

I have already grouped the marine fishes provisionally according to their relations to the shores and sea-bottom. Their migrations involve a temporary change in their relations, offshore fish coming in to the coast or even ascending rivers. We may, however, arrange fish by the migrations and movements into the following groups:

(1) *Anadromous fish.*—Species passing most of their time in the ocean, and when mature entering and ascending fresh-water rivers and lakes for the purpose of depositing their eggs; the young fish remaining for more or less time, and then descending to the ocean and there attaining their full growth, probably not going very far from the mouth of the river which they thus descend. The more important species in this connection are as follows:

The Sturgeon (in part).
The Salmon.
The Smelt.
The Shad.
The Alewife.
The Tailor Shad.
The Gizzard Shad (?).
The Striped Bass (in part).
Various species of Cyprinidæ.
The Lamprey Eel.

A somewhat similar condition occurs entirely in fresh-water, where certain species which spend most of their time in larger or smaller lakes pass at the breeding season into the streams empying therein, to lay their eggs on the gravelly ripples. This is the case with nearly all the *Coregoni* or whitefish, the landlocked salmon, and smelt, the *Salmo oquassa*, or Rangeley trout, the brook trout, &c. Whether the fish ever *descend* into an outlet is an interesting problem.

Among the fish of this group we find species of great economical value, embracing as it does some of the finest table-fish, and sometimes in overwhelming abundance. They appear with great regularity in the mouths of rivers, ascending them to their very source, or at least until stopped by some impassable obstruction. They present a great advantage over the sea fishes so far as man is concerned, in the greater facility of capture. This pursuit is prosecuted with little comparative risk and exposure, while any one with a line, or a net of simplest construction, and a small boat, or even from the shore, can secure an abundant supply of food.

It is among the anadromous fishes that man in a savage or semi-civilized state finds his most copious supply of food, depending sometimes almost entirely upon it for subsistence through the year, eating it fresh during the run and dried or smoked the rest of the time.

The most prominent fishes under this head belong more especially to groups of the salmon, the herring, the shad, and the sturgeon. It is in the temperate regions of the northern hemisphere, so far as I am aware, that the anadromous habit is seen in its grand development.

No better illustration of the numbers in which anadromous fish enter the rivers can be given and the extent of diminution of the supply from various causes, hereafter to be referred to, than a presentation of the case as it relates to the Potomac River in the short distance between its mouth and the Great Falls of the Potomac, only twelve miles above Washington. Although this stretch of water is even now very productive, and annually becoming more and more so, as the result of careful propagation, many years will elapse, if ever, before it gets up to the measure of yield mentioned by Martin in his History of Virginia,* a work published in 1835. It is proper to say that some old fishermen along the river deny the accuracy of his statements in their detail, but admit that the numbers taken were enormously in excess of the present yield. I give, however, the statement, allowing it to speak for itself:

"As Alexandria is the shipping port of the District of Columbia, and one of the principal marts for the immense fisheries of the Potomac, it may be well to mention that in the spring of the year quantities of shad and herrings are taken which may appear almost incredible. The number of shad frequently obtained at a haul is 4,000 and upwards, and of herrings from 100,000 to 300,000. In the spring of 1832 there were taken in one seine at one draught a few more than 950,000 accurately counted. The prosecution of the numerous fisheries gives employment to a large number of laborers, and affords an opportunity to the poor to lay in, at very reduced prices, food enough to last their families during the whole year. The shad and herrings of the Potomac are transported by land to all parts of the country to which there is a convenient access from the river, and they are also shipped to various ports in the United States and West Indies. The lowest prices at which these fish sell when just taken are 25 cents per thousand for herrings and $1.50 per hundred for shad, but they generally bring higher prices, often $1.50 per thousand for the former and from $3 to $4 per hundred for

*A new and comprehensive gazetteer of Virginia and the District of Columbia, containing a copious collection of geographical, statistical, political, commercial, religious, moral, and miscellaneous information, collected and compiled from the most respectable and chiefly from original sources, by Joseph Martin. To which is added a history of Virginia from its first settlement to the year 1754; with an abstract of the principal events from that period to the independence of Virginia, written expressly for the work by a citizen of Virginia. Charlottesville, published by Joseph Martin. Moseley & Tompkins, printers, 1835, page 480.

the latter; in the height of the season a single shad weighing from 6 to 8 pounds is sold in the market of the District for 6 cents. Herrings, however, are sometimes taken so plentifully that they are given away or hauled on the land as manure for want of purchasers." Some idea may be formed of the importance of these fisheries from the following statement:

Number of fisheries on the Potomac, about	150
Number of laborers required at the landings	6,500
Number of vessels employed	450
Number of men to navigate these vessels	1,350
Number of shad taken in good season, which lasts only about six weeks	22,500,000
Number of herrings under similar circumstances	750,000,000
Quantity of salt required to cure the fish ..... bushels	995,000
Number of barrels to contain the fish	995,000

In further illustration of the former extent of the fresh-water fisheries of the Potomac River, I give an extract from Burnaby's Travels in North America, referring more particularly to the sturgeon, although incidentally to the shad and herring.* At the present day the yield of these fisheries has decreased enormously, although enough are left to encourage the hope of a great improvement whenever the proper means for protection and the artificial propagation of fish are entered upon.

In the year 1873 the shad, herring, and bunch fish caught in the Potomac and sold in the Washington market amounted to 8,541,851 pounds; in 1874 the total sales at Alexandria, Washington, and Georgetown, from the same river, amounted to about 16,122,533 pounds, a by no means indifferent presentation.

(2) *Catadromous fish.*—Species of fish which are born in the sea, ascend the rivers and reach their maturity in two to four years, and then, when mature, descend to the ocean to spawn, and possibly never leave it again.

The Eel is the only species to which we can at present assign this peculiar habit.

(3) *Inshore fishes*, more especially fishes found inshore during the summer season, coming in apparently to breed. They are more or less closely related to the bottom, seldom or never schooling at the

*In the first report of the U. S. Fish Commission I have given numerous quotations from early authors in reference to the abundance of various fishes in the rivers and along the coast of the United States. Burnaby (Travels through the middle settlements of North America in the years 1759 and 1760, London, 1775), in speaking of the Potomac River, remarks as follows (on page 9): "These waters are stored with incredible quantities of fish, such as sheepsheads, rock-fish, drums, white-pearch, herrings, oysters, crabs, and several other sorts. Sturgeon and shad are in such prodigious numbers that one day, within the space of two (2) miles only, some gentlemen in canoes caught above 600 of the former with hooks which they let down to the bottom and drew up at a venture when they perceived them to rub against a fish; and of the latter, above 5,000 have been caught at one single haul of the seine." It is probable that the seines used in the Potomac waters over a hundred years ago were much smaller than those now employed, one of one hundred yards being, doubtless, of remarkable magnitude.

surface, and are generally most abundant within a few miles of the shore. These include a great variety of fishes on the American coast, confined for the most part to the United States and the region south of Cape Cod, which do not enter fresh waters, but are found, during the summer season at least, and are most abundant near the shore or on particular spots not far distant.

So far as we at present know, our information, however, being extremely imperfect, they come in regularly from the deep waters of the ocean, probably from the western edge of the Gulf Stream, in the spring of the year to spawn, remaining until fall. A few, as cunner and tautog, can be found at almost all seasons of the year. The rest, however, retrace their steps to spend the winters in the warmer depths outside, probably along the edges of the Gulf Stream.

The principal fish of this group are as follows:

Series 1.	*Series* 2.
The Scup or Porgy,	The Sheepshead,
The Squeteague or Weakfish,	The Lafayette,
The Sea Bass,	The Drum,
The Sea Robin (*Prionotus*),	The Whiting,
The Tautog,	The Kingfish,
The Cunner,	The Red Snapper,
Certain flat-fish,	The Red Bass,
The Dogfish and other Sharks.	The Pompano,
	The Mullet.

Of these the members of Series 1 are known to come in immense schools in the early spring on the south coast of New England, and are taken extensively in traps, pounds, and wiers. The movements of Series 2 are less well defined. They make their appearance on the coast in gradually increasing quantity, although farther south they are found in moderate numbers throughout the whole year.

There are two dogfish taken, one, the spinous dog (*Acanthias americanus*), coming first in enormous numbers, the livers furnishing a large supply of oil; the other, the smooth dog, succeeding it in smaller numbers. The spinous dog scarcely belongs to this section, as it does not remain inshore during the summer south of Cape Cod, although abundant north of it. It might be placed with the pelagic fishes but for not showing at the surface. It, however, appears more in enormous schools along the coast during spring and fall, and is very obnoxious to the fishermen, as all fishing becomes unproductive whenever the dogfish make their appearance.

An analogous movement is seen in certain fishes of the Great Lakes, as the salmon or lake trout, whitefish, &c., which, while residing for the greater part of the year in the deep waters where they are more or less undisturbed, during the spawning season (in the autumn) come inshore, especially the whitefish, and are taken in immense numbers by

the traps and pounds. The white fish exhibit a very decided tendency to enter the mouths of rivers on this occasion, especially in Lake Superior and Hudson Bay. Detroit River is an especially favorite spawning-ground. Indeed, the whitefish might with eminent propriety be classed among the anadromous fish of the fresh waters, like the land-locked salmon, the blue-back trout of Rangeley Lake, &c. The spawning along the shores of lakes at all may be due to their being barred out from the rivers by artificial or other obstructions.

We may possibly place in this schedule the Capelin (*Mallotus villosus*), which is exclusively northern, and the Tomcod, although the latter sometimes enters fresh water to spawn, and may almost be entitled to a position in the first division, perhaps near the smelt.

(4) *Offshore fish.*—Not schooling at the surface; usually spawning in the deep seas, for the most part during the late autumn or winter, though generally resorting to rocks and banks, and sometimes near the shore for the purpose; never swimming at the surface, and their presence only to be determined by actual capture. During the winter they range considerably farther south than in summer. Of these may be mentioned the cod, the hake, the haddock, and most other *Gadidæ* except the pollock. The pollock, belonging to the cod family, is more of a surface fish, and is very often seen swimming or schooling near the top of the water. In some respects the halibut belongs in this division.

(5) *Pelagic or wandering fish.*—Usually surface swimmers, and for the most part regular migrants in large bands or schools from north to south in autumn and from south to north in spring; not at all regular, however, in their movements, and sometimes, for one cause or another, disappearing gradually or suddenly from a certain region, not to return again until the lapse of many years. Some, as the herring, the bluefish, and the menhaden, are autumn and winter spawners; the others lay their eggs, as far as we know, in summer or spring. It is among the fish of this group that we find, with the exception of the *Gadidæ*, the most important of all the sea fish in the entire northern hemisphere, whether we consider the number of fish taken, their excellence and high price, or the amount of capital and number of hands employed in their capture. They belong almost exclusively to the *Clupeidæ* (the herring family) or to the *Scombridæ* (the mackerel family). Two species of the former group, the shad and the alewife, have been fully considered under the first head, while no species of the second family belong elsewhere. The principal species are the following:

The Sea Herring.	The Cero.
The Menhaden or Pogy.	The Bonito.
The Common Mackerel.	The Tunny or Horse Mackerel.
The Chub Mackerel.	The Swordfish.
The Spanish Mackerel.	The Bluefish.

(6) *Deep-sea fish.*—We have already referred to this group under the head of relationships. How far they can be considered as migrants is

to be ascertained. It is probable that they change their locations but seldom, living as they do at great depth, where the prevailing low temperature (30° to perhaps 45°) is thought to vary but little.

Until within a few years little has been known of this group, the researches of the Challenger having been principally instrumental in showing its extent, variety, and the remarkable peculiarities of its different members. Many species have also been revealed to us by the contributions of the Gloucester fishermen to the U. S. Fish Commission.

Probably the only important factor in influencing the change of situation in this group of fishes is the search for food or the pursuit by fellow fish, cephalopods, &c.

In addition to the regular, periodical, or occasional movements of fish just referred to, there are cases in which the change of location is not so easily explained. Among these may be mentioned the selection of a fresh-water abode by species which are generally exclusively marine, and *vice versa*. Of course, the change in anadromous fishes is intelligible; but why such fishes as the sawfish, shark (*Pristis*), the sting-ray, and quite a number of other kinds should live and apparently thrive in fresh water, is not so easily understood. Other species are found up rivers to a considerable distance from their mouths beyond the brackish portion.

HIBERNATION.—Another subject which may be considered in connection with that of migration and movements is that of hibernation.

Many fresh-water fishes, such as carp and others, are known to bury themselves in the mud, either partially or entirely, during the cold weather, and to remain there until the warm season of the year. This is also the case to a greater or less extent with the eels, both in fresh water and on the coast. To what extent other kinds of strictly marine fish exhibit the same habit is at present difficult to determine. The disappearance from our coast during the winter season of the mackerel, menhaden, and some other species has given rise to the belief by some that they bury themselves in the mud at suitable places off the coast. Indeed, there are not wanting statements to the effect that mackerel have been speared in the mud by persons who were attempting to capture eels in this well-known method. Some of these instances appear to be fairly well substantiated; but whether they represent anything like a permanent condition it is now difficult to say. Those who believe in the hibernation of mackerel point to the existence of a film over the eye on the first appearance of this fish in the spring, which they suppose to be the result of the long exclusion of light or of contact with the mud, this film going away in the course of the summer.

The sturgeon is believed to be a hibernating fish to some extent.

Having thus considered the better marked movements of fishes under their different heads, I now propose briefly to consider the causes of such movements so far as we can understand them.

PHYSICAL CAUSES.—The more regular changes of position with the

seasons are caused by the reproductive instinct, by conditions of temperature, and by search for food. They are also to a less degree affected by the pursuit of predaceous fish and other fellow occupants of the ocean and by the action of man.

Temperature of the water.—The most important of these agencies is probably that of temperature; since while there are certain species that appear to be quite insensible to considerable variations in this respect, the distribution of others is largely dependent upon the degree of heat in the water. Certain fishes, such as the cod and herring, are to be taken only in cold water, the herring usually at a temperature not exceeding 50° to 55°; the cod at a still lower degree. This relationship has an important bearing upon the herring fisheries; since, when the heat of the surface water is above the degree indicated, herring are seldom seen; as this decreases they make their appearance. This is so well established that now the herring fishery on the coast of Scotland is largely regulated by the temperature observed, and when it is decidedly above 55° the herring are not looked for.

On the coast of the United States there are two well-defined regions, one bounded to the south by Cape Cod and the other having this boundary as its northeastern limit. A few stragglers may be found occasionally on either side; but practically the cape constitutes the boundary line.

As a general rule the winter temperature of the ocean at different points along the New England coast is about the same, the surface water as well as that at the bottom showing the minimum degree down to absolute freezing. During this season, therefore, all the more delicate fish leave either to go south or off the shore until they find the temperature they require; possibly, however, not until they reach the edge of the Gulf Stream. The summer temperatures, however, vary extremely, and these variations are accompanied by the presence or absence of fish of different kinds. On the south side of New England the warmest temperatures observed were in Peconic Bay, where, in August, 1874, the bottom temperature was from 71° to 72½°, the surface temperature in one instance being as high as 74°. Here the same southern types of marine animals were predominant.

At Wood's Holl, in 1873, the mean temperature at the bottom in June was 61.7°, and in July 69.5°, and in August 70°, or an average of 67°. The surface was sometimes a few degrees higher.

Elsewhere on the south side of New England the bottom temperature ranged from 61° to 65° off the coast of Connecticut, in from 4 to 20 fathoms; in rather deeper water from 58.5° to 64°. Off Cox's Ledge it was 50° at 52 fathoms in August, and off several miles northwest of Block Island it was 45.5° at 47 fathoms, this being accompanied by a somewhat different fauna. In general, we may say that south of Cape Cod, while the inshore surface of the water during midsummer ranges from 62° to 70°, at a greater distance outward, up to perhaps fifteen or twenty miles, it ranges from 62° to 68°, and that at the bottom, inside

the northern current that sweeps around the outside of Cape Cod and No Man's Land and into Fisher's Sound, the temperature inshore ranges from 61° to 70°; more offshore, it ranges from 60° to 64°. But in the colder water about Cox's Ledge and off Block Island and in certain parts of Fisher's Sound, it ranges from 45° to about 50°.

At Portland there is quite a different condition. The maximum temperature was observed inside of Casco Bay, where the range was from 57° to 65°, and outside from 50° to 59°. The bottom temperatures during the summer inshore were from 54° to 56°, and in the deeper waters of Casco Bay from 45° to 49°. Farther east and in the Bay of Fundy still lower degrees are shown.

The following table of temperatures actually observed along the coast at different times of year will be of interest. It is compiled from observations made by the U. S. Signal Service as a matter of special cooperation with the work of the U. S. Fish Commission.

Absolute highest and lowest temperature of water at the bottom at 3 p. m. during the year ending February 28, 1877.

Place of observation.	Spring.				Summer.			
	Highest.		Lowest.		Highest.		Lowest.	
	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.
Indianola, Tex	Apr. 23	78.0	Mar. 21	57.0	.....	.....	.....	.....
Galveston, Tex	Apr. 30	79.0	Apr. 2	62.0	.....	.....	.....	.....
Mobile, Ala	May 4	68.0	Mar. 22	54.0	July 20	88.0	June 10	70.0
Punta Rassa, Fla	May 22	87.0	Mar. 21	67.0	July 17	93.0	July 31	79.5
Key West, Fla	May 3	84.8	May 24	57.0	June 24	90.0	Aug. 22	76.0
Jacksonville, Fla	May 22	84.0	Mar. 21	62.0	July 14	90.0	June 12	81.0
Savannah, Ga	May 30	73.0	Mar. 22	53.0	Aug. 20	86.0	June 15	69.0
Charleston, S. C	May 30	77.0	Mar. 22	54.0	Aug. 20	88.0	June 15	75.5
Wilmington, N. C	May 29	76.0	Mar. 3	51.0	July 19	87.0	June 10	74.0
Norfolk, Va	May 30	73.5	Mar. 4	44.0	.....	.....	Aug. 27	70.0
Baltimore, Md	May 28	71.0	Mar. 3	38.0	July 11	80.0	June 1	72.0
New York, N. Y	May 29	58.0	Mar. 1	32.0	July 20	75.0	June 1	55.0
New London, Conn	May 30	57.0	Mar. 2	34.5	Aug. 13	76.0	June 1	54.0
Wood's Holl, Mass	May 28	57.0	Mar. 1	30.0	July 6	70.0	June 1	58.0
Portland, Me	May 30	50.0	Mar. 1	31.5	Aug. 15	64.0	June 6	49.5
Eastport, Me	May 31	40.5	Mar. 18	31.0	Aug. 15	51.0	June 9	40.0

Place of observation.	Autumn.				Winter.			
	Highest.		Lowest.		Highest.		Lowest.	
	Date.	Temp.	Date.	Temp.	Date.	Temp.	Date.	Temp.
Indianola, Tex	.....	.....	.....	.....	.....	.....	.....	.....
Galveston, Tex	.....	.....	.....	.....	.....	.....	.....	.....
Mobile, Ala	Sept. 5	88.0	Nov. 1	57.0	Dec. 1	55.0	Jan. 9	40.0
Punta Rassa, Fla	Sept. 2	91.5	Nov. 26	68.0	Jan. 23	76.5	Dec. 5	52.5
Key West, Fla	Sept. 1	89.0	Nov. 11	65.0	Dec. 24	84.0	Dec. 6	45.0
Jacksonville, Fla	Sept. 2	89.0	Nov. 11	64.0	Jan. 20	64.0	Dec. 7	45.0
Savannah, Ga	Sept. 2	87.0	Nov. 27	52.0	Jan. 21	58.0	Jan. 5	37.0
Charleston, S. C	Sept. 3	84.0	Nov. 26	55.0	Feb. 3	55.0	Jan. 1	42.5
Wilmington, N. C	Sept. 1	83.0	Nov. 29	51.0	Jan. 22	51.0	Jan. 4	35.0
Norfolk, Va	Sept. 1	80.0	Nov. 29	46.5	Dec. 1	45.0	.....	.....
Baltimore, Md	Sept. 1	78.0	Nov. 30	45.0	Dec. 1	45.0	.....	.....
New York, N. Y	Sept. 1	72.0	Nov. 30	39.0	Dec. 1	38.0	.....	.....
New London, Conn	Sept. 1	72.0	Nov. 30	46.5	Dec. 1	45.0	Jan. 6	33.5
Wood's Holl, Mass	Sept. 1	70.0	Nov. 30	39.0	Dec. 1	38.0	Jan. 1	29.0
Portland, Me	Sept. 2	58.0	Nov. 26	41.0	Dec. 6	42.0	Jan. 16	29.0
Eastport, Me	Sept. 29	51.5	Nov. 26	43.5	Dec. 1	43.5	Dec. 26	27.0

The capture during the summer and autumn of fishes of the southern coast as far east as Long Island Sound, Vineyard Sound, and Buzzard's Bay, is not a matter of surprise.

The influence of temperature upon the movements of fishes, as already stated, is seen both in different parts of the coast and at different altitudes in the same region.

Oceanic currents also have more or less influence upon the distribution of fishes. This, however, depends more upon the pursuit by them of the less independent algæ, jelly-fish, crustaceans, ascidians, &c., that float hither and thither with the tide.

The apparent clearness of the water is also a factor in this consideration, various species preferring one extreme or the other, and coming inshore or near the surface with this variation.

The temperature of the atmosphere probably influences the movements of fish only so far as it affects the temperature of the water itself, the surface strata being, of course, heated or cooled very readily with variation of the air in this respect. The clearness of the sky and the consequent amount of light has a very decided influence on some fishes, especially the pelagic species, invertebrates too being affected in a similar manner. A bright sunny day will frequently call up forms that are never seen at any other time, while others again only approach the surface on cloudy days or even in the night exclusively. The action of the winds of the ocean is also to be considered in this connection, although possibly more is due to local currents as affecting the water than anything else. It is not impossible that variation in temperature may have great influence upon some fishes provided with air-bladders, by which the depth of immersion can be conveniently graduated.

In what way the influence of aerial currents or winds are felt by fish is difficult to say. Von Frieden, however, as the result of a comparison between the actual catches of herring by the German fishermen and the records of the corresponding days and hours, has come to the conclusion (Circulaire des Deutschen Fischerei-Vereins, 1874, p. 200) that the best results always followed with the wind from the northwest, and that generally northern winds were better than southern, and western better than eastern.

THE REPRODUCTIVE INSTINCT.—It is under the stimulus of the reproductive instinct that many of the more notable movements of fish take place, although by what prescience they are enabled to understand that the interests of their progeny require a change of abode, and especially from salt water to fresh, it is, of course, impossible to explain. The anadromous movements, or the ascent of rivers by salmon, shad, and fresh-water herring, &c., all in countless myriads, and with almost unerring regularity, are notable examples. It was formerly supposed that these fish moved in great bodies along our coast, sending off detachments into the mouths of the rivers as they went by. The more rational hypothesis now is that they live in the deeper waters of the sea

in nearly the same latitude as the mouths of the rivers in which they were born, and return to them at the proper season. The young remain in the fresh water for a time, the period varying with the species, after which they also follow their parents in their return to the sea.

The movements of what we had previously designated as inshore and pelagic fish are also largely connected with the same reproductive instinct, and even the fishes of the Banks illustrate it to a greater or less degree.

SEARCH FOR FOOD.—Next, perhaps, to the influence of reproduction comes the search for food as influencing the migration and movements of fishes, certain species of fishes following up particular forms of other fishes, the attempts of which to escape fall under the same category; or of the lower animals, as they are carried almost unresistingly by winds and currents in various directions. A notable illustration of this is seen in the herring.

Professor Möbius, in investigating the food of the herring in the German seas, found that a certain copepod shrimp, one of the *Entomostraca* (*Temora longicornis*), was more eagerly sought after than anything else; this being so minute, however, that 18,000 were taken from the stomach of one herring and 60,000 from that of another.*

Professor Möbius thinks that the comb-like fringes attached to the gills of the herring serve as tangles in capturing these shrimps, precisely as do the similar apparatus of the basking shark and the whalebone of the whale. These specimens were obtained in February of 1872, when both the shrimp and the herring were in exceptional abundance; and he subsequently observes that the same relations were found continually, the abundance of the herring being in strict proportion to that of the shrimp.†

The chain of connection does not cease in the relation between the *Temora* or shrimp and the herring. A great variety of sea birds, gulls, gannets, &c., follow up the herring, as also numerous mackerel, tunnies, blackfish, swordfish, and even whales and porpoises, which devour the herring in countless numbers. The movements of the capelin in the North Atlantic influence very largely those of the cod and other species, as when the former come into the shores of Newfoundland and elsewhere in immense numbers to deposit their eggs on the beach, the cod, &c., follow, and are then captured within a very short distance of the shore.

DRIVEN BY ENEMIES.—A notable instance of these relationships is seen in the menhaden and the bluefish. The menhaden, in its movements along the coast, is very frequently accompanied by vast schools of bluefish, which, as already explained in a previous report, probably destroy more menhaden in a day than are taken by man in a whole sea-

* Circulare des Deutschen Fischerei-Vereins, 1873, p. 112.
† Circulare des Deutschen Fischerei-Vereins, 1874, p. 90.

son's fishing. This is not unfrequently illustrated in the driving ashore of the menhaden by the bluefish in immense masses, while the bluefish themselves in their ardent pursuit are stranded at the same time. A similar pursuit of the mackerel by the bluefish is often noticed. The bluefish themselves are, by an act of retributive justice, pursued and driven ashore by schools of porpoises and horse-mackerel or tunnies.

HUMAN AGENCIES.—The influence exerted by man in determining the abundance or the movements of fishes, apart from their actual capture, is manifested in various ways, although more particularly in the case of the anadromous fishes than any other. Whenever any impassable obstruction is laid across a river, ascended by anadromous species, as shad, salmon, &c., for the purpose of reproduction, the exclusion from their breeding grounds has very soon a marked effect. Usually, for the first two or three years not much difference is appreciable, as these species require three or four years to mature after passing down the river before they return to their starting point. There will therefore be three years of successive returns of schools, and after that there will be no young fish to keep up the supply, which will be confined to the older individuals returning in the vain attempt to find spawning beds. At the expiration of six or eight years the supply will probably cease entirely, and there will be no further run in the river. In this event the remedy is the removal of the obstructions by taking down the dams or barriers, or introducing a fishway, and planting the young fish above the former obstruction; at the end of three or four years the mature individuals will make their appearance again.

Nets constitute an obstruction of less moment than dams, since they are of temporary application and constantly liable to be torn or destroyed by the elements, or removed by legal enactments.

The disappearance of fishes to a greater or less degree from certain localities has frequently been ascribed to such agencies as the sound from the paddles of steamboats, the firing of cannon, &c. How far this is of any moment remains to be seen. A variation in abundance of fish is not unfrequently caused indirectly by man in destroying or fostering predaceous species. It has not unfrequently happened that one species of fish has greatly multiplied in consequence of the capture by man of some special enemy. There is no doubt whatever that the number of bluefish caught during the summer season for market purposes permits a vast increase in the number of menhaden, scup, sea bass, and other fishes which would otherwise be devoured.

Many such cases could readily be adduced, and suggest extreme caution in the adoption of measures for protecting certain fishes from natural enemies, without a careful inquiry as to the possibility of indirect results not anticipated. A noticeable instance has been furnished by Mr. Whitcher, the distinguished commissioner of fish and fisheries of the Dominion of Canada.

He states that the *Beluga*, or white whale, is a great consumer of fish of all kinds, but is especially destructive to the salmon and cod of the Lower Saint Lawrence, the former particularly. Some distance up the Saguenay River, where the salmon were supposed to have been much injured by the *Beluga*, a license was taken out in 1872 for their capture, and in 1873 a large number (some sixty) were secured at one haul. In this way a very great diminution was effected.*

These have in turn reacted upon the fisheries, since the sharks, which had been kept down in point of numbers by the belugas, multiplied, or at least came in such numbers as, in their turn, to affect very seriously the fisheries, the fish being greatly diminished and those captured showing marks of laceration by the teeth of their new enemies. The increased abundance of the sharks was also shown by the much larger number of them captured in the nets.

Another statement of Mr. Whitcher still further illustrates the relation between the white whales and the salmon. It is well known that within a few years the salmon fisheries within the Dominion of Canada have been very greatly increased by the enforcement of legislation for the protection of fish during their spawning season, and for the increase of the supply by artificial propagation.

Another illustration of the same character, as also furnished by Mr. Whitcher, is to be found in the Bay of Chaleur. In former years the streams emptying into this bay abounded in salmon, but presented the usual appearance of salmon rivers in a marked decrease in numbers by overfishing and other agencies, and this continued for a period of a number of years. More recently, however, as a result of the wise legislation on the part of the Canadian Government of protection during spawning season, and the measures of artificial propagation, the fish are again found in very great abundance. For twenty years the white whales were not known in the Bay of Chaleur, or only by stragglers, but latterly they have returned in large numbers. The first year of their occurrence they came after the salmon had entered the bay and drove them into the shores, where they were taken in very large numbers by the traps and nets that had got a small capture in the lower parts of the rivers. The next year the belugas, or porpoises, came early in the season, before the salmon, and apparently awaited their arrival. They committed great havoc among them and cut them off apparently from the immediate shores.

*According to the report of the British Fishery Commission, p. xliv, at one time in consequence of the apparent diminution in the abundance of fish in Loch Fyne, one of the best known herring fisheries in Scotland, what was then considered a very destructive mode of fishing, by the circle-net, was interdicted for a number of years. It was found, however, that this had not produced the effect supposed, as the decrease of the fish continued for a time, and after the circle-net fishing was restored the fish again became as abundant as ever.

D.—NUMBERS AND ABUNDANCE OF FISH.

That fish of many varieties have decreased greatly in abundance within the historic period in all parts of the world is well established, the reduction in some cases being truly enormous. This, however, applies only to certain varieties, especially of the anadromous fish, or those running up the rivers from the sea to spawn, and to the more inshore forms. The most indubitable cases of diminution are those of the shad, fresh-water herring, salmon, and striped bass. On the other hand, there is no reason to suppose that the cod, mackerel, bluefish, and the sea herring have been reduced essentially, if at all, in numbers, the stock of these fishes being from year to year about the same, and an apparent diminution in one region being balanced by a greater supply in another.

In previous pages of this article, in illustrating another subject, I have referred to the difference in the numbers of shad and herring in the Potomac at the present time and in the past, an experience which is shared to a greater or less extent by all the rivers of the Atlantic coast. Many streams which formerly furnished a vast quantity of food, within easy reach, have now become entirely unproductive, so that it is only by a combination of measures of artificial propagation in the rivers and judicious legislative enactments that anything like the earlier experience can ever be again realized.

The causes of this variation in abundance, so far as they can be detected, may be considered under two heads: first, the natural, or uncontrollable; and, second, the artificial, or those connected with the interference of man. Where the former alone are responsible there may be a hope of a return to original abundance; man's influence acts persistently and with increasing effect throughout long continued years.

There are two classes of natural causes of variation: first, those induced by physical conditions; and, secondly, the dependence of the fish upon, or the relations of fishes to, their fellow-inhabitants of the sea. The action of man is either direct or indirect. The direct agencies are those of overfishing and the pollution of the water. The indirect consist of the obstructions to the movements of the fish, the disturbance of the balance of nature, by unduly fostering or destroying certain classes of animals, and by breaking up the schools of fishes during a critical period, and preventing their spawning.

We have already considered under the heads of migrations and movements of fishes the subject of variations in abundance, depending upon migration, or change of place, where, although the fish may be scarce in one locality, they are proportionally more abundant in another, the actual number in the sea remaining the same. At present we are considering the subject of diminution in actual number of fish. It will be more convenient to consider this subject of variations in the abundance of marine fishes under the next head, of dangers and fatalities, where I propose to go into more details.

E.—Their dangers and fatalities.

A general account of the fisheries of the North Atlantic coast of the United States is not to be completed without some mention of the agencies by which they are affected and reduced in abundance other than as the result of age. The variety of such influences is very great; perhaps more than in the case of the terrestrial vertebrates, and comparable only to the affections and influences upon insects, which, like the fishes, occur in overwhelming abundance at one time to be more than decimated at another.

We may consider the subject of the dangers and fatalities under three heads: first, those brought about by their fellow-inhabitants of the sea; second, by man; and, third, by natural or physical causes and changes.

1. From other forms of marine life.

The injuries caused by their fellow-inhabitants are twofold in their action: first, upon the eggs and embryonic fish, and second, upon the more fully grown fish. The destruction of the eggs of fishes is something truly enormous, the percentage of the yield of even the youngest fish from a given number of eggs being extremely small. It has been calculated, in the case of the salmon or shad, that not five eggs out of one thousand produce young fish, able to commence feeding, all the rest being destroyed in one way or another. It is quite likely that even this ratio is too large. A part of this loss of eggs is due, however, to imperfect fertilization, and it is here that artificial propagation has the advantage in securing the contact of the milt with all the ripe eggs, leaving an insignificant fraction not fertilized. Probably not half, and sometimes even much less than half, the eggs discharged experience the same fortune in natural spawning. It would seem as if the immense disproportion of eggs to the resulting fish was an intentional provision in nature, to furnish food to the small inhabitants of the sea, especially to the young fish themselves, of various species, no other bait being so attractive to fish, even to those that have just laid the very eggs used for this purpose. The size of the eggs varies very greatly with the species, as will be seen in a subsequent chapter, some being adapted to the smallest mouth, others requiring one of considerable capacity to take them in. There is almost no season of the year when fish eggs cannot be found in the water, either floating free or else adherent to some object, and the work of devouring them is carried on continually. Of course it is only the smaller fishes that pick up the small eggs; but the former, in turn, contribute to some of larger size, and those to larger again, until finally, in the sequence, the largest inhabitants of the sea obtain their proper food.

It is among the aquatic mammals that we find the most powerful destroyers of fish, these requiring a much larger amount in proportion

to sustain life, as they feed not merely for subsistence but for material to keep up the animal heat.

The cetaceans of various species are, of course, the most destructive by their much greater bulk, the larger of the porpoises being most notable in this respect. It is not unfrequently with feelings of satisfaction that the human spectator observes schools of bluefish that have devoured and driven on shore schools of mackerel and menhaden, themselves attacked and subjected to a similar treatment by troops of porpoises, forming a line outside of them and devouring them with extraordinary rapidity, frequently forcing them on the beach in large numbers. Whales, too, take their part in this conflict, but probably confine themselves to smaller fishes, especially the herring, and possibly mackerel, capelin, or other species, of which large numbers, while schooling can be taken at a gulp.

The method of feeding of the whale is, of course, only appreciable when the operation is conducted at the surface. Here they may be often seen (the finback whales especially), with the mouth wide open and swimming with great velocity against large bodies of herring and floating invertebrates, such as pteropods, jelly-fishes, &c. The greater the development of whalebone in the mouth, the less do the whales apparently feed on fish and the more on invertebrates. The finback is characterized by the small amount of whalebone. To what extent the sperm whale, which is essentially a large porpoise, feeds upon fish is not known; its principal food, however, is believed to be the giant cuttle-fish, which inhabits the depths of the ocean, with the largest of which it appears able to cope. It is very seldom that a sperm whale is captured without having in its stomach some fragments of this large cephalopod, the beaks being almost always found in their intestines and excrement. Ambergris almost always contains such remains.

Seals come next to the cetaceans in voracity and destructiveness, and occupy only a second place, in view of their more limited distribution and their confinement to a certain proximity to the land. The numbers of fishes, especially of the *Gadidæ*, doubtless also of salmon, devoured by the seals in the North Atlantic must be something almost beyond calculation, and the destruction on the part of the much larger seals, sea-lions, fur-seals, &c., of the Pacific is probably still greater.

How far the walrus is a destroyer of fish I am unable to say, although it is generally believed to depend, to a considerable extent at least, upon mollusca for food.

Otters are also worthy of mention in this connection, the sea-otter of the Pacific Ocean being very destructive in proportion to its size and numbers. The common otter also devours large numbers of fish in fresh water, levying tribute on many a fine salmon, shad, and other valuable fish.

Although at first sight we may not be inclined to attach much importance to birds as destroyers of fish, yet it is found that they repre-

sent by no means an insignificant factor in the casualties of the class. Every fish-culturist is painfully aware of the destruction of his trout, carp, or other fresh-water species by herons and kingfishers. The fish-hawks take their toll in the rivers and lakes, perhaps more rarely in the sea; but it is among aquatic birds, especially the gulls, the *Pelecanidæ* (including cormorants, pelicans, gannets, &c.), the *Alcidæ*, or auks, and some of the ducks that we find the most active oceanic enemies of the finny tribe. In many parts of the ocean the number of birds belonging to these groups is enormous, and even supposing that each bird devours daily only half, or even a quarter, of its weight (a by no means difficult feat), the amount of destructiveness is something quite appalling. It has been estimated that the gannets alone, on the coast of Scotland, devour more herring than are taken by man, their voracity, like that of the cormorant, being very marked. The gulls are less destructive, as they must confine themselves more particularly to the smaller fish which come to the surface, either spontaneously or as driven by predaceous fishes.

The reptiles probably contribute but little to the mortality among fishes in the open sea; but in lagoons and along the shores of islands, especially in brackish water, as well as in fresh, they play their part in the economy of nature. It is especially among the crocodiles, alligators, and caymans that this destructiveness is seen. The sea-snakes of the tropics and sub-tropics in all probability consume large numbers of fishes of such size as can be readily swallowed entirely. In fresh waters the various species of water-snakes also consume a considerable number. Some species of turtle are very destructive to fish, although it is more particularly in fresh water where such forms as the snapping-turtle of North America play well their part. The sea-turtles are said to be vegetable feeders rather than animal, seeking the eel-grass, algæ, and other plants. Probably, however, they do not disdain an occasional fish.

Frogs are also very destructive to fish in fresh water, and require a careful looking after by the fish-culturist. The salamanders are too diminutive to devour large fish, but probably consume eggs and young on a large scale. The *Menobranchus*, or large salamander, in the Great Lakes, is said to commit great havoc on the whitefish spawning-grounds, gorging itself on the eggs, and by the aggregate of their numbers largely reducing the crop of young fish.

The destruction of fish in the sea, as might naturally be expected, is greatest from fellow-fishes, the smallest being consumed by those a little larger, these again falling victims to the still more powerful, and so on until we reach such forms as the swordfish, the tunny, the largest sharks, &c., which apparently at least, when fully grown, are free from danger from their own kind. Here, however, there come in as antagonists and destroyers the larger cetaceans; possibly the giant cuttle-fish, and man; although such insidious enemies as the lamprey, the myxine, or hag, the pug-nosed eel, and other parasitic fish may even cause the very largest to succumb.

In most cases the fish is destroyed by being taken in at a gulp, by one of its fellows larger than itself, although there are certain forms, such as the *Chiasmodes*, the *Saccopharynx*, &c., which, in the possession of very wide jaws and a capacious stomach sac, can take in entire and digest fishes of twice their own size. Specimens illustrating this are to be found in the National Museum. In many cases, as with the sharks, bluefish, &c., the victim is lacerated, either torn or bitten in two. Fish like the sand-lance (*Ammodytes*), when swallowed alive, often burrow through the stomach and produce death. It is not uncommon for codfish to be taken with the sand-lance in the abdominal cavity, encysted and mummified, several specimens of these having been obtained by Captain Atwood, of Provincetown. The lampreys and myxines, already mentioned as destroying the very large fish, frequently do this still more extensively on the smaller ones. The so-called pug, nosed eel of the Gloucester fishermen (*Simenchelys parasiticus*) is not unfrequently found nestling along the backbone of the halibut and cod where they seem to have the power of abiding for some time without actually causing death. The eel is another of the fishes that destroy life in an unusual way. It is especially noteworthy in connection with gilling for shad, in view of its habit of fastening upon a ripe female, when meshed, and penetrating the abdominal cavity and devouring the eggs in its progress. It is a very common experience for the gillers to find perfectly sound, plump shad, taken in the net, with one and sometimes two or three eels in the abdomen, their destruction having been effected within a period of a few minutes.

It may safely be said that of oceanic fish more or less predaceous, there are many forms that live on vegetable substances while young, but for the most part changing to a carnivorous habit when old. How many species confine themselves exclusively to fish it is impossible to say, as a careful examination of the stomachs of most forms shows at least the occasional presence of crabs, worms, radiates, &c.

I have already referred to the subject of the rapacity of fish, under the heads of migrations and movements, and variations in abundance, &c. I would here simply call to mind the ravages of the bluefish in its attacks upon the mackerel, menhaden, and other species. Great as are these ravages, however, they are probably nothing in comparison with those of different species of the sharks. These, by their enormous size and immense abundance, must, of all oceanic forms, be the most destructive of fish life and constitute the largest factor in the element of mutual injury. Neither is it the largest of the sharks that are the most dangerous. The smaller forms, which come in large schools, migrating with the season, are most effectual in their agency. Every fisherman on the New England coast is familiar with the so-called dogfish (*Acanthias americanus*), a species which rarely exceeds 3 feet in length, but which frequently comes in on the fishing-grounds in countless num-

bers and renders the fisherman's life a burden by the destruction of his bait and the disturbance of the fish.

Holdsworth (Deep-Sea Fishing) refers to the finding of twelve full-sized herring in the stomach of a pollock, and from thirty to thirty-five in the stomach of a codfish. I have taken forty-seven scup of quite considerable size from the belly of a bluefish of about 5 pounds weight. Instances of this kind could be readily multiplied.

To what extent fishes are destroyed by invertebrates it is difficult to decide, although probably this agency is one of considerable moment. Many species are infested with entozoa or intestinal worms, which find a lodgment in the brain, in the muscles, or the viscera, and which must necessarily involve more or less of mortality. Others have external parasites adherent to them, consisting in larger part of crustaceans of greatly modified shapes. The free-swimming crustacea, as lobsters, crabs, &c., undoubtedly kill great quantities of fish. Their office seems to be more particularly that of scavengers to destroy the weakly or dead individuals. Certain of the jelly-fishes are known to feed on small fishes. It is quite probable that the squids and cuttle-fish live mainly upon fish. Enormous numbers of squids are found at certain times in certain waters, and represent undoubtedly great destruction among fishes. Many illustrations of this relationship could be multiplied, but the subject need not be continued, as I merely wish to show the general relationships.

How far fishes are affected by epidemics or other diseases it is difficult to say, although there are many instances on record in which this condition is assigned as the cause of their disappearance. It is said that the bluefish off the coast of New England were all exterminated by some disease shortly after the middle of the last century, their carcasses being found floating in enormous masses over the sea. Whatever may have been the cause of their absence it is very certain that the bluefish was not known again until about 1820, when they made their appearance gradually, of small size, but for many years in nothing like their original abundance. It is said that they were often known of such magnitude in the last century that fifteen would fill a barrel, representing a weight of 200 pounds when cleaned and dressed. Comparatively few such fish are now taken in Vineyard Sound.

Of late years there have been seasons, especially in the summer and autumn, when fish in the Gulf of Mexico have been found dead in immense numbers. The cause of this has not been ascertained, some ascribing it to actual disease, others considering it the result of some poisonous infusion or exhalations in the water.

2. THE INFLUENCE OF MAN.

A very large element in the aggregate of destruction of fishes by the agency of other animals is furnished by the fishing and fisheries, man deriving, in all parts of the world, especially near the sea-shore, a large

part of his food from the sea, and drawing upon it for supplying distant localities, or laying up stores for seasons when fish could not be readily obtained. These fisheries in the northern hemisphere are particularly extensive, a large portion of the population of both shores of the Atlantic finding extended employment in this vocation. The herring fisheries of Scandinavia, Holland, and Great Britain, and in less degree of British America and New England, the fisheries for cod and other *Gadidæ* in the entire North Atlantic, the capture of halibut, salmon, &c., are all included in this list. In the North Pacific Ocean the salmon and cod represent for the most part this industry. In the warmer countries of the world, although fish are perhaps absolutely as abundant as in the north, they can be used only for daily consumption, it being found almost impossible to salt or dry them for future use; and hence the anomaly of vast importation of cod, herring, and other salted and dried fish into Cuba, the West Indies, and South America, when these regions can show much better food-fish in countless abundance.

Great, however, as is the destruction of fishes by man in his various fisheries, it can easily be shown that it constitutes a very insignificant portion of the slaughter, when compared with what is effected by fishes themselves, and it may safely be said that the total of the fisheries of the North Atlantic and Pacific for the year does not equal the destruction, possibly in a single hour, by other causes.

We are apt to ascribe a very undue influence to human agencies in affecting the supply of fish by positive diminution or by direct extermination. That man does influence the supply to some extent may readily be conceded, especially in the case of the anadromous fish. The obstructions of rivers by dams are among the most important. The other agencies of poisoning the water by refuse from factories have little weight excepting in rivers, scarcely attaching to bays and shores. It is even a question whether, in some instances, man does really increase the food supply by the destruction of certain forms that are predaceous. Reference has already been made to the great problem whether the pursuit of the bluefish by the Gloucester fishermen on the eastern coast of the United States is attended by a further increase of the fish on which it especially preys, such as the menhaden, scup, weakfish, &c., and whether every shark and every porpoise killed by man also gives a new lease of life to a great number of fishes.

A movement now (1877) on foot promises to add another to the illustrations of man's indirect influence upon the fisheries in the disturbance of the balance of power. It has been ascertained that by treating fish with bisulphide of carbon or benzine the oil can be extracted much more easily than by the ordinary process, leaving, indeed, a residuum in the form of a dry powder. It is claimed that the by-product of oil is about 80 per cent. more than by the kettle or presses, and the dried scrap instead of yielding 10.5 per cent. of ammonia produces 14.

A building is now being erected at Wood's Holl (85 feet by 40, and

34 feet high) to practice the process, which will be in operation before the close of 1877, with the special object of making artificial fish-flour and dried powders for fertilizing purposes. In this process they expect to work up a great number of refuse fish, which they promise to purchase at the same price as menhaden and in the following order of preference: Bluefish, porpoises, sharks, dogfish, menhaden, and skates. They propose to work up twenty tons of fish each day, and to employ from one to three steamers to cruise for these supplies, extending from Block Island to the coast of Maine, touching all intermediate points.

The extent of destruction to fish caused by the porpoises, skates, and dogfish is well known, and should the anticipated manipulation of forty thousand pounds of refuse fish per day be accomplished, or say twelve millions per year (counting three hundred days to the year, and allowing ten millions of pounds for the destructive kinds), we shall have an enormous withdrawal of predatory fish from the scene of action. This aggregate might be considered as equivalent in destroying capacity to two millions of bluefish at five pounds each; and an estimate of the amount of fish that would be devoured by such a body has been given in my first report. If the success anticipated for this venture be realized, it is probable that other establishments of a similar kind will be started, constituting a still greater relaxation of the exhaustion of the yield of fish. A few years of such fishing should present a marked influence upon the supply of edible fishes along the middle and northern coast of the United States.

3. NATURAL CAUSES OR CHANGES.

Fish as a class are quite subject to fatalities arising from natural causes, and which sometimes operate on a very large scale. Among these, volcanic eruptions are not the least momentous. It very frequently happens that such phenomena from volcanoes near to or in the sea are accompanied by discharges of boiling water or of poisonous gases, which contaminate the waters and cause great distruction to animal life therein. Many cases of this character are on record as incidents in the history of volcanic discharges. Not unfrequently mud is thrown out in vast masses, which fills lakes and streams, or invades the edges of the ocean with disastrous consequences to life. Violent storms and hurricanes are also to be considered in this connection, fish being not unfrequently blown on the shores or taken up bodily and carried to a great distance inland. Sudden changes by winds and currents of the sea bottom not unfrequently cut off portions of the sea occupied by large bodies of fish, which, unable to get back to proper physical surroundings, soon perish. Very often, too, this action of the winds and waves renders the waters very turbid and unfit for animal life in the sea, which is consequently speedily destroyed. Of this, striking illustrations will be given in a succeeding chapter.

An excessive change of temperature, whether the change be to extreme heat or extreme cold, constitutes an important member of the agencies injurious to fishes. The latter phase, however, is the more dangerous, as while the fishes that belong to the colder waters of the ocean are but seldom exposed to an unnatural degree of heat, those of the South Atlantic and the Gulf Coast of the United States are frequently killed at once by a severe turn of cold weather, hundreds of tons of fish frequently perishing within a limited district. This is quite a common accompaniment in the fall and winter of the severe northers on the Texas coast. Similar cases of death by cold or freezing are often observed on the shores of the New England and Middle States, although usually not so marked in their presentation. It is, however, quite common to find in early winter numbers of scup, tautog, sea bass, and other species in a drying condition on the beach.

Fish killed by cold.—I find among some manuscript notes communicated to me by J. Carson Brevoort, esq., that in 1849 many fish were killed in Massachusetts by the cold, 60,000 pounds of striped bass having been taken from Polk pound, and 120,000 pounds from Newton pound, Martha's Vineyard, and sent to the New York market. He also records that on the 30th of September, 1844, the shores of Jamaica pond were covered with young pompanos, from 1½ to 5 inches in length, supposed to have been killed by the cold.

Dr. H. C. Yarrow reports that in the winter of 1870–1871, in the latter part of December, great numbers of drum, flounders, small mullet, trout, and spots were frozen at New River (a prolific fishing ground), 45 miles from Fort Macon. The trout, mullet, and flounders were piled on the shore knee high, and were carted all over the country as manure, selling at $1 per barrel.

The same thing happened a year or two later. Thousands of fish have been frozen at the same place. Almost every winter during the last ten years more or less of the food-fishes have been destroyed by cold.

In addition to the destruction of fish in large numbers by sudden chilling of the water, such as frequently takes place in the Gulf of Mexico and the eastern coast of Florida after a severe norther, many are killed by the action of anchor-ice. Thus, in the vicinity of Wood's Holl, Mass., young herring and other fish are often found in the winter time floating in vast numbers, and also imbedded in the ice which forms at the bottom and floats to the top.

OTHER FATALITIES.—A further example of the method by which large numbers of fishes and other inhabitants of the waters may have been destroyed simultaneously is given by Mr. Henry O. Forbes, of Aberdeen, Scotland, in his account of a visit to the Cocos or Keeling Islands in 1884. In this region, immediately after a cyclone, which occurred January 28, 1876, the water on one side of an adjacent lagoon was observed to be rising from a considerable depth and of a blackened color. It continued to flow for about fourteen days, had an inky

hue, and its smell was "like that of rotten eggs." This was diffused gradually around the lagoon, and passed into the ocean; and within twenty-four hours every fish, coral, and mollusk in the part impregnated with this discoloring substance died. So great was the number of fish thrown on the beach that it took three weeks of hard work to bury them in a vast trench dug in the sand.

It is supposed that this water was impregnated with hydro-sulphuric or carbonic acid. The statement is made that the corals and shells were deeply corroded, the corals, especially, being in many places worn down to the solid base. For a long time after the catastrophe there were no signs of life in the lagoon.

Precisely to what cause we are to ascribe the destruction of fish in the summer season, in the Gulf of Mexico, it is impossible to say. Here, without any apparent reason because of change of temperature or other physical condition, for a period of weeks together, myriads of fish, of all species, are found dying or dead, so much so that they drift ashore in vast numbers, threatening to create a pestilence. It appears that the cause, whatever it be, is disseminated in the water, as smacks loaded with living fish in their wells, intended for the markets of Key West, Cuba, or the north, when entering certain zones experience the loss of their entire cargo. It is possible that the fatality is caused by some algous or fungous plant, which exercises a deleterous effect upon animal life. The statement that the zones of dangerous water are differently colored from the main body, would strengthen this impression. One explanation is that the water from the Everglades, pouring into the Gulf, in some way exercises a deleterious influence.

As a general rule, of the fishes which perish from one of these causes or another, no matter how great the mass, it floats at the surface of the sea until decomposed and wasted, leaving but little in the way of definite remains.

In regard to the agency of physical causes in destroying immense numbers of fish simultaneously, under circumstances to involve their being imbedded and their skeletons thereby preserved, numerous illustrations can be adduced in modern times, as we have already shown. The eruptions of volcanoes along the sea-coast frequently discharge immense bodies of acid or heated waters into the sea that poison everything around them, the fish being imbedded in the mineral matter which accompanies the discharge, or covered up by the ordinary tides, or by the extraordinary currents produced by the same outbreak.

Another very frequent and important natural source of destruction to which we have just referred is in the sudden cooling of tropical waters by the "northers." These are frequently observed in the Gulf of Mexico, where, in the winter especially, the waters are frequently changed abruptly and to a very marked degree by the persistent blowing of an intensely cold and long continued wind from the north. This

in the regions west of the Gulf is usually accompanied by blinding snow and involves the destruction of man and beast; and on the sea-coast millions of fish of all kinds frequenting the shallower waters are killed. Not unfrequently these are blown ashore in great heaps, poisoning the atmosphere and sometimes constituting by their decomposition the alleged cause of the yellow fever and other serious diseases.

The most plausible explanation of the phenomena of the occurrence of fossil fishes in enormous numbers is suggested by Dr. A. Leith Adams, of the British army,* as the result of personal observation in New Brunswick. The occurrence took place at a small creek, called Anderson's Cove, a short distance to the east of the Magaguadavic River, which empties into the northwestern part of Passamaquoddy Bay, not very far from the town of Saint Andrews and from Saint Stephen. This cove is a lagoon of about 1,300 feet in circumference, into which a small stream enters and communicates with the sea, at high tide only, by a narrow channel. But in the vehement rush of the Bay of Fundy tides the water enters this lagoon with great force and stirs up the mud into a paste, which runs off slowly, at low tide. The incoming stream continually brings down a fresh supply of mud and slime.

On the 24th of September, 1867, a very heavy gale from the west blew directly into Anderson's Cove, disturbing the mud to an unusual degree. The same storm brought into the cove immense numbers of young herring, about six inches in length, with a few other fish, as mackerel and flounders. These, after the storm, were found washed up on the beach in great numbers, while the mud, which by this time had settled, was completely filled with them. The bottom of the lagoon was covered with a layer several feet in depth, the total amount of destruction being almost fearful to contemplate.

There is no reason to doubt that similar conditions, in earlier times, have given rise to some of the fossil deposits referred to.

Another of the natural causes of the destruction of fish is found in the numbers of certain fishes which are stranded when seeking the shallow waters for the purpose of depositing their spawn. Of these the capelin of Newfoundland and Gulf of Saint Lawrence is a notable instance, as it comes in close to the edge of the water in enormous numbers to deposit its eggs. Here the pressure of the continually succeeding schools is such as to force the fish in a body on the beach, this action being sometimes aided by high winds or heavy waves. Windrows of the fish are to be found on the beach, which are in large part carried away and used as manure on the fields. Many of these, of course, would become imbedded in the sand and mud, and constitute material for the investigation of the future geologist. It is in all probability to these circumstances that we owe the occurrence of the capelin as a Tertiary

*Field and Forest Rambles, or Notes and Observations in the Natural History of Eastern Canada. London. Henry S. King, 1873. p. 264.

fossil of the valley of the Saint Lawrence and of certain portions of Northern Europe.

The occurrence of fossil fish in immense numbers in certain geological formations has been a subject of much interest to the geologist and naturalist, and many hypotheses have been promulgated in explanation thereof. It is not at all probable that the ordinary casualties happening to fish would produce anything like the phenomena in question. It is believed that very few fish die of old age, the incidents of life in the sea being such that whenever any animal loses the ability to care for itself some enemy is ready to devour it. The accumulations referred to, found at Monte Bolca in Sicily, in Syria, in many parts of the United States, and elsewhere, probably result either from some mysterious disease attacking the fish in large bodies, or from some physical cause. There is but little evidence to prove the existence of serious epidemics among fish in the sea, although such an occurrence is not at all improbable. Even here, however, it is likely that there would be enough scavengers to devour the dead and dying almost as rapidly as they succumbed to the baleful influence.

One of the methods by which fish are destroyed in great quantities, and yet kept in a condition favoring their ultimate preservation, as in rock strata, consists in the sweeping of large schools, during storms, into low, shallow basins at the edge of the sea, where, of course, death will very soon ensue. The gradual concentration, however, of the water by subsequent evaporation, answers the purpose of a slow and careful salting of the fish, so that for a considerable time after the basin is dry the fish remain in a good state of preservation. If, as is probably often the case, sand and mud are swept in with the fish, and this is repeated at short intervals, a succession of strata with skeletons of fish and other marine objects may result.

A case of this kind has been mentioned to me by Lieut. Z. L. Tanner, U. S. N., who noted the phenomena during the cruise of the United States steamer Narragansett in 1872, at Christmas Island. The surface of the shallow basin inside of the beach was occupied by many hundreds and even thousands of fish, varying in length from a few inches to three or four feet, and preserved in perfectly good condition, the thoroughly cured flesh being, however, too strongly salted to be palatable.

F.—THE NATURAL FOOD OF SEA FISH.

The vegetable kingdom at sea, as well as on land, constitutes the starting point of all animal life, and whatever may be the extent to which animals devour their fellows, whether as adults, embryos, or eggs, there is no doubt that without the presence of plants in some form or other and their assimilation, the existence of animal life in the sea would be an impossibility. It is less easy, however, in the water than on the land to see the connection between the two kingdoms in this respect, especially as the most important element of the vegetable division is in

the extremely minute and more or less microscopic form of diatoms. These, however, swarm in all portions of the ocean and extend into its uttermost ramifications, occurring at depths of three or four thousand fathoms, or at the surface, and equally abundant in the middle of the ocean as on its shores.

There appears to be an immense variety of the lower order of animals, whose special function it is to assimilate these minute algæ and convert them into animal matter. These, in turn, are devoured by animals of a higher organization or of larger dimensions, although still microscopic; and after a time, by a succession of such transformations, the matter becomes a portion of the organism of the larger mollusks, crustaceans, radiates, worms, or vertebrates.

The larger plant-growths in the sea also have similar relationships, the so-called sea-weeds, sea-mosses, kelp, &c., furnishing a rich variety of food. Various mollusks and crustaceans devour both the living sea-weed and the dead with avidity. The *Nereis* and others among the worms, too, will consume decaying vegetable matter.

The great sea-turtles are also believed to depend very largely upon sea-weeds for food, and the manatee or sea-cow of tropical and sub-tropical regions also feeds upon sea-weeds and other submerged marine vegetables.

There are comparatively few fishes within our knowledge that certainly eat sea-weed as a portion of their food, although it is said that the stomach of the striped bass frequently contains such quantities of ulva and other succulent vegetation as to render it almost certain that it must have taken it as an article of food. Not unfrequently the vegetable contents of the stomachs of certain fishes may have been taken in accidentally in connection with some shrimp or mollusk which was resting upon it at the time of capture.

Of the higher order of plants very few species are known in the ocean (indeed the *Zostera* or eel-grass is said to be the only form), but immense quantities of the trunks of trees, &c., are constantly carried into the sea from the rivers, and are very speedily attacked by animals specially appointed for the purpose, the most familiar being the teredo or ship-worm, and sometimes certain shrimps or crustaceans, the best known of which on our coast are species of *Limnoria* and *Chelura*. These very soon perform their part in honeycombing and reducing to minute fragments vegetable matter of whatever magnitude, and the fragments, after being made too small to serve as burrows, become in this finally divided state food for other marine objects.

The echini, so abundant on our coast, and especially in the northern waters, are quite omnivorous in their habits and consume both animal and vegetable substances, and are apparently especialy adapted for those of harder texture. They devour greedily the soft portions as well as the bones of fishes and possibly of other vertebrates, and have been known to eat off the bark from the stakes used in constructing the

weirs for herring at Grand Manan. Fastening on the exterior, they eat off the bark in circular spots.

There is, therefore, no difficulty whatever in establishing the existence of vegetable matter in the sea in sufficient quantity to serve as the basis for the stupendous mass of animal food derived from it.

Starting thus from the vegetable kingdom the chain of succession of animal life furnishes in one or other of its links food to all the animals of the sea, in the process of such assimilation enormous numbers of distinct organisms being consumed for the support of a single individual. Nor is there any definite ratio between the size of the food used and that of the animal raised upon it, since the baleen or bone whales are believed to live almost entirely upon shrimps, floating mollusks, and upon the smaller fish whenever they can be obtained in sufficiently large schools. It is well known that herring are devoured in multitudes by whales, such as the finback, &c.

Sixty thousand copepods (*Temora longicornis*), by actual count, have been taken from the stomach of a single herring, while many thousands of herring have been taken from the similiar receptacle of the whale, which shows that this miscroscopic shrimp may be regarded as one chief source of the subsistence of the whale—another case of the relation between the infinitely small and the infinitely great.

Some fishes are believed to feed very largely upon the organic mud of the sea-bottom, this of course being rich in some of the smaller forms of animals and the diatoms. The examination of stomachs of large numbers of the common menhaden, by Professor Verrill, revealed no other substances than the mud in question; the fish being provided with very thick, muscular walls to its stomach, a so-called gizzard, for the special purpose of utilizing it. The *Dorosoma*, or gizzard shad, of the rivers of the Atlantic coast, has also a similar provision.

A favorite implement of the naturalist is that called the towing-net. This is simply a bag of gauze, the mouth of which is held open by a ring or brass frame, which is towed behind a boat or vessel so as to take a skimming of the surface of the water. This can never be used in any part of the ocean without very soon obtaining a greater or less number of the minute animal organisms, such as the adult shrimp, the larval stages of certain crabs, embryos of mussels and other mollusks, and small fishes.

Around floating sea-weed in mid-ocean are always congregated great swarms of minute animals. The presence of whales, dolphins, albicores, and other species of animals in mid-ocean also proves the occurrence of food in vast quantities; as although all these species may not themselves devour the lower order of animals, they yet feed upon fishes which do find their sustenance therein.

It is not probable that any fish feed directly upon purely inorganic matter. It is through plants that mineral substances of any kind are introduced into the system, especially that which is required for the formation of bone.

Except in the earlier stages of life, as already explained, the chief sustenance of fishes in the sea consists of animal matter, either dead or living. While some kinds of fish are believed never to feed upon anything but living animals, others are, to a very great extent, scavengers, being especially appointed to devour dead or decaying substances, such as offal or the so-called gurry, &c. The cyprinodonts of the coast are particularly active in this direction. Sharks also exercise the same function in a very marked degree. There are probably but few of the bottom fish that will disdain such substances, consuming living forms with the same readiness. In the business of clearing out refuse fish they are assisted largely by crustaceans, certain mollusks, echini, &c.

The living food of fishes may be divided into two sections: first, eggs and embryos; second, fishes and marine invertebrates of more mature and advanced ages.

The earliest form in which the fish serves as food for its fellows in the sea is in that of the egg, and it is for this reason that with the enormous fecundity of certain fish there is so little apparent increase in their schools. It may safely be assumed that only a small fraction of 1 per cent. of the total number of eggs laid by fishes ever develop embryo fish, by far the greater part being devoured in a very short time. The young fish, also, after birth, is for a certain time immature and to a considerable degree helpless and only able to take food for itself after the absorption of its yolk-bag and the accompanying development of its fins. Before it assumes the shape of the perfect fish and is able to care for itself, it becomes a prey to innumerable enemies; and if of the original deposit of eggs one fish becomes able to care for itself by feeding and hiding to every ten thousand eggs hatched, it may be considered a very satisfactory yield. The proportion, however, doubtless varies with the species.

Under the rate of the fecundity of fishes will be found a table of the numbers of eggs laid by particular kinds of fishes, partly copied from Buckland and partly original, from which we understand that even with this percentage of loss there is still a margin left for the maintenance of the species.

Although the percentage of loss after the embryonic development of the fish is complete is less than before, there is still a very great drain upon the numbers of the species, there being at every step an enemy lurking in wait to devour.

To the large fishes of course there comes a time of comparative immunity, when nothing but the rarer and more powerful inhabitants of the sea can interfere. Even then, however, numbers of smaller enemies may combine together for the overthrow of the monsters that would be more than a match singly for any antagonist, and thus while fish of the known voracity of the cod, haddock, &c., may consume readily species of a smaller size, they have as their antagonists the sharks, the various porpoises, and other cetaceans, and the rarer

giants among the true fishes, such as the swordfish, the tunny or horse-mackerel, &c., which in turn have their antagonists as already mentioned.

The seals, too, devour the larger fish in great quantities; and in turn they are attacked by the cetaceans, such as the orca, or killer whales, and other kinds especially adapted for their destruction. Again, the whales are also antagonized by the killers and various species of swordfish; and, indeed, possibly with the exception of the sperm whale, there is no animal in the sea but what has its foe. Man, however, presents himself as the enemy and antagonist of all the species, and is provided with means for their capture.

We have already referred to the abundance of vegetable matter in the sea, and to the possibility of supplying it in sufficient quantity to serve as the basis of marine animal life, and the marine zoologist will have no difficulty in understanding how the countless numbers of fish in the ocean obtain their food, in view of the myriads of crustacea, of mollusks, of worms, &c., which inhabit the waters.

It is not the species that remain in or near the bottom that are of the most importance, but the free swimming and floating forms that are most extensively and readily devoured. While at no time does the apparatus of the zoologist fail to reveal the presence of animal life, even though of microscopic dimensions, at times this manifests itself in bodies, the masses of which almost stagger the imagination, the sea for hundreds of miles in extent being an animated mush, what with shrimps and other crustaceans, salpæ, and larvæ of mollusks, worms, &c., a bucketful of water taken indiscriminately over the entire area seems filled with animal life. Nor are these organisms confined to the surface, the evidence of the beam-trawl and the dredge revealing its existence in equal quantities below. Various species of minute crustacea are not unfrequently thrown in masses on the beach, so as to constitute windrows of many miles in extent, this of course being but a small percentage of what is left behind. Where these smaller animals are aggregated in unusual numbers are generally to be found great schools of mackerel, herring, whales, and other animals pursuing them, as though certain definite instincts of migration influence them, or they are driven in their season in a definite direction. Schools of fish follow, which are thus brought more nearly to the nets of the fishermen. Indeed, generally the movements of the fish are directed by the instinct of reproduction, in which they aim at finding a suitable locality for the deposit of their spawn, or in search of food, which they either follow or travel to meet.

Among the inhabitants of the deep sea which serve as food for the larger fishes and cetaceans are probably various forms of the cephalopods or cuttle-fish, of which the stomach of the sperm whale frequently contains large masses, proving their occurrence of dimensions far beyond those of which actual critical observation has yet been made. It will, therefore, be readily understood, from what has already been

stated, that life in the sea is a perpetual contest, and that the problem of the survival of the fittest is there worked out to its extremest conclusion. As already shown, no form, however powerful, is free from danger of attack, the giant whale or the enormous kraken being equally liable. Of course many of these species when in fullest vigor can protect themselves by superior fleetness or strength, but with increasing years and infirmities they too must succumb. In this we see the wise provision of nature in securing the perfection of animal existence by providing for the reduction in the excessive abundance of certain forms of animal life and in the removal from the sea of such as are not possessed of the highest bodily vigor.

Much outcry is made not unfrequently as to the wastefulness of different modes of fishing, and legislation is invoked to protect fish, on the ground that the stock will become reduced and the business of the fishermen destroyed. When, however, we fully appreciate the enormous fecundity of marine animals and the immense mass of life that exists in the sea, we can readily understand that the destructiveness of what we are inclined to protect as food-fishes constitutes but a small fraction of the whole. Several calculations have been made by various persons in this regard. Thus, Professor Huxley, in considering the question of the destruction by the herring and cod fisheries on the British coast, calculated that the cod and ling alone actually caught in British waters would, if left undisturbed, have destroyed many more herring than the entire catch by the fishermen, who numbered 15,000 in 1872. Nearly a million barrels were cured, to say nothing of the vast numbers used fresh and for other purposes.

In the first volume of the Reports of the United States Fish Commission, I endeavor to estimate the amount of food devoured by a single species, the bluefish, which occurs in such overwhelming numbers on our coast. Here, taking 1,000,000 fish as the annual consumption in the New York market, and assuming the total number of these fish on our coast to be 1,000,000,000, of 5 pounds each, which may be regarded as an exceedingly moderate calculation, we may consider the amount of other fish that this body of marine wolves will consume. Allowing ten fish per day, which is a moderate estimate, the total destruction daily would be 10,000,000,000, which in the one hundred and twenty days of their abode on the eastern coast of the United States would give 1,200,000,000,000 of fish taken in this part of the season alone. It is not at all an extravagant presumption that each bluefish consumes half its own weight of food per diem; and we should therefore have a total destruction of 2,500,000,000 pounds daily, or 300,000,000,000 pounds in the year. The food of the bluefish consists of menhaden, mackerel, herring, scup, and other species.

It will also be remembered that while the bluefish prey upon other fishes of proportionate size, for every one weighing 5 pounds we may estimate at least a hundred of a smaller size. These are equally voraci-

ous, destroying other fish in proportion, so that it will somewhat tax the human imagination to appreciate the total destructiveness of animal life, resulting from the action of this one species alone.

Mr. Goode, in discussing the distribution and natural history statistics of the menhaden, attempts to make an estimate of the number of these fish devoured on the coast of New England in the summer months by bluefish and other species, and he comes to the conclusion that these may safely be given at three thousand millions of millions. In comparison with this the 750,000,000 captured by man during the same period sinks into utter insignificance. This calculation might be pursued to any extent; but I have presented enough to show that the question of human agencies in the way of affecting or influencing the great ocean fisheries is scarcely worth considering. I by no means wish to be understood as deprecating any legislation in regard to the fisheries, especially in respect to the spawning-grounds, as interference here, while not unnecessarily diminishing the supply to any appreciable extent, may tend to prevent their coming on particular parts of the coast, and thus within the reach of fishermen of a special neighborhood.

If it were in any way our duty to take measures for the prevention of the destruction of life in the sea, and of maintaining the yield of fish generally at its largest figure, we could accomplish it in no better way than by increasing the extent and magnitude of certain of our fisheries. Thus I have shown that there may be a saving of herring by the capture of the cod and ling on the British coast. For every bluefish captured in the waters of the United States many hundreds of other fish are left to enjoy their life, perhaps, however, in their turn to be the means of an increased destructiveness in another series of animals. The capture of whales gives a respite to the schools of mackerel and menhaden, while the destruction of the herring and menhaden relieves, though in an almost infinitesimal degree, the drain upon the crustaceans and the smaller fish.

Another consideration must not be lost sight of, namely, that the adult and old fish, which constitute an object of pursuit on the part of man, are, in proportion to their numbers, much greater destroyers of other fish and the marine animals generally than the younger. It is a well-established principle in the development of vertebrates that the earlier in life the greater the increase of the body resulting from the same amount of food. Thus the new-born infant of 8 to 12 pounds will double his weight in a few months, and with increasing ratio the rate of growth diminishes until when maturity has been reached, unless under particular conditions of the system, the consumption of several pounds per diem does not produce the slightest appreciable increase, and, indeed, may be attended by an actual reduction in weight. The same principle applies to fishes, although, perhaps, to a less degree, and experiments have been carefully made in regard to trout, the culture of which has been the source of greater care than that of any other fish.

Here, according to some writers, it has been ascertained that, while it may require 1 pound of flesh to increase the weight of a trout from 3 ounces to 6, the addition of the next 3 ounces to the weight requires at least 2 pounds of flesh; for the next 3 ounces, 3 pounds; for the next, 4 pounds, and so on in a constantly increasing ratio. Finally, when the fish has attained the maximum development possible in the given limits of the pond or stream, comparatively little effect is produced by any amount of feeding.

In this point of view, therefore, and in reference to a future supply of food, the capture of all the old and fully matured fish is especially desirable, apart from their own greater commercial value.

Worms, mollusks, &c., feed on the organic mud of the sea bottom, caused by the decomposition of sea-weeds, eel-grass, and land or fresh-water plants carried down. Other animals and fish feed on this. Infusoria eat diatoms; larger forms consume infusoria.

Apart from the consumption of shrimps and other crustaceans the stomachs of mackerel are not unfrequently found to contain small sand-lance and what the fishermen call all-eyes. These are said by them to be the embryors, quite recently hatched, of fishes, in which the body is transparent and the eyes very conspicuous, indeed, almost the only portion visible. In summer, schools of all-eyes are found on our coast, sometimes in immense quantities. Captain Hulbert informs me that in July the stomachs of the mackerel were fou nd loaded with these fish which were seen also on the surface of the water, forming extensive schools. On one occasion he went out seaward from Block Island for 25 miles without getting through the schools, and they were equally abundant to the right and left of him, so thick, indeed, that a dozen at a time could be scooped up in the palm of the hand.

To what species these belong is uncertain, although the fishermen surmise that they are young mackerel. It is, however, quite probable, after all, that they may be the young or zoea-stage of crustaceans.*

Fishermen inform me that they frequently find mackeral apparently feeding on the jelly-fish, their method of attack being from below, coming upward and striking through the center and making a hole in it. It is very common to find the jelly-fish floating on the surface torn to pieces in this way.

* I have frequently found young mackerel—blinks—several inches in length in the stomachs of mackerel. These are sometimes as large as they are able to swallow. Without doubt they also feed to some extent on the smaller crustaceans. As is well-known, a variety of these forms grow on floating sea-weed, and many fishermen consider it a good sign of mackerel in the vicinity when they see floating eel-grass broken into small fragments. They assert that the cause of the eel-grass being "chopped up" in such a manner is because it is bitten into by mackerel. This is perhaps true, and, if so, is doubtless done by the fish while feeding on the small shell-fish with which the grass or sea-weed is generally covered. I have observed mackerel attacking jelly-fish.

J. W. COLLINS.

Whether they actually find nutriment in the jelly-fish itself, or whether they are in pursuit of young fish or crustacea that so often accompany the medusa, I am unable to say.

The habit of association between the jelly-fish and other species is a very curious one. In Norway the association of young cod and haddock with the *Cyanea arctica* is well known, Professor Sars having called attention to it, and having furnished specimens of fish taken under such circumstances to the National Museum at Washington.

It is a very common thing to find a number of young harvest-fish, dollar-fish, or butter-fish (*Stromateus triacanthus*), swimming near the jelly-fishes, and running under them for protection on the approach of an enemy; indeed, I have seldom found very young butter-fish except in association with the medusa. Young hake are frequently found in a similar association.

G.—Reproduction.

The last division of our topic of the natural history of fishes relates to the subject of their reproduction, and I now proceed to give a brief statement of the more interesting facts of this character. The reproduction of fishes is, for the most part, by means of eggs discharged from the body and hatched externally to it, these eggs when emitted being either adherent to each other and to whatever they touch, or free, floating near the surface of the water, or sinking to the bottom. Not unfrequently the parent covers up the eggs in furrows excavated by a rapid movement of the tail. Occasionally the eggs are discharged in large masses, notably so in the case of the *Lophius*, or fishing-frog, where they are imbedded in a shell of jelly, sometimes 50 feet or more in length and several feet wide. In some instances adhesive eggs are attached to the body of the parent, where they remain until the young are hatched out. At other times they are carried in a pouch under the abdomen, most frequently of the male, as in the pipe-fish (*Syngnathus*); sometimes of the female, as in the *Solenostoma*. Occasionally regular nests are prepared (again generally by the male) usually of vegetable substances, as in the case of the sticklebacks, in which case the eggs are hatched and the young cared for by the male. Numerous other varieties of presentation could be mentioned, but these are sufficient for my present purpose. In not a few instances the eggs are retained in the body of the parent until they are fully developed, although without placental adhesion, except in a modified degree in some of the sharks. In one family, that of the Embiotocoids, of the Pacific coast of California, not more than five to ten or fifteen young are produced at a birth, these sometimes being 3 or 4 inches in length, from a parent of not more than 8 or 10.

Certain species of sharks and sting-rays produce living young, some showing an indication of placental relation to the mother. In all cases

of this kind, where the young are hatched out within the body of the mother, the number is extremely small, compared to what is seen in the case of free eggs, and illustrates very well the enormous waste of life. The different species of Embiotocoids are enormously abundant on the California coast, fully equal, if not surpassing, in numbers many kinds the females of which lay hundreds of thousands of eggs at a time. As, however, all the ova developed produce young, which are protected in the belly of the mother to a period far beyond even that at which the young feeds itself, the larger part of the dangers of infancy are guarded against, and a yield of five to twenty young, from each parent, keeps up the supply more efficiently and extensively than sometimes where ten thousand times that number of eggs is discharged.

The eggs themselves, as laid by the parent, are for the most part globular, and vary greatly in size, those of the eel being microscopically minute; of the cod, much larger, though still very diminutive; those of the salmon, on the other hand, being of the magnitude of a pea; eggs of the ocean catfish are of still greater bulk, being sometimes half an inch in diameter. The males of some, if not all, of the marine *Siluridæ*, or catfish, have the curious habit of carrying the eggs either in the mouth or the cavity of the gills until they are hatched, half a dozen to a dozen eggs constituting a laying. One of the largest known eggs, with the exception of those of the Plagiostomi (sharks, skates, &c.), is that of the myxine, or hag, a fish well known in the North Atlantic as a parasite, attacking fishes caught on the hook. Here the shape of the egg is ellipsoidal, much like that of an olive, and the greater diameter sometimes almost three-quarters of an inch in length.

A great variety in shape and size of eggs is found among sharks and skates, these sometimes having a horny shell, and looking as much like dried sea-weed as anything else. The egg of the cestracion shark, of the Pacific Ocean, resembles a bit of sea-weed, twisted up into a spiral shape. That of certain skates is familiar to most visitors to the seashore from its resemblance to a brown pillow-case, with the four corners extended into tendrils. These cases are from 2 to 10 inches in length, according to the species. By means of the tendrils they can be attached to sea-weeds and other objects at the bottom of the ocean, and held there until the young are hatched out and escape through the open end of the bag. Many varieties of form of egg-cases exist among the skates, and furnish excellent specific characters.

In further reference to the number of eggs laid by fish I present herewith a table giving some computations, both original and selected, which will serve to illustrate better the variety in this respect:

Species.	Number of eggs.	Weight of fish.	Weight of roe.	Authority.
		Pounds.	*Pounds.*	
Cod	6,867,000		7¾	Buckland, British Fishes.
Do	3,400,000			Bertram, Harvest of the Sea, 1873, p. 4.
Turbot	14,311,200	23	5.93	Buckland.
Flounder	1,250,000			Bertram, Harvest of the Sea, 1873, p. 4.
Sole	1,000,000			Do.
Mackerel	500,000			Do.
Herring	35,000			Do.
Perch	155,620	3⅛		Buckland
Lumpfish	194,112	11	1½	Do.
Smelt	36,000			Bertram, Harvest of the Sea, 1873, p. 4.
Carp	2,059,750	16½	5½	Buckland's Familiar History of British Fishes.
Goosefish	1,050,100	50		G. B. Goode.
Do	2,592,000	60		S. F. Baird.

As especial attention has been given by the U. S. Fish Commission to the numbers of eggs laid by the various species of sea-fishes and their average magnitude, I will not here pursue the subject further, but merely insert some original measurements by the Commission of eggs of the herring, cod, and mackerel, showing their average size.

Kinds of fish.	Eggs.	Measurements.	Average.
		Inches.	*Inches.*
Herring (*Clupea vulgaris*)	29	1.09	.0372
	41	1.56	.0380
	63	2.31	.0366
Cod (*Gadus morrhua*)	43	1.43	.0332
	46	1.40	.0304
	62	1.79	.0289
Mackerel (*Scomber scombrus*)	39	0.98	.0251
	29	0.72	.0248
	77	1.93	.0251

The places of deposit of eggs by fish have already been referred to to some extent under the head of migrations and movements of fish as affected by the reproductive instinct. I shall therefore make only a brief recapitulation of some of the primary divisions.

The anadromous fish, as already explained, are those that run up from the ocean into the rivers and sometimes lakes in which to deposit their eggs, returning after a short time, and followed by the young after a period sometimes of months and sometimes of one or two years.

The catadromous fish, of which the eel is the only known instance, are those the eggs of which are laid in the sea, the young passing up the rivers and remaining in the fresh waters during the period of immature existence, after which they return to the ocean and probably never again leave it; others, coming from the depths of the ocean, come to the shore to spawn in the summer season, and sometimes even in the depth of winter; others, again, discharge their eggs freely in the sea wherever they happen to be, these eggs, as already explained, floating or sinking to the bottom and being adherent or non-adherent.*

* Prof. Alexander Agassiz has paid special attention to the character and place of deposit of the spawn of fishes of the Atlantic coast, and has furnished me with the

In the investigations before the British Fishery Commission as to the injurious effects of the beam trawl-net, much stress was laid upon its destructiveness to the spawn of fish, notably that of the cod, mackerel, plaice, turbot, and other species. Ample evidence, however, was adduced, both within the knowledge of Professor Huxley and from reliable investigations by Sars and others, that the ova of most of the important sea fishes are discharged in the open sea and float in it until the young fish escapes from the shell. Sars found this to be the case when visiting the Lofoden Islands for the purpose of this investigation, a conclusion absolutely contrary to his previous opinions. Nothing struck him with greater astonishment than the immense number of eggs, either containing embryos or emptied of them, which were to be met with in every direction, these being thickly scattered in the waters over many square miles.

---

following list of what he calls pelagic spawners, or those the eggs of which are found floating freely in the sea:

The common Sea Perch.
The Tautog.
Five or six species of Flounders.
The Silverside or *Atherina*.
The Butterfish.
The Menhaden.
The Mackerel.
The Striped Bass.
One species of *Cottus*.
The Goosefish or *Lophius*.
The Cod.
The Hake or *Phycis*.

Most of these were observed by him in the vicinity of Nantucket and a few at Newport. The time of the spawning of these fish, as noted by him, was as follows:

The Flounders, from June to early September.

The Perch and Tautog, the last of June and early in July.

The Cod, in August.

The Hake (*Phycis*), from June to September; the young of all stages swimming on the surface.

The Sea Bass, recently hatched young seen from July to September.

Menhaden, August and September.

Atherina, June and July.

Cottus, July to September.

Butterfish, July to September.

Lophius, June and early July.

The eggs of these several species vary in size from the .06 to the .03 of an inch in diameter. He finds the young are easily identified by the pigment cells, the oil bubbles in the egg, the position of the yolk-bag, the extent of the development of the eyes, and the character of the fins. The only sea fishes whose eggs he knows are deposited on the ground are the *Batrachus tau*, or Toadfish, and some of the Cottoids.

As the result of his extended inquiries on the subject, as secretary of the British commission, Holdsworthy thinks that the herring comes shoreward to spawn, but that the eggs may be emitted at a considerable distance from the coast. The eggs are discharged near the bottom and cover the gravel or sea-weed with a kind of cake, which is then immediately milted by the male.

According to observers on our own coast, herring, when spawning, are sometimes in pairs; at others, a large number of both sexes appear to join together, the females discharging their eggs almost simultaneously and the males their milt, in such quantity as to whiten the water.

The Pilchard, a clupeoid fish, second in importance in England according to Holdsworthy, certainly spawns in deep water, and then both the adults and the young approach the shore.

Mackerel.—The mackerel, too, he found to have the same characteristic, the eggs of both species being found far out at sea. In both cases the egg was provided with a small globule of oil, apparently for the express purpose of facilitating its suspension in the water, and which was contained in the abdominal sack of the young fish in hatching, and constituted a large part of its embryonic nutriment.

Plaice.—The eggs of the plaice, too, one of the principal flat-fish of Europe, were found floating freely in the sea, and the inference was drawn that most of the flat-fish family, including the turbot, sole, &c., possessed the same characteristics. An analogy in the habits and physiological condition of other species of the cod family, such as the haddock, the pollock, and the hake, also induced Sars to include them in the same category.

As a general rule, the eggs of fish that float freely in the sea are single, and belong to the so-called dry eggs, or lack the glutinous envelope which is found in the case of the herring and some less important fish, which causes them to adhere to each other in masses and to any other object with which they may come in contact. The herring is almost the only sea fish of economical importance that exhibits the last mentioned characteristic. (Deep Sea Fishing, p. 42.)

Many forms of animal life, including fishes of the various *Antennarius*, *Chironectes*, &c., live habitually in mid-ocean, especially among the masses of floating sea-weeds, of which some species actually make nests in which their eggs are introduced.

The rate of growth of the young fish varies with the group. In *Crystallagobius*, according to Collett, and perhaps in other forms, the capacity of reproduction is developed in a year's time. For the most part, however, it is thought that the ordinary fishes require a period of three or four years before they are able to propagate their kind. It is likely that the sharks require a still greater allowance, although nothing definite is known on this subject.

The actual rate of growth of the individual varies with the species, and probably to a certain extent with the individual, and the average at maturity varies very much with different so-called schools. Thus among the codfish, a school of mature fish coming in to the coast of New Jersey and elsewhere on the south side of New England, may average not more than 5 to 10 pounds, while another school, which visits Cape Ann for the same purpose, averages a much greater weight, individuals of even 100 pounds not being extremely rare. The same difference in the size of cod occurs elsewhere, as also in that of other kinds of fish. What causes this difference it is, of course, impossible to say.

Many fishes experience curious changes of shape and color during the breeding season. These alterations are very much marked in the salmon, the male of which develops a lengthened, hooked jaw, in which formidable teeth make their appearance. A common alteration consists

in the development of a hump in the nape of the neck or in the back of the male, as in the sea bass.

A change of color is also a very common feature, the male generally assuming brilliant tints during the brief season which are not appreciable at other times.

It is difficult to say how long fish can maintain their ability of propagation or reproduction, some forms, in all probability, being more persistent in this respect than others.

In conclusion, a volume could readily be written in regard to the peculiarities of habit, condition, and relationship of fishes, but as the present essay is intended more particularly as an illustration of the fisheries of the North Atlantic, I shall now bring this portion of my subject to a conclusion, and proceed to a more important division, that of the methods, processes, and results of the fisheries themselves.

II.—METHODS OF CAPTURE.

A.—The fishing grounds.

In the Western Atlantic there is a remarkable chain of submarine elevations situated between the Gulf Stream and the east coast of North America, and extending from the vicinity of Cape Cod to a point far east of Newfoundland, a distance of more than 1,100 miles. Many of these elevations are of large extent, and, together with others of a similar character but comparatively smaller size that are nearer the land, lying inside of the main range, they constitute what are known as the "banks" or the great fishing-grounds for cod (that is, the various species of the *Gadidæ*, of which the cod, *Gadus morrhua*, is by far the most abundant) and halibut.

For the better understanding of the relative position of the banks, their importance, &c., the description will begin with the southwestern grounds and proceed to the north and east.

GEORGE'S BANK.

George's Bank is by far the largest and most important fishing-ground near the coast of the United States, and is second to none in the Western Atlantic except the Grand Bank of Newfoundland. It lies to the eastward of Cape Cod and Nantucket Shoals, and is seemingly an extension of the latter, since the water is no deeper between the southern part of the shoals and the western part of the bank than in many places on it. As laid down on the charts the southern limit is in 40° 40′ N. latitude, although 10 miles south of that the depth of water does not exceed 44 fathoms, and therefore the southern boundary may be placed at 40° 30′ and the northern at 42° 05′ N. latitude. The eastern part is in 66° 27′ and the western in 69° 00′ W. longitude, making the greatest length about 130 miles from the northeast to the southwest extremity, and the greatest width 95 miles north and south. The

depth is from 2 to 50 fathoms. On the western part, between the parallels of 41° 10′ and 41° 53′ N. latitude, and the meridians of 67° 20′ and 68° 37′ W. longitude, are a number of shoals known as the East Shoal, the North Shoal, the Southwest Shoal, Cultivator Shoal, &c. The Southwest Shoal is the largest, being 15 miles in length. There is from 2 to 15 fathoms of water on these shoals and between them from 12 to 30 fathoms. The tides sweep over these with great force, causing strong rips, and during rough weather the sea breaks heavily on them, rendering approach to their vicinity extremely hazardous. The bottom is chiefly sand, although patches of rough ground, gravel, pebbles, and rocks, of more or less extent, are found on some parts of it.

Its situation between the Bay of Fundy and the Gulf Stream causes the tides to run swifter than on the other banks, and to swirl around instead of going directly back and forth in opposite directions. They run around the compass, from left to right, attaining the greatest strength when at SE. and NW., and the least in a southwest and northeast direction. The first attempt at fishing on this bank of which there is any record was made in 1821 by three Gloucester vessels. But the George's cod and halibut fishery is of later date, as it did not become fully established as a permanent business enterprise until about 1835, although vessels went there for halibut in 1830. At first the catch was mostly halibut, but since 1850 it has been chiefly codfish, although more or less halibut are taken with them. During the months of February, March, and April large schools of cod make their appearance on the bank. They are generally found on the "winter fishing-ground," a part of the bank lying to the eastward of the shoals, between 41° 30′ and 42° 00′ N. latitude and 66° 38′ to 67° 30′ W. longitude. This is essentially a spawning ground for the cod, which appear to come on the bank from the southeast, as they almost invariably, after reaching the ground, move slowly to the north and west as spring approaches. This is in the direction of the shoals, and, as the pursuit of the fish brings the vessels near the latter, great loss of life and property sometimes occur in heavy easterly gales and storms. As soon as the spawning season is over the schools of cod break up, but more or less fish are caught on different parts of the bank during the entire year, though rarely, if ever, are they found so plenty as when the winter school is on.

The codfish fleet, which numbers about one hundred sail, is wholly from Gloucester, Mass. Besides these there are twenty-five to thirty vessels from the same port that fish on George's for haddock in the winter, and a few others from New London, Conn., and other ports on Long Island Sound engage in the cod and halibut fishery in spring and summer.

BROWN'S BANK.

Brown's Bank lies in a northeasterly direction from George's Bank, being separated from the latter by a gully. This bank is imperfectly

laid down on the charts, which therefore fail to give an adequate idea of its extent and importance as a fishing-ground. Its greatest length east and west is 53 miles, from 65° 10′ to 66° 23′ W. longitude, the greatest breadth 47 miles, from 42° 15′ to 43° 02′ N. latitude, and the depth varies from 20 to 55 fathoms. There is a small shoal on the northern part, the location of which has not been definitely determined, where it is said there is not more than 9 to 15 fathoms. The bank slopes gradually from the shoal in a southerly direction, but falls off steep on the northern side. The bottom is mostly composed of gravel, pebbles, and rocks, the latter predominating near the shoal.

The tides are nearly as strong here as on George's Bank, but run more directly to and from the Bay of Fundy, the northeast and southwest set being generally much weaker than on the latter bank.

Cod, halibut, and haddock are the principal fish taken, although cusk, pollock, and hake are found more or less. Cod are quite plenty in the winter and some good fares are obtained, although but comparatively few vessels fish there at that season, most of them being in the George's fleet. At other seasons, however, the fishing on Brown's Bank compares favorably with that on any of the banks in the vicinity, and quite a number of the so-called Georgesmen are engaged in fishing there. The cod is found the year around. Halibut were formerly found very plenty, but at present occur in much less numbers. Sometimes the haddock fishermen make a trip to this bank during the winter and good catches are occasionally obtained.

JEFFREY'S LEDGE.

This may perhaps be considered one of the best shore fishing-grounds in the Gulf of Maine, although it is comparatively small. It is seemingly an extension of the shoal ground that makes off in a northeasterly direction from Cape Ann. It is about 20 miles long NE. and SW. and from 2 to 4 miles wide. Its southern limit is 42° 54′, and northern 43° 11′ N. latitude, and the eastern and western boundaries may be placed at 69° 58′ and 70° 18′ W. longitude. The bottom is rocky on the shoalest parts, with gravel and pebbles along the edges. The depth of water is from 27 to 35 fathoms on the bank, falling off to 40 and 50 fathoms on the borders. Usually there is little or no tide, though occasionally there is some current setting to the SW. Cod, cusk, and haddock are taken in the fall, winter, spring, and early summer, with more or less hake or pollock mixed with them. For a number of years Jeffrey's Ledge was a favorite winter fishing-ground for haddock, which were very abundant, and even at the present time many vessels resort there in pursuit of haddock; but since the haddock fishermen have extended their cruises to the outer banks, a less number, of course, go to Jeffrey's. Besides the haddock catchers, the vessels engaged in the shore fisheries resort to this ground in the spring and fall.

CASHE'S LEDGE.

This is not a very important fishing-ground at present except for a brief season in the spring, although it is resorted to somewhat by the shore fishermen in summer and fall, and sometimes good trips are obtained. It bears east from Cape Ann, from which the shoals are 76 miles distant. The bank is about 22 miles long, from 42° 49′ to 43° 11′ N. latitude, and about 17 miles wide, from 68° 40′ to 69° 3′ W. longitude. There are three small shoals on the western part of the ground. The southern one has 7 fathoms, the middle one 4 fathoms and the northern one 11 fathoms of water. The position of the middle shoal is 42° 56′ N. latitude and 68° 52′ W. longitude. From this the south shoal bears S. by E. and the north shoal NNE., each being 3½ miles distant from it. These break in rough weather, and, though of small extent, are dangerous to passing vessels, especially as they are almost directly in the track of vessels bound to and from Cape Sable to Massachusetts Bay. With the exception of the shoals the depth of water ranges from 15 to 60 fathoms. The ground is more or less broken, with bottom of sand, pebbles, and rocks. The greater part of the fish caught here are cod, hake, and cusk. Halibut are rarely seen, and haddock and pollock are less plenty than the other kinds. Good trips are often secured on the edge of the ground in May and June, but the dogfish, which appear about the last of June or in July, usually drive everything before them and for a time stop the fishing. The class of vessels fishing on Cashe's range from 15 to 45 tons, and are what are known as shore-trawlers.

JEFFREY'S BANK.

This bank, which lies east of Cashe's Ledge, is of comparative little importance as a fishing-ground. It is about 20 miles long SW. and NE., and 10 miles wide, the northern and southern limits being 43° 15′ and 43° 30′ N. latitude. The eastern edge is in 68° 25′ and the western in 68° 46′ W. longitude. The bottom, which is somewhat broken, is composed of mud, sand, gravel, and pebbles, with a depth varying from 35 to 70 fathoms. Cod, haddock, hake, and cusk are the fish most plentiful; some pollock are caught, but halibut are rarely taken. The best season is in late spring and early summer, before the dogfish schools strike, after which but few fish can be obtained. This bank is resorted to by the smaller-sized vessels of from 15 to 50 tons.

GERMAN BANK.

Although this bank is not usually laid down on the charts it is one of the most important in the Bay of Fundy. It bears SE. from Baker's Island light (Mount Desert), from which the northwest part is about 52 miles distant. The length is about 15 miles and the width 9 to 10 miles. It lies between 43° 38′ and 43° 53′ N. latitude, and 66° 58′ to 67° 15′ W. longitude. There is from 65 to 100 fathoms of water. The bottom is

mostly a tough red clay, but with spots of mud, sand, gravel, and pebbles on some parts. The tide sets out and in the Bay of Fundy about SW. and NE., but is not so strong as might be expected. Cod, hake, cusk, and haddock are the fish which are chiefly taken, but a few halibut and pollock are occasionally caught. The fishing season is from April to October, although fish are usually the most abundant in the spring. This bank is resorted to chiefly by vessels from the coast of Maine, but is sometimes visited by the Massachusetts fishermen.

MARBLEHEAD BANK.

This fishing-ground, which is quite an important one for the shore cod-fishermen, is not laid down on the charts. Therefore the fishermen who visit it are probably the only persons familiar with its location, or who are able to estimate its extent. The ground which they call Marblehead Bank is situated between Grand Manan and German Banks, the shoal water bearing SSE. from Mooseabec light, a distance of 32 miles. It is about 12 to 15 miles long and 7 or 8 miles wide, and lies between 44° 00′ and 44° 10′ N. latitude and 66° 58′ to 67° 13′ W. longitude. There is from 35 to 70 fathoms of water, and the bottom is mostly clay and gravel. The fish that occur in the greatest numbers are cod, pollock, and haddock, but with these are more or less hake and cusk. The best fishing is generally in the spring and early summer. The same class of vessels—shore fishermen—as frequent Grand Manan and German Banks also resort to this, but occasionally those of a larger size make one or more trips during the summer season.

GRAND MANAN BANK.

Grand Manan Bank lies at the entrance of the Bay of Fundy, and bears SW. ½ S. from the southwest head of Grand Manan Island, from which the northern part of the bank is 15 miles distant. It is 10 miles long and 5 miles wide, and lies in a SW. and NE. direction. The bottom is mostly stones and gravel, and the depth of water varies from 24 to 45 fathoms. The tides are quite strong, but not enough so to prevent trawling. Cod and pollock are the principal fish, cusk, hake, haddock, and halibut being less plenty. The fishing season is from April to October, when the fish come on the bank to feed. In the spring the fish are usually the most plentiful on the southwest part, but later in the season the best fishing is generally obtained on the other end of the ground. It is a favorite fishing-ground for the class of small vessels commonly known as shore-fishermen.

SEAL ISLAND GROUND.

Off the western part of Nova Scotia there is an important fishing locality known to the fishermen as the "Seal Island Ground," although no name is given on the charts. This may not, perhaps, be called a

bank, as it is shore soundings, which slope gradually from the land to the south and west, but continue in a northerly direction beyond what may properly be considered the limit of the ground. To the south it extends nearly to Brown's Bank, from which it is separated by a narrow gully; to the west 38 miles from Seal Island, the western land of Nova Scotia; and to the northwest about 35 miles. The southern limit is in 43° 00′, and the northern in 43° 45′ N. latitude, while the western boundary may be placed at 66° 40′ W. longitude.

There is a small shoal, the Pollock Rip, with a depth of 7 fathoms, which bears SW. from Seal Island, from which it is distant 9½ miles, but with this exception, the ground slopes quite gradually, the depth varying from 15 to 70 fathoms. The bottom is principally composed of coarse gravel and pebbles, with occasional rocky spots of more or less extent. The tides sweep out and in the Bay of Fundy with considerable force, the course changing with the direction of the land, so that while they run nearly north and south on the northern part of the ground, they swing around to northwest and southeast to the southward of Seal Island. The flood is much stronger than the ebb, and the fishermen estimate that one flood will carry a vessel nearly as far in a northerly direction as two ebbs will in the opposite way.

The fish that are principally caught on this ground are cod, haddock, and pollock, although halibut, cusk, and hake are taken to a limited extent, and occasionally herring or mackerel are netted for bait. Cod are generally more plentiful from spring to fall than during the winter, but haddock and halibut are found all the year. Fishing usually begins in April or May, and continues until October. Halibut were formerly very abundant, but are now comparatively scarce.

This ground may be considered essentially a feeding-ground for the cod, which come here after the spawning season is over to fatten upon the crabs and mollusks on the bottom and the herring and other species of small fish that are swept back and forth in the tide-rips. All parts of the Seal Island ground are fished on at the same time. This was formerly a favorite fishing-ground for vessels from the coast of Maine, but since trawling has come to be so universally adopted but few American vessels except "hand-liners" go there. The fleet engaged in fishing there now is principally composed of vessels belonging to the western part of Nova Scotia, which generally "fish at a drift," going back and forth over the ground with the wind and currents.

ROSEWAY BANK.

Roseway Bank lies in a northerly direction from Le Have Bank and SE. from Shelburne light. It is oblong in shape and of small extent, the greatest length being only 19 miles, and breadth 12 miles. The limits are 43° 13′ and 43° 32′ N. latitude, and 64° 30′ to 64° 38′ W. longitude. The bottom is sand, gravel, and rocks, and there is a depth of from 33 to 48 fathoms. The current here is not nearly so strong as

in the vicinity of Cape Sable, or Brown's Bank. The general set is about WSW. and ENE., the westerly current usually being much the strongest, although both the force and direction is somewhat influenced by the winds.

The principal fish are cod, haddock, and cusk, but hake, pollock, and halibut are occasionally taken. The season is usually from May to October, during which time fishing is carried on principally by small-sized vessels from the western part of Nova Scotia, although a few American vessels occasionally go there. To the northwest of Roseway, and between it and the land, is "Cape Negro Mud," a good ground for cod at certain seasons. It is of small extent, with muddy bottom, and a depth varying from 60 to 80 fathoms.

LE HAVE BANK.

Le Have Bank is situated to the eastward of Brown's and south and east of Roseway Banks. It extends from 42° 53′ to 43° 24′ N. latitude, a distance of 31 miles, and from 63° 50′ to 64° 47′ W. longitude, a distance of 41 miles. Much of this westerly extension is a long narrow prong that makes out from the main body of the bank. The bottom is largely composed of coarse gravel, pebbles, and rocks, with only here and there small spots of sand. The depth of water is from 40 to 50 fathoms. The general set of the current is mostly to the westward, but this, however, is influenced very much by the direction and strength of the winds. The fish that are chiefly taken on this bank are cod and haddock, although the other species of bottom fish are found more or less plentiful. Cod are found at all seasons of the year, but are more abundant during the early winter than at any other time, and good trips are frequently obtained by the Gloucester vessels, which are the only ones that go there at that season. The Gloucester winter haddock-catchers, who carry these fish fresh to Boston market, have extended their trips from George's and Brown's Banks to Le Have, and during the present winter (1880–'81) have made some remarkably good catches.

LE HAVE RIDGES.

The fishing-ground known as Le Have Ridges is simply a continuation of Le Have Bank to the eastward in the direction of the Western Bank, a distance of about 45 miles. This makes the eastern limit in 62° 50′ W. longitude, while the northern and southern boundaries are about the same as those of Le Have Bank. The bottom is a succession of ridges of gravel and pebbles, with occasional patches of rocks, and the depth varies from 55 to 85 fathoms. The current is weaker here than farther west on the bank, and, excepting with easterly winds, is but little noticed. The general set is westerly. The "Ridges" were for a number of years one of the favorite places of resort for the halibut catchers in the winter, and many good trips of cod have also been taken at that

season. At present but few halibut are caught, except in the deep water along the southern edge of this ground, where sometimes they have been found quite plenty for nearly the entire year. Hake are also found in large numbers in the deep water about the borders of the ground, and even on the ridges. As a general thing but few vessels besides those from Gloucester have made a practice of fishing on Le Have Ridges, though a few cod fishermen from other places stop there now and then during the summer.

SAMBRO BANK.

This bank lies in a westerly direction from the Western Bank, but is so small that it is of little importance as a fishing-ground and is but little resorted to by American vessels. It lies between 43° 36′ and 43° 47′ N. latitude and 63° 40′ to 63° 00′ W. longitude, the greatest length being 15 miles and width 11 miles. There is from 50 to 60 fathoms of water, and the bottom is mostly sand, gravel, and pebbles.

WESTERN BANK.

The Western Bank is one of the most important fishing-grounds in the Western Atlantic, considered either as to size or the amount of fish taken on it. Lying off the eastern coast of Nova Scotia, it has Le Have Ridges on the west, and Bankquereau on the east, from both of which it is separated by gullies. The general direction of the bank is WSW. and ENE.; the eastern limit is 59° 07′, and the western 62° 27′ W. longitude, making the extreme length 193 miles. The southern limit is in 42° 51′, and the northern in 44° 46′ N. latitude, the extreme width, therefore, being 95 miles.

On the eastern part of the bank is Sable Island. This is about 20 miles long and 1½ miles wide, and composed wholly of sand, which for nearly the entire length is in hummocks, caused probably by the action of the wind. Off either end of the island are long and dangerous sand-bars. The general direction of the island and bars is east and west, although they take the form of a crescent with the concave side on the north. The depth on the bars for a distance of from 7 to 10 miles from the island does not exceed 2 fathoms, and even 10 miles farther out in an easterly and westerly direction there is not more than 10 or 11 fathoms. On the middle ground—a portion of the Western Bank which lies in a northerly direction from Sable Island about 25 miles distant—there are several shoal spots with from 10 to 19 fathoms on them.

As a general rule the bank slopes gradually from the island to the south and west, the depth ranging from 18 to 60 fathoms. The general character of the bottom is sandy, but there are patches of gravel and pebbles. The currents in the vicinity of Sable Island are occasionally quite strong, and generally irregular, being very much influenced by the winds. On the greater part of the bank there is usually but

little current. The set of what there is, however, is mostly in a westerly direction. Cod and halibut are the principal fish taken, though the other species of bottom fish are found in limited quantity. The former are generally the most abundant in the spring, from the first of March to June, although good fares are obtained throughout almost the entire year. For more than twenty-five years the Western Bank has been a favorite resort of the halibut fishermen. At first these fish were found very plenty in from 45 to 60 fathoms, and since 1876 have been caught in great numbers along the edge on the south and east sides in from 100 to 300 fathoms. Like the cod, they are found during the entire year, the period of greatest abundance, however, being from the first of January to the first of October. The Western Bank may be considered both as a feeding and spawning ground for the cod and halibut. It abounds with shell-fish and crustaceans, as well as with several species of small fish upon which the cod and halibut prey. Although the cod do not gather in such great schools in winter as they do on George's Bank, it is nevertheless quite evident that they assemble at that season for the purpose of reproduction. Usually they are found the most plentiful on the western part of the bank in winter and early spring, but as the season advances they move into shoaler water in the vicinity of Sable Island, the "bend" of the island and about the bars being favorite grounds during the late spring and early summer. Vessels from all along the New England coast and from the British Provinces resort to this bank to pursue the cod fishery, but fishing for halibut is almost exclusively carried on by the Gloucester fleet.

THE GULLY.

Although the "Gully" cannot be called a bank, being just what its name suggests, a deep gully between two banks, it is nevertheless too important as a halibut fishing-ground to be omitted from a general description of the fishing banks. This lies between Bankquereau and the Western Bank, being bound on the north and east by the former, and on the south and west by the latter. The entire length of the gully is more than 60 miles, but the halibut ground is of less extent, and the limits, east and west, may be placed at the 59th and 60th meridians of west longitude. It is about 18 miles wide, on the eastern part, from 44° 08′ to 44° 26′ N. latitude, but narrower farther west. There are several ridges with rocky and gravelly bottom and a depth of 75 to 125 fathoms, on which the halibut are usually caught. On either side of these ridges the bottom is generally sand or mud, excepting in the eastern section, where it is composed mostly of pebbles and sharp rocks.

The current generally sets in a westerly direction, but is very irregular in strength; an easterly wind often causes it to increase very perceptibly, while at other times there may be but little or no tide. When the halibut fishing first began on this ground it was carried on chiefly

in the spring on the northern and western part, but in the spring of 1877 the fishermen made trials farther out, in deeper water, and excellent fares were obtained as late as June and July. Since that time good fares have been taken during the winter season, and it appears that halibut come to this place especially to feed, as they generally move to other localities just previous to the spawning season. With a few exceptions the Gloucester halibut vessels are the only ones fishing on this ground.

BANKQUEREAU.

This may be considered among the most important of the fishing banks lying between the 40th and 48th parallels of latitude. It lies in an easterly and northerly direction from the Western Bank, being separated from the latter by the "Gully." The former bank is long and comparatively narrow, and lies in an east and west direction. The extreme length is 118 miles, from 57° 20′ to 60° 04′ W. longitude. The southern limit is 44° 05′ and the northern 45° 01′, a difference of 56 miles, but the widest place, the eastern part, does not exceed 46 miles.

There is a shoal ground called the "Rocky Bottom," on the eastern part of the bank, which has a depth of 16 fathoms, while elsewhere there is from 18 to 50 fathoms. The Rocky Bottom is much frequented by the hand-line dory fishermen during the summer, and sometimes several hundred dories are fishing there very close together.

The bottom is generally rocky, but there are patches of sand and gravel on some parts of the bank. The current from the Gulf of Saint Lawrence and the polar current meet here, but, though this causes considerable irregularity, the latter is usually the strongest, and the set is therefore chiefly in a westerly direction. The force is much influenced by the wind, so that there may be quite a strong tide for several days together and then but little or none.

But few kinds of fish, with the exception of cod and halibut, are taken on Bankquereau; hake, haddock, and cusk being comparatively rare. Halibut are found throughout the entire year in the deep water along the edges of the bank, where, at a depth of from 100 to 400 fathoms, large numbers of them are often taken. These are apparently both feeding and breeding grounds for the halibut, and it is not unusual for a school of them to remain several weeks or even months in one locality, although it is probable that some of the schools that "strike" on the eastern part of the bank in the spring are migrating farther north. The best season for cod is from May to November, when the schools gather on the bank to feed on the lant, squid, crustacea, and shell-fish that usually occur in great abundance. As a general thing cod are found the most plentiful on the eastern part of the bank, although good catches are frequently obtained farther west. French, British, Provincial, and American fishing vessels resort to this bank for cod in summer, and the American (Gloucester) fresh halibut fleet visit it at all seasons.

CANSO BANK.

This bank lies to the south and east of Cape Canso, from which it derives its name; it is unimportant as a vessel fishing-ground, and is too distant from the land to be much resorted to by small boats. It lies between 45° 00′ and 45° 16′ N. latitude and 59° 58′ to 60° 42′ W. longitude; the greatest length, in an east and west direction, being 30 miles, and the width 16 miles. There is a depth of from 30 to 56 fathoms, and the general character of the bottom is sandy, with spots of gravel or pebbles.

MISAINE BANK.

Although Misaine Bank is quite large, it is but little resorted to by fishermen, and therefore it may be said that as a fishing-ground it is unimportant. This fact seems quite remarkable, since it is not more than 30 miles distant in a northerly direction from Bankquereau, which is a good ground for cod and halibut. The extreme length is 61 miles, in an easterly and westerly direction, the limit being 58° 08′ and 59° 28′ W. longitude. The width is 41 miles, from 44° 59′ to 45° 40′ N. latitude. The depth of water varies from 40 to 60 fathoms, and the bottom is generally broken and rocky. But little can be said concerning the abundance of fish on this bank, since it is so rarely visited by fishing vessels that no reliable information can be obtained concerning this matter. The natural inference is, however, that the bank has been fished on more or less, and though cod and other bottom fish are found they are not so plentiful as on other banks.

ARTIMON BANK.

Artimon Bank lies north from the eastern part of Bankquereau, being separated from it by a narrow gully. It is of such limited extent that, compared with the latter, it is of but little importance as a fishing-ground. The fishermen generally prefer to try on the larger bank, and therefore but comparatively little is known about the abundance of fish on Artimon Bank, although it is known that the same kinds may be taken on one as on the other. It is 17 miles long and 10 miles wide, with a depth of 37 to 50 fathoms, and bottom of coarse gravel and rocks.

SAINT PIERRE BANK.

Until quite recently the bank of Saint Pierre was considered a very important fishing-ground for both cod and halibut, and was much resorted to by American as well as French and British provincial fishermen. At present, however, fish are much less abundant than formerly, and it can scarcely be placed in the front rank of fishing banks. It is situated to the northwest of Grand Bank and Green Bank, and off the south coast of Newfoundland, the northern part being only 11 to 15 miles distant from the French islands of Miquelon and Saint Pierre. It

is oblong in form, and extends in a northwest and southeast direction. The length is 110 miles, and width 60 miles, and it lies between the parallels of 45° 15′ and 46° 45′ N. latitude, and the meridians of 55° 21′ and 56° 21′ W. longitude. There is from 22 to 50 fathoms of water. The bottom is generally rocks and pebbles, covered with a growth of reddish-colored bryozoans, but on some parts there are places of considerable extent where it is composed of sand or gravel. Ordinarily there is not much current on this bank, although sometimes, when driven by strong winds, the polar current, which sweeps around the south coast of Newfoundland, is quite strong. Cod and halibut are the only food-fish that are found in any numbers, although a few cusk and haddock are sometimes taken. The season for both cod and halibut is from the 1st of April to November. The best season for cod is from the 1st of June to October, when they come here in pursuit of capelin and squid. Halibut were formerly taken on the shoal parts of this ground during the spring and summer, but at present are rarely found in any abundance except in the deep water along the edge, or on rocky spots, a distance of 15 to 20 miles from the bank, where there are no soundings laid down on the charts. Some of the schools of halibut find their breeding grounds on these rocky patches, but the greater part pass along the edge in the spring on their way to the north. With the exception of the fresh halibut catchers, few fishermen besides the French make an attempt to fish on Saint Pierre, as the other banks offer much greater inducement.

GREEN BANK.

Green Bank is one of the least important of its size in the Western Atlantic, if only that part laid down on the charts as such is considered. But it may be said, however, that one of the best halibut grounds is in the deep waters near its southern part, and as this is also called Green Bank by the fishermen, it may not be out of place to consider it in this connection. This bank is situated between Grand and Saint Pierre Banks, being 7 miles distant from the former and 13 miles from the latter. The extreme length is 54 miles north and south, between 45° 15′ and 46° 09′ N. latitude, and it is 33 miles wide, the meridians of 54° 17′ and 55° 03′ W. longitude bounding it on the east and west.

The depth varies from 40 to 60 fathoms, and the bottom is composed of sand, shells, pebbles, rocks, and corals. The general direction of the polar current, which sets over this bank, is usually from northwest to southwest, its course, as well as force, being more or less influenced by the wind. But little is known of the abundance of the cod here, as the fishermen prefer to go to grounds that are better understood than to stop on this.

Since 1875 halibut have generally been found very abundant in the winter and spring and sometimes, even during the summer, in from 75 to 300 fathoms, along the edge of the ground between the Grand and

Saint Pierre Banks, which is near the southern part of Green Bank. This locality appears to be a feeding-ground in winter, and during the spring is in the direct line of the route followed by the halibut that are migrating from the Grand Bank to other places farther north, and at this season it is not uncommon for immense schools to make their appearance, moving leisurely along the edge, perhaps in some cases only a very little for several days at a time, and again more rapidly. The only vessels fishing for halibut at this place are from Gloucester, Mass.

GRAND BANK.

Considered either as to area or with regard to the extent of its fisheries, the Grand Bank is by far the most important fishing-ground in the Western Atlantic, if not in the world. It lies south and east from Newfoundland, is triangular in form, with sides nearly equal, one of them facing the east, one the south and west, and the other to the north and west. The north and east sides are each about 264 miles in length, and the other is 225 miles from the southern to the northwestern limit. It extends over more than four degrees of latitude, from 42° 57′ to 47° 02′ N., and nearly six degrees of longitude, from 48° 22′ to 54° 16′ W.

The most remarkable shoals are the Virgin Rocks and the Eastern Shoal Water. The former are a number of rocky hummocks, severally known as the Main Shoal, Portuguese Shoal, the Haycocks, and the Eastern Shoals. On these the depth is from 4 to 25 fathoms, while between them it is from 40 to 50 fathoms. One or two of them break in rough weather, and though not very large, are at such times dangerous to passing vessels. They lie between 46° 25′ and 46° 30′ N. latitude and 50° 31′ to 50° 58′ W. longitude. The Eastern Shoal Water extends from about the fiftieth meridian nearly to the eastern edge of the bank and from 43° 50′ to 44° 50′ N. latitude. The depth of water is from 22 to 30 fathoms and the bottom is chiefly sand, but with some patches of rocks or gravel. With the exception of the shoals already mentioned, the bottom is generally level, the depth being from 30 to 50 fathoms, excepting in the whales deep, near the western part of the bank, where there is from 52 to 67 fathoms on a muddy bottom. The Grand Bank may be considered as a vast sandy plain in mid-ocean, but notwithstanding this is the general character of the bottom, there are extensive tracts where it is either composed chiefly of rocks and gravel or where these occur in patches of more or less extent.

There is perhaps less current here than on any other of the banks, and oftentimes for days and weeks together it may be scarcely perceptible. This is generally the case during moderate weather, but a continuance of strong winds usually makes some tide.

The principal food-fish taken here are the cod and halibut. Haddock, cusk, and hake are rare. There are a few cod ("ground keepers") in winter, but the best season is between the first of April and the first of November. The Grand Bank is essentially a feeding-ground for the

cod, which find there not only an abundance of shell-fish and crustacea of various kinds, but mollusks and several varieties of small fish that they are especially fond of. The appearance of large schools of cod at the same time with certain kinds of bait, for instance the capelin and squid, has caused these to be known to the fishermen as the "capelin school" and the "squid school." The spring fish, which feed largely on the bottom, and to some extent on lant, are at first found the most abundant on the southern part of the bank, but later spread over a large area. The capelin school comes in May and June, and at that time fish are found more or less plentiful all over the bank, although the locality between the latitudes of 44° 00′ and 45° 15′ and that east of the Virgin Rocks north of the forty-sixth parallel are the most generally resorted to by trawl fishermen, while the dory hand-liners gather about the Virgin Rocks, which is a favorite place for them at that season. The squid school appears in July and is found on the same grounds as the capelin school. Indeed, it is quite probable that it is made up chiefly of the same fish, their numbers increased, perhaps, by some new accessions. For several years but comparatively few cod have been taken after September. Cod-fishing on the Grand Bank dates from the earliest settlement of America. The halibut fishery, however, is of comparatively recent date. This was begun in 1865, at which time, and for several subsequent years, halibut were found very numerous on the bank. At first they were taken almost wholly on the Eastern Shoal Water, later on other parts of the bank, and since 1875 principally in the deep water along the western edge, where immense schools have been found in the winter and spring, and, though less frequently, sometimes in summer. During the early part of the year the halibut usually do not remain long in one place, as many of the schools perform their migrations at that season. The summer schools, however, are generally spawn fish and move but little.

A large fleet of French vessels of various rigs, but mostly brigs and barks, resort to this bank to engage in the cod fishery. Besides these there is a fleet from the British provinces and another from the United States, the whole aggregating several hundred sail, with crews numbering many thousands of men.

FLEMISH CAP.

Although the Flemish Cap is quite large, but comparatively little is known of it, and its boundaries are not fully defined on any of the charts. It is the most northern of the large fishing banks in the Western Atlantic, being located between 46° 36′ and 47° 59′ N. latitude and the meridians of 44° 06′ and 45° 25′ W. longitude. The extreme length is therefore 83 miles and width 53 miles. The bottom is broken into patches of more or less extent of mud, rocks, pebbles, gravel, and sand. A slaty rock is the most common on that part of the bank resorted to by fishing vessels. The depth varies from 73 to 155 fathoms.

Cod and halibut are the only fish taken as an object of pursuit. Owing to the bank being situated so far to the north and east nothing is known about the abundance of fish in the winter season. Indeed, all that is known of them is in the period between the last of April and the first of August. In the spring and early summer cod and halibut have been found in great abundance. During the spring, however, the weather is often so rough that fishing can be carried on but a small part of the time, and after June the ground is so much infested with ground-sharks that the trawls are soon destroyed. Besides this there is more or less danger from drifting icebergs, which are often seen in great numbers. All these causes combined have hindered most of the fishermen from making any attempt to fish there. The only vessels known to have visited this bank for cod and halibut are a few from Gloucester, Mass., and this has never been done until within a few years.

COD FISHING-GROUNDS IN THE BAY SAINT LAWRENCE.

The cod fishing-grounds in the Bay Saint Lawrence are comparatively of little importance except to the fishermen of the British Provinces. But few American fishermen go there, as the ocean banks are generally preferred by them. There is little difference between the depth of water and character of the bottom of the banks and elsewhere, and therefore the whole bay may be considered as a cod fishing-ground, with from 10 to 60 fathoms of water, and bottom generally rocky but somewhat diversified with areas of greater or less extent of sand, gravel, or mud. The only places of which special mention need be made are Bradelle Bank, Orphan Bank, "Pigeon Hill Ground," and "Miscou Flat."

Bradelle Bank is in a northeasterly direction from the North Cape of Prince Edward Island, and in a direct line between that and the northern Magdalen Islands, the SW. edge being 22 miles from the former headland. It is 36 miles long and 24 miles wide.

Orphan Bank is north of Bradelle. The center bears ESE. from Point Miscou, from which it is 47 miles distant. It is 36 miles long NE. and SW., and 15 miles wide, with a depth of from 10 to 30 fathoms, and bottom of rocks, coral, and sand.

Pigeon Hill Ground is the shore soundings that lie southeasterly from Shippegan Island at a distance of 10 to 20 miles, and extends in the direction of the coast about 18 to 20 miles.

Miscou Flat is a stretch of rocky shoal ground that makes out from Point Miscou about ESE. nearly twenty miles. There is from 10 to 22 fathoms of water, the ground gradually sloping toward the outer part.

On all these grounds cod-fishing is pursued only during the warmer season, from May to October. The abundance of cod, especially of the large fish, varies somewhat with different seasons, their presence in greater or less numbers being governed to a great extent by the amount of bait-herring, mackerel, &c., on the ground. The fishing is largely car-

ried on by the local residents in small boats, although some Nova Scotia vessels, and a limited number from the United States, sometimes engage in it.

FISHING-GROUNDS NEAR THE MAGDALEN ISLANDS.

The cod and halibut grounds about the Magdalen Islands are at present of little importance to American fishermen. Since the introduction of trawl-fishing it has usually been found that better results could be obtained elsewhere. These grounds are rocky patches, and generally of limited extent, with comparatively shoal water and sharp bottom. They occur all around the islands, but are not of sufficient importance to make a special description necessary. A few trips of halibut have been taken on the shoal about Byron Island, but the appearance of these fish is so uncertain in that locality that the halibut catchers rarely go there. The fishing is done almost wholly in the small boats of the resident fishermen, and by the small vessels belonging to the British possessions and at the French islands of Saint Pierre and Miquelon.

CAPE NORTH FISHING-GROUND.

Around the northern part of Cape Breton Island, at a distance varying from 4 to 15 miles from the land, is a fishing-ground that is of considerable importance for a few weeks in the spring and early summer. This lies between Cape North and Saint Paul Island, and extends westerly about 15 miles, and southwesterly along the coast as far as Limbo Cove. The land is bold and high, with steep shores, so that notwithstanding the close proximity of the fishing-ground the depth of water on it is from 65 to 100 fathoms. The bottom is mostly tough clay, but 10 or 15 miles from the land there are some rocky ridges. The current sets out of the Gulf of Saint Lawrence toward the southeast, although the direction in which it runs in the vicinity of Cape North changes more or less in conformity with the land. The strength is increased by strong westerly winds, and after a long continuance of these, the current sometimes runs 3 or 4 miles an hour. As a general thing, however, the tides run slowly About 1860 and 1861 cod and halibut were found in abundance, but later the halibut seemed to disappear, and for several years have been taken only occasionally. The cod are still found quite plenty in May and June, at which time they are moving slowly in by the headland on their way to the shoaler grounds in the bay of Saint Lawrence. The fishing is often obstructed by floating field-ice, which sometimes prevents the vessels from reaching the ground until late in the season. This place is resorted to by provincial and American vessels, but owing to the difficulties that have been alluded to, the fleet is usually small.

THE GREENLAND HALIBUT BANKS.

Mr. N. P. Scudder makes the following statement about the grounds in Davis Strait which are resorted to by the halibut fishermen of Gloucester:

"The fishing banks are 15 to 40 miles from the coast, and, if we can rely upon the Danish charts, extend from Disko Bay to within 3° of Cape Farewell; for these charts give soundings all along the coast between these two points. Extensive as the banks may be, only a small part of them, the part about Holsteinborg and Cape Amalia has been tried by American fishermen. That the fish are to be found throughout the whole extent is more than probable; for the species is identical with that taken on the Grand Banks, and we would naturally infer it would be found in all favorable situations within the limits of its distribution. It is also reported that Capt. Rasmus Madson, commonly known as 'Captain Hamilton,' who has been to Greenland several times, set his trawls for these fish farther to the south (probably off of Godthaab) and found them very abundant, but was unable to secure many on account of the numerous ground-sharks playing the mischief with his trawls.

"The depth of water on the banks is from 15 to 90 fathoms. * * * At the inner edge the banks have a sudden slope, leaving a long submarine valley, the depth of which I did not ascertain, between them and the mainland. The surface of the banks is varied, though generally rocky, with here and there sandy and clayey spots. The character of the fauna varies considerably and often abruptly in places a little distance apart. * * * The halibut were also more plentiful upon the edge than any other part of the bank. * * * It will readily be seen from the preceding remarks that a careful survey of the banks, with the view of determining their limits, character, and fauna, could not fail of being of great use to the fishing interest, to say nothing of its immense importance from a natural history and geological point of view." (Report U. S. F. C., 1880, pages 193–4.)

Besides the banks that have been described there are many small patches, generally some part of the shore soundings, along the coast from Florida to Maine which are resorted to by small boats and also by larger craft. Although these fishing-grounds are important in the aggregate there are none of them sufficiently large to require a special description in this place.

Mention should also be made of some of the more noted inshore fishing-grounds of the north. Among these, perhaps the most important is the Strait of Belle Isle, though at present this locality is rarely visited by fishing vessels of the United States. The inshore halibut grounds, along the shores of Anticosti Island and the coast of Lower Labrador, were important for a few years, 1870 to 1874, but have seldom been visited since 1875, the few trips that have been made to those localities since that period being usually unremunerative. Other inshore

localities, which are no longer good grounds for halibut, might be mentioned, but it may suffice to say that at present the only place where halibut are found abundant near the shore is on the west coast of Newfoundland.

THE MACKEREL FISHING-GROUNDS.

The principal fishing-grounds for mackerel (*Scomber scombrus*) are along the coast of the United States north of Cape Hatteras and in the Bay and Gulf of Saint Lawrence. The ordinary range of the mackerel on the American coast is between the parallels of 35° and 52° N. latitude. Instances have been recorded of their appearance north and south of these limits, but all the evidence goes to show that their presence in those waters is exceptional. The extent of the fishing-grounds on which mackerel are commonly caught is considerably less than that first mentioned, since they are rarely taken south of the thirty-seventh or north of the fiftieth parallel of north latitude, and the best obtainable evidence shows that the average southern limit of the first catches in the spring is about 38° 00′ N. latitude.*

The most northern localities where mackerel have been found abundant by fishermen who were seeking them (this is by no means a common occurrence) are the Seven Islands, 50° 05′, and Mingan Islands, 50° 14′ N. latitude, both of these groups of islands being situated near the coast of Lower Labrador.

Mackerel appear on the coast of the United States early in April—very rarely in March—and until the middle or last of May the fishing-ground for them is along the coast from off the capes of the Delaware to the South Shoal of Nantucket, advancing northwardly with the season and at varying distances, say from 3 to 60 miles, from the land. From June to September the best grounds for these fish are off the coast of Maine. Sometimes they are caught in the bays, some distance inside of the outer islands, but more generally from 5 to 70 miles offshore. Large schools of mackerel frequently appear on George's Bank in the summer, and it is not uncommon for that to be one of the favorite grounds for these fish during a large part of the season. When the autumn migration of the mackerel takes place, which is generally in October, and continues sometimes through November, they begin to move southward; the fishing-grounds, of course, change (the vessels follow-

* The journal of schooner Alice, of Swan's Island, Maine, records the fact that the first mackerel in 1879 were caught in 37° 50′ N. latitude and 74° 03′ W. longitude. The first catch of the Alice in 1878 was in 38° 38′ N. latitude.

The journal of schooner Augusta E. Herrick, of Swan's Island, records first mackerel taken in 1879 in 37° 57′ N. latitude and 74° 22′ W. longitude.

First mackerel taken by schooner John S. McQuin, of Gloucester, in 1879, in 37° 42′ N. and 74° 13′ W.

First fish by Charles Haskell, 1879, in 38° 08′ N., 73° 57′ W.

First fish by schooner Albert H. Harding, 1879, in 38° 08′ N., 74° 30′ W.

First fish caught by schooner John Somes, in 1838, was in 38° 21′ N. and 74° 12′ W.

ing the schools) from the coast of Maine to Massachusetts Bay and the waters off Cape Cod. They have never been followed far south of Cape Cod when leaving the coast, the inclemency of the weather at that season generally preventing such an undertaking. It should, however, be said that mackerel have been found for the past few years quite abundant and of large size during the entire summer season and quite late in the fall, in the vicinity of Block Island.

We will now consider the more eastern or northern resorts of the mackerel. Toward the latter part of May, about the time when the southern wing of the great army of mackerel is approaching the waters of Cape Cod, another body, which may be called the northern wing, and which would appear to be distinct from the other, sweeps in past the island of Cape Breton and enters the Bay of Saint Lawrence. The mackerel make their appearance in those waters late in May or early in June. These are, however, apparently but the vanguard of the schools of fish that follow, and which are undoubtedly part of the same body of fish that first makes its appearance on the coast of the Middle States. During the month of June large quantities of mackerel are moving along the coast of Nova Scotia and passing through the Gut of Canso into the Bay of Saint Lawrence. Many fish are caught in nets, seines, and pounds while these migrations are taking place, and also during the fall when the mackerel are returning over the same track on their way south, and therefore the coast of Nova Scotia for a brief season in the early summer and late autumn may be considered a fishing-ground for mackerel, although the fishery on that coast is carried on exclusively by residents of the Province. Of the Bay of Saint Lawrence it is only necessary to say that from early in June to October, seldom later, this is a well-known habitat of the mackerel, though since the universal adoption of the purse-seine by the mackerel catchers much better fares have been obtained on the coast of the United States, and as a rule trips to the bay have resulted in loss. This is partly due to the mackerel being less abundant and of a poorer quality than formerly, but in a greater degree to the difficulties of seining on grounds where the water is generally shoal and the bottom foul. In conclusion, mention should be made of the fishing-ground off the east side of Cape Breton Island, in the vicinity of Sidney, where mackerel have occasionally been found abundant; Sable Island, where they were found quite numerous and of large size for one or two seasons, about 1853 and 1854; and the west coast of Newfoundland, where they have been known to occur at irregular intervals and where at least one trip has been obtained by an American schooner.

B.—The fishery marine.

Important changes have been made in the models of fishing vessels during the last half century, and in the appliance of labor-saving apparatus to their rig and fittings. Although these improvements have

contributed much to the comfort and safety of the fishermen as well as to the success of the fisheries, it will, perhaps, suffice for the present purpose to allude very briefly to the vessels of former days, some of which may yet be occasionally seen, particularly in the shore fleet of Eastern Maine.

The "bankers" of the last century and the beginning of this were narrow, straight-sided, square-sterned schooners, with high quarter-decks, and very bluff—nearly square—bows. They were short-masted, consequently having but a small spread of canvas, and were extremely slow sailers. These vessels were usually from 40 to 75 tons, carpenters' measurement. The Chebacco boats, or "ram's-head boats," as they were sometimes called, which at that time were employed in the shore fisheries, were of small size, 10 to 20 tons, and were generally sharp aft, with two masts and no bowsprit. Next came the pinkie and the square-stern schooner with low quarter.* About 1845 the "half sharp" schooner made its appearance, and from this date rapid changes were made, and a few years later, about 1850, the "sharp-shooter" (as the clipper schooner was at first called) was introduced.

The fishing vessel of the present time is the embodiment of the combined and intelligent efforts of fishermen and builders through a long period of years, and as a result we now have the schooner-rigged clipper, with broad beam, a large spread of canvas, and possessing excellent sailing and sea-going qualities. Although there is a general resemblance to each other among the vessels composing the fishing fleet, certain changes in the rig and slight differences in the model are sometimes rendered necessary for their better adaptation to certain branches of the fisheries. Nearly all of the larger class of vessels are, however, constructed on a model which is well adapted for any fishery, and it is only the so-called market boats, which are usually of smaller size, and a very few vessels built for the mackerel fishery alone that differ from the rest; these are usually very sharp, and sometimes not so deep as the others, large deck room and swift sailing being the qualities most desired. There are, however, considerable differences in the rig. These are rendered necessary by the changes in the seasons, it being evident that in some branches of the fishery where speed is a special object a larger number of sails can be carried in the summer, when light winds are prevalent, than during the winter months, when heavy gales are frequent. The winter rig of the vessels employed in the George's cod-fishery is the lightest of any. To fit them for a winter trip the maintopmast is sent down, and they then carry but three sails, namely, mainsail, foresail, and jib. In the spring, when there is no longer a probability of meeting heavy gales, the topmast is replaced, and they then carry a staysail, and some have also a gaff-topsail.

* Although sloop-rigged vessels have been and are still employed in the fisheries, these form but a comparatively small part of the fishing fleet, the schooner rig having always been a favorite one with our fishermen.

The summer rig of the Georgesmen, that has just been described, is the same as the winter rig of the vessels that are employed in other branches of the fisheries; for instance, the bank halibut fishery, the haddock fishery, and the shore cod fishery. In summer nearly all of the bankers and mackerel catchers have flying-jibs. Many of the latter class of vessels, and also a few of the halibut catchers, have a foretop-mast, and carry, in addition to the sails that have already been mentioned, a fore gaff-topsail and balloon-jib. A vessel rigged in this manner has eight sails, and resembles a yacht in appearance; a schooner of 75 tons will spread nearly 1,300 yards of canvas. The necessity of making rapid passages to and from the fishing-grounds, and moving swiftly from place to place in pursuit of fish, renders it necessary to have a large amount of canvas to improve the prevailing light winds of summer.

The size of the vessels engaged in the fisheries varies from 5 to 193 tons, although there are but few that are more than 110 tons. The fleet engaged in shore fisheries is composed of vessels of the smallest class, from 5 to 50 tons, the average being about 20 tons. A portion of these, more particularly on the east coast of Maine, are old-fashioned vessels—a few of them are pinkies—and are not employed except during the season when fine weather may be expected. The greater part of the shore fleet, however, are the best class of small-sized vessels, and many of them are employed in fishing at all seasons. Many of these pursue the cod and haddock fisheries in winter. In summer the small vessels engage in many kinds of fishing, changing from one to another, and following whatever promises the best results at the time.

The winter haddock catchers are usually all first-class vessels varying in size from 25 to 80 tons, averaging about 50 tons. Many of these vessels are among the finest in the fleet, and the majority of the larger ones are generally employed in the mackerel fishery in summer. While the smaller haddock schooners do not go farther than 30 or 40 miles from the land, and usually a much shorter distance, the larger ones make trips to George's and Brown's Banks, and occasionally even farther east.*

The Georgesmen are all first-class vessels, averaging a little more than 60 tons, the extremes being from 40 to 85 tons. These vessels, like all others that are employed in the winter fisheries, are heavily ballasted with rocks or iron (generally with the former); the ballast is covered with planks, which are fastened down in the most secure manner. Above this platform the hold is divided by bulkheads and partitions into sections or pens, in which the fish are packed away in ice, or salted. Although the vessels undoubtedly fish on George's Bank the greater

* Trips are made to the western part of Nova Scotia, and during the winter of 1880-'81 many of the large vessels went as far as Le Have Bank, where haddock were found in great abundance, some of the vessels getting as many as 500,000 to 600,000 pounds each during the winter, most of which were caught on this bank.

part of the time, they also make trips to Le Have Bank, Brown's Bank, Seal Island Ground, German Bank, and occasionally to some other grounds. A few trips have been made as far east as the Western Bank (Western Bank and Le Have trips are usually made in December and January), and as far south as Block Island, but only at rare intervals.

The greater part of the vessels composing the mackerel fleet are clipper schooners, many of them being equal in appearance and sailing qualities to first-class yachts. It has already been mentioned that some of them carry a great amount of light sail, but while this is true of the larger vessels and for some others, there are a few of the smaller ones that have no flying-jibs. The average size of the mackerel catchers is about 60 tons, the extremes being from about 20 to 151 tons. There are few, however, over 100 tons; and the largest one is a three-masted schooner.

The bankers average larger than the vessels employed in other fisheries. Few are less than 60 tons; the average size is about 75 tons; while a small number are more than 100, and the largest, a three-masted schooner, is 193 tons. The fleet is composed chiefly of the finest class of sea-going vessels, and this may especially be said of those employed in the bank halibut fishery. There are, however, a few old-fashioned schooners that make trips for cod in summer. The salt carried by the cod-fishermen serves for ballast, and this is stowed in "pens" or bins in the hold. The halibut catchers and a few other bankers are ballasted like the Georgesmen, though perhaps not so heavily, the ice and salt they carry making up the deficiency. The fishing-grounds visited by the bank fleet extend from Le Have Bank to Davis Strait, although the Grand Bank, Banquereau, and Western Bank are the principal ones.

The vessels of the New York market fleet belong chiefly to the ports on Long Island Sound. They differ in some respects from the vessels of Northern New England, as they are, with the exception of the halibut catchers, nearly all welled smacks, and a considerable portion of them are sloops. The smacks take the greater part of their catch to market alive, preserving, however, the dead fish in ice. The vessels engaged in the halibut fishery are arranged somewhat similar to those already mentioned, and the fish are kept in the same manner, namely, by icing them. Although there is not so large a proportion of extremely sharp vessels in the New York fleet as in the fishing fleet north of Cape Cod, there is, nevertheless, a general resemblance between the schooner-rigged vessels and those of Massachusetts. The average size of the market smacks is about 40 tons, the extremes being 20 and 65 tons. The smacks fish from Cape Henlopen to George's Bank, principally on some part of the shore soundings, catching cod, haddock, &c., in the winter, and besides these several other varieties in summer. The halibut catchers go farther east on George's Bank and adjacent grounds. The few vessels employed in the southern coast fisheries belong to the same class as the smacks that have been mentioned; indeed the greater part of them were built in the ports of Long Island Sound.

The next to be considered are the open boats, of which there are a great many kinds, a few only of which, the more notable forms, can be mentioned here.

The sharp-stern fishing-boat is more universally used in the coast fisheries than any other, and to show how widely these are distributed along the coast it is only necessary to mention that the boats of Block Island and No Man's Land, the "five-handed" boat of Cape Cod and the coast of Maine, and the "quoddy" boat of Eastport, belong to this class.

One of the most peculiar fishing-boats on the coast is the cutter-rigged sloop, used exclusively by the Irish fishermen of Boston. These are said to resemble the fishing-boats of Ireland, and are generally called "Dungarvan boats" by other fishermen. The length varies considerably, the average being about 30 feet on top. They have a reasonably sharp but rounding bow, square stern, with the rudder hung outside; are deep in proportion to their length, with a wide stem and deep keel. They are said to be excellent sea-boats. The forward part is decked over, thus forming a cuddy where the crew eat and sleep. There is a cockpit aft, with a seat around it. The midship section is partially covered on each side. In the bottom of this is placed the ballast, on top of which the fish, gear, &c., are stowed. The bowsprit is adjustable, and two jibs are carried, one being set on a stay, the lower end of which fastens to the stem. In other respects they do not differ materially in rig from other sloops. In spring, summer, and fall these boats are employed in the cunner, haddock, and other fisheries for Boston market, the catch being chiefly sold fresh. In autumn most of them engage in the herring fishery with gill-nets at Cape Ann and other points in Massachusetts Bay.

The dory, which is so well adapted to the deep-sea fisheries, and is quite indispensable to our bank fishermen, originated during the latter part of the last century in Salisbury, Mass. This boat was originally designed for a lighter, and for many years was scarcely used for any purpose besides that of removing the cargoes from vessels at Newburyport. It was, however, employed to some extent in the fisheries early in the present century, and since the introduction of trawl fishing it has come into general use. The thwarts are adjustable, and, when these are removed, several dories may be "nested" inside of each other, the whole occupying the same space as one boat, and for this reason they are much better adapted for stowage on the deck of a vessel than any other style of boat. In addition to this, they are excellent boats in a rough sea, are capacious, light to handle, and also cheap; therefore it follows, as a matter of course, that they are extensively used in most of the important fisheries, among which may especially be mentioned the bank cod and halibut fishery and the mackerel fishery (each vessel with a purse-seine usually carries two dories). Large numbers are also employed on the haddock vessels, the shore fishing fleet, and in the boat

fisheries of the coast. These boats are flat-bottomed, with flaring sides, sharp bows, and V-shaped, oblique, projecting sterns. They are from 12 to 16 feet in length (bottom measurement), different sizes being required for the various kinds of fishing. There is but little variation in the models, although for certain purposes* they are built somewhat wider and deeper than the average.

The seine-boat that is used in the mackerel fishery is a modification of the whale-boat, and is sharp at both ends. It has been found admirably well adapted for purse-seining, as it moves easily through the water and at the same time has sufficient buoyancy to carry safely a large seine while being towed very swiftly by a vessel. The ordinary size of these is 36 feet in length, though a few larger and smaller ones are used.

In addition to the boats that have been described, the following may be mentioned as being, perhaps, the most noticeable: (1) The square-sterned, sloop-rigged lobster-boat of Bristol, Maine; (2) the square-sterned "reach-boat"; (3) "double-ender" (a canoe-shaped boat), both this and the preceding being common on the coast of Maine; (4) the "drag-boat" of Cape Cod; (5) the square-sterned, cat-rigged boat of Southern Massachusetts; (6) the sloop lobster-smack of Long Island Sound; and (7) the surf-boat of New Jersey.

The other forms of fishing-boats are mostly modifications of those that have been noticed, and it is scarcely desirable to make further mention of them here.

C.—METHODS OF CAPTURE OF SEA-FISHES, AND THE CHANGES IN THIS RESPECT IN LATER YEARS.

The different varieties of sea-fish and their varying habits and modes of occurrence involve the necessity of special or peculiar methods for their capture; and the great diversity of implements and processes in use in different parts of the world is therefore not a subject of wonder. For the most part, however, nearly all the methods will fall under the head of the bow and arrow, the spear or lance, the line, the seine, the beam-trawl, the weir or trap; with some subsidiary means, such as the employment of narcotics or poisons, explosives, &c. I shall consider these methods under the foregoing heads.

The bow and arrow.—It is probable that in the pursuit and capture of wild animals our savage ancestry first made use of the hand or foot, the power of running, the strength of arm, and the acuteness of the perceptions, especially those of sight and smell, which in all probability were developed to a very high degree, and in this respect equaling, if even

*Dories built expressly for haddock fishing, where but little rowing is required, are not so sharp as others, carrying capacity being the chief requirement. The same may be said of those used by the fresh-fish companies in the larger fishing ports. A few have been built with rounding sides, but this form has not been so favorably received by our fishermen as the other with straight flaring sides.

they did not sometimes surpass, the most highly favored of the associated animals. Very soon, however, subsidiary apparatus would be called into play, either the throwing of stones or sticks, picked up at random, or the use of a specially fashioned club either for striking or throwing; and ultimately the arming of the stick with an implement for piercing, constituting the spear or lance, and, finally, the discharge of this spear, in a modified form, by means of a bow, constituting the bow and arrow.

It is, of course, difficult to say how soon the arrow and the lance were brought into play. We only know that among the very earliest prehistoric implements are the stone tips, undoubtedly used for this purpose and continued to be employed by the wild tribes down to the present day. The bone and wooden tips, which doubtless were called into play at about the same time, perished, as being constructed of less durable material.

The spear and the bow and arrow constitute very efficient means for capturing fish, in view of the closeness of approach to many species which is possible. No more effective method could be devised for capturing such species as the salmon than the spear, with its modifications of the harpoon, the grains, &c. In sea fishing it is especially such fish as the flounders, skates, eels, and other kinds that fall victims in large numbers to this method. The Esquimaux and the Indians of the northwest coast of America employ the bow and arrow very extensively for the capture of fish of various kinds. There are numerous and varied illustrations of this fact among the collections of the National Museum at Washington.

The harpoon comes legitimately in this series of weapons and has numerous applications. The head is placed at the end of a stiff handle, and sometimes when this is buried in the flesh it slips off, but remains connected by a thong or cord either to the harpoon itself or to a buoy which is thrown overboard. The latter method is most generally employed in the capture of the swordfish. In the whale fishery the end of the line is attached to a boat, which thus serves as a buoy or float. The combination of a torpedo or an explosive with a lance, either kept in the hand or discharged from a gun, is a more recent and extremely efficient method of capture of the large animals of the sea.

The line.—This may be considered essentially under the two divisions of the line held in the hands or at the end of a rod affixed to some object on the shore or to a float of some kind, and having at the extreme opposite end one or more hooks baited, with or without floats, for buoying the hook to a certain height above the bottom, or for showing by its motion the attack of the fish. Here we have the first idea of the hook, either covered with some substance attractive to the fish that conceals its character or simulates small fish and other objects that tend to attract its victims. The use of the hook and line in combination for the capture of fish is of the utmost antiquity in this respect, perhaps little inferior to the bow and arrow. While, of course, the lines themselves

have perished with time, we still have the hooks, sometimes of stone and sometimes of bone, of shell, or of metal, and usually constituting very attractive objects of archæological research. Usually the barb of the hook is on the inner or concave line. A curious anomaly, however, in this respect, is seen in the hooks of the prehistoric tribes of the coast of Lower California, which, whether made of bone or of shell (sometimes of extreme artistic beauty), invariably have the barb on the outer or convex outline. Sometimes the barb is dispensed with entirely, with or without some device to occupy its place and function.

The hook and line, whether in the hand or affixed to the end of a rod, is the simplest of all methods for capturing fish, and the one most universally employed. Where fish are abundant it will generally take a sufficiency for all ordinary purposes, although where a large market is to be supplied it is not wholesale enough for the requirement. It does not waste the fish as much as other methods, and has especially the advantage of seldom taking those about to spawn, most species refusing, when in this condition, to be allured by the bait. There are some fish, indeed, which cannot be induced to take the hook at any time, and of course we have to depend on other methods, especially the net, in one form or another, for capturing them.

The trawl-line.—Where fish are needed in larger number than they can be taken by the hand-line, with a given number of persons, and where distant markets, rather than the local consumption, are to be provided for, what is called the trawl-line comes efficiently into play. This term, however, is applied to it only in the United States, where it is sometimes called the "set-line." On the continent of Europe it is known as the "long-line," while in England it is called the "bultow," and one variety of it, the "spiller." It consists of a long line, having fastened to it at regular intervals, usually 6 feet, a succession of short lines, usually about 3 feet in length, and having hooks at the ends. The antiquity of the trawl or long-line is probably very great, the period of its first introduction into Europe not being anywhere a matter of record. It was first used in North America on the banks of Newfoundland for sea fishing by the French. Its introduction to the main land of the provinces and of the United States has been somewhat more recent, although now it is very generally made use of.

According to Captain Atwood,* the use of trawl-lines was first introduced into Massachusetts by a number of Irish fishermen of Galway, who settled on Cape Cod. Their success with this novel apparatus was so great as to induce its immediate adoption by the native population.

There has been a singular antagonism on the part of those who use

* Writing of the occurrences of the year 1843, Captain Atwood says: "About this time we began setting trawls for halibut, as has been described elsewhere." Capt. Peter Sinclair, of Gloucester, claims to have been the first to use trawls in Massachusetts Bay, about 1850, and makes the statement that a man named Atwood, who belonged at Provincetown, and was with him at the time, afterwards introduced the method of trawling in that place.

the hand-line, to the introduction of the trawl, and many accusations have been brought against it, on the score of its destruction of the fish and the injury to the fishing-grounds, in regard to which we shall inquire hereafter.

One proof of the antiquity of the long-line is the fact of its existence in almost the form used by civilized nations among the Indians of the northwest coast of America. It usually happens that aboriginal methods now employed by savage tribes have been handed down from a very high antiquity, and it is not at all improbable that the people of modern Europe simply developed an implement made use of many thousands of years previously by their ancestors.

The trawl-line as mentioned consists essentially of a line of varying length, sometimes, as on the coast of England, as much as 7 or 8 miles, more usually, however, from 100 yards upwards, with short lines of perhaps 3 feet in length attached at intervals of 3½ to 6 feet, each with a hook, but commonly not provided with leads or sinkers. To one end of this long line is attached a weight, by means of which it is carried to the bottom. The line is then paid out at the side of the boat, the hooks being previously properly baited, and the other end is weighted and dropped to the bottom also. At each end of the long line is an attached buoy, which, floating at the surface, indicates the location of the two ends. Sometimes, in the case of very long lines, there may be intermediate weights and intermediate buoys, those at the extreme ends in such a case being differently marked for their proper designation.

The bait used on the long-lines varies with the country and the circumstances, the longer lines used in England for the capture of cod being baited almost entirely with the whelk (*Buccinum undatum*), a mollusk or shell-fish very abundant in England, and for the capture of which numerous vessels of from 10 to 20 tons are employed.

The whelk is taken sometimes with the net, more usually by the use of some bait which attracts them into a basket or inclosure, in which they are then lifted out. The abundance of this object in the European waters is very great, as with all its consumption the numbers do not appear to decrease.

In the ordinary boat fishing the long-line is usually baited with the common muscle, the use of fish, such as fresh herring, &c., being much less common than in Northern Europe and in America. The whelk and species closely allied to it are abundant in the United States; but so far comparatively little use is made of them. It is probable that in the search for improved qualities and increased quantities of bait for the capture of codfish this will soon come into play and constitute a very desirable and satisfactory substitute for the other varieties. The clam among the mollusks is more generally employed for this purpose, both the *Mya arenaria*, or soft clam, and the *Venus mercenaria*, or hard clam. There are several other species which are used in large numbers for this purpose, to which reference will be made in another

place. Of course fish may be employed, either herring or mackerel, fresh or salted, as well as capelin, portions of the cod, the lamprey, and, indeed, fish generally; the most appetizing and attractive fish bait for this and other purposes is probably the menhaden or pogee.

The trawl-line reaches its maximum of application and of size in the cod and other white fisheries which are carried on in the North Sea on a very large scale. At Great Grimsby, one of the principal centers of this kind of fishing, the long-lining is prosecuted by means of smacks of about the class and size of those employing the beam-trawl, from 40 to 60 tons, and even greater tonnage. A crew of nine to eleven hands is required to bait and work the lines; and the fish when caught are kept alive as long as possible, in wells. A complete set of long-lines, as used in all these vessels, consists of about 15 dozen, or 180, lines, each of 40 fathoms in length, and carrying 26 hooks on smaller short lines, called snoods. These are placed about a fathom and a half apart, so as to prevent the snoods from becoming entangled with each other. These 180 lines are united into one, forming a single line of 7,200 fathoms, or about 8 miles in length, and carrying 4,680 hooks. Contrary to the practice in Norway, where the lines are set in the afternoon and taken up the next morning, in England the lines are always put down and taken up by daylight; they are "shot" at sunrise or earlier, and taken up before night; sometimes, indeed, two casts can be made in one day. The baiting is generally done at night. A small anchor holds the line steady at every 40 fathoms, with a buoy at each end, and at each intermediate mile, as already explained.*

According to Mr. Holdsworth the use of wells in cod-fishing was first tried at Harwich, in 1712, and soon increased very rapidly, until now it is very extensively employed by many nations. In the work of Holdsworth (Deep-Sea Fishing and Fishing Boats) will be found very useful statements in regard to the use of the trawl in England.

As already stated, the whelk is used as bait on the largest long-lines, as any other would be too readily washed away by the rapid tide. The shorter lines, shot from boats, usually in quieter waters, are served by means of the softer muscle, a mollusk, also extremely abundant in the United States. The fish are usually taken alive, and after a puncturing

* Although the British fishermen set longer trawl-lines in one string than the Americans do, they rarely if ever use so many fathoms or such a number of hooks to the vessel as the latter. The greater part of the American "bankers" set more than nine miles of trawl in the aggregate, having 9,000 hooks attached, while the smallest amount would be about two-thirds as much. It should also be borne in mind that it is not uncommon for the American fishermen to set and haul this amount of gear twice a day. The vessels engaged in the winter haddock fishery on our coast have a still greater number of hooks than the cod fishermen. The smallest class of these rarely have less than eight miles of trawl, with 12,000 hooks attached, while all of the larger vessels have, at least, half as much more, and quite a number have twice as many, namely, 24,000 hooks, or about sixteen miles of trawl.—J. W. COLLINS.

of the air bladder by a long needle, they are placed in wells in the vessel and carried alive to market when a cargo has been obtained.

According to Holdsworth (p. 148), there is no reasonable ground to believe that the catch on the coast of England has been diminished in numbers in consequence of the action of the long or trawl lines, the principal means of capture. On the contrary, the same ground has, year by year, furnished an increasing abundance in proportion to the number and size of the vessels employed, the catch being nearly if not entirely as great on any given number of hooks as it was many years ago.

The capture of cod on the Norwegian banks is also made principally by the trawl-line, although the hand-line and the gill-net are also brought into play.

For the purpose of ascertaining the present views of the Norwegian experts charged by the Government with the supervision of fishery operations, I addressed a letter to one of their number, Mr. Robert Collett, of Christiania, Norway, and his reply is herewith presented:

"You ask me whether any question has arisen in Norway as to the greater destructiveness to fish or to the fishing-grounds in consequence of the use of the long-lines. Not at all. I am quite sure the long-line is just used in the 'great cod-fisheries,' particularly in Lofoden Islands and along the coast of Aalesund, *in the spawning season*, and it would be a very bad fishery if the fishermen had nothing but hand-lines.

"I never heard of any putrefaction of the grounds by the fishes breaking off from the hooks, and in the great depths, where the fishery is very good, nothing of that kind would be felt. I never heard of such a thing in Norway, and I could give you an example from the herring fisheries that proves there is nothing probably in this outcry.

"In the year 1834 great herring flocks were caught in a little fiord, Oxlofiord, a branch of Stonfoldenfiord, in Namdalen. By an accident once, the masses could not be taken up from the nets, and several thousand barrels died before they could be used. All these dead fishes were thrown into the water on a very small area in a narrow fiord and covered the bottom with a very thick layer. Notwithstanding, two years later the fiord was again full of fish, and thousands of barrels were caught just on the spot where the fishes had been thrown out.

"As to the nature of the bait, it is partly fish, greatly invertebrates. On the great cod-fisheries in Lofoden, where they are catching the fish from January to March (the spawning season), they use herring. In Finmark they use *Mallotus villosus*, the best bait that is known. (When this fish is in the fiord you cannot get cod with any other kind of bait.)

"Here they also use cephalopods (*Ommastrephes*). In the southern part of Norway, where they catch cod every season, they use *Mytilus modiolus*, *Mytilus edulis*, young *Clupea harengus*, *Arcnicola piscatorum*, and *Palæmon squilla*. I have not heard of any other sort of bait. The bait is

always used fresh, and it is only in the case of extreme scarcity of fresh bait that salted herring are used.

"I remember now another fish which they use in the northwestern parts, viz, the *Ammodytes lancea*. These as well as the young herring are used whole, *i. e.*, the whole little fish on a hook.

"ROBERT COLLETT.

"CHRISTIANIA, NORWAY, *October* 4, 1877."

The winter fishing on George's Bank is entirely by hand-lines, the weather being too inclement to permit the use of the trawl. At the Lofoden Islands, 24 lines, each with 120 hooks, are usually fastened together into one, thus carrying 2,880 hooks, although sometimes, in particular localities, where the nature of the bottom requires it, a much shorter length is employed. As in England, the short lines, or snoods, are between 6 and 7 feet apart. Here, however, the lines are shot in the afternoon, remaining down all night and taken up the next morning. No line can be put down before noon, nor can it remain down after midday.*

Very often a glass ball, the size and shape of an egg, is fastened about a foot from the hook, so as to buoy the bait a few feet from the bottom and make it more easily observed by the fish.

The usual yield of a long-line, with the number of hooks given above, is 240 to 360 fish per day, and it is readily managed by two persons, while a hand-line, worked by one person, rarely takes more than 50 per day, thus showing a marked difference in favor of the trawl. Very frequently the long-line, instead of being kept down for a period of twelve hours or longer, is overhauled much more frequently, especially in comparatively shoal water, where the line is no sooner fairly down than it is again overhauled and rebaited.

Various modifications as to the size and bait of trawl-lines are found in other countries; but what we have already stated will furnish a sufficient idea of the general character and applications of this important item of fishing apparatus.

As already stated, very grave complaints have been made against the long or trawl line in the United States, and legislation or mutual consent invoked either for its entire abolishment or its restricted use under certain specified conditions.

The advantages of this method will readily be understood, as consisting in the much greater efficiency and the much larger yield of fish taken by the same force of men; as also in the fact of the more continued exposure of the bait, in consequence of which fish that are deterred from biting at the hand-line in its incessant motion, or only kept down during the convenience of the fisherman, are more tempted by the bait on the long-line, which is much more quiet and remains on the ground sometimes for a number of hours.

* Baars, Des Pêches de la Norwége; Paris, 1867. H. B., Die Fischerei Industrie Norwéges, Bergen, 1873.

The disadvantages of the long-line, as alleged by those opposed to its use, may be formulated essentially as follows:

(1) It is more expensive, requiring a larger capital, and consequently rendering the poor fishermen unable to compete with the more wealthy in regard to its acquisition and employment. Objections of this kind generally come from the hand-line fishermen, who, however, when able to purchase the long-line, are very apt to forget their former scruples and to use it without hesitation. This change of policy, is excused on the score of self-protection and the necessity of employing methods similar to those of a rival fisherman for the purpose of making a living.

(2) It is sometimes objected that it requires two or more persons to use the trawl-lines instead of one. That a combination of persons should accomplish a much larger result than the aggregate of their separate endeavors is in accordance with the general principles of a sound political economy.

(3) It is asserted that the line is much more liable to be lost than the hand-line. This is said to be caused by the wearing of the line on rocks, although generally the buoys at each end enable the separate portions to be recovered. As a matter of actual experience, however, the expense of lines absolutely lost in this way amounts to a very small percentage of the original cost.

(4) The fish are brought up dead or not always perfectly fresh, and many of them are devoured by other fish, as eels, codfish, sharks, crabs, &c., either while living or after death.

This objection is, of course, one that may be fairly put; but after all, the yield of sound, merchantable fish is sufficiently great to permit an average wastage; and if it be fish killed on the hook and remaining in the water for some time, it is for the advantage of the consumer to have the services of these scavengers in assuring a supply of perfectly fresh fish for the market.

Although these objections will not apply to so great an extent to the hand-line, yet they do attach to the use of the gill-net, and, in fact, to a still greater degree, in both methods a considerable loss taking place. This destruction, however, which has been claimed as involving a wastage of the fish in the sea, is not a question for the consideration of the owner of the line, as an equivalent in weight to the very fish thus consumed while attached to the hook would in all probability have been taken while swimming free in the sea by these same enemies.

The practical experience in trawling, however, is that while some of the hooks are brought up entirely empty, very few hooks have mutilated fish upon them, a large proportion being alive and in good condition, and on being placed in the wells of the smacks are capable of being kept for a long time.

As a general rule codfish in England are sent alive to the markets, and the enormous quantity consumed there and elsewhere is taken for the most part by the long-line. If in consequence of a storm or some

special condition the line be necessarily left down longer than usual, a still larger percentage of fish will be found dead, possibly the entire number. But it must be remembered that this fishery is almost universally prosecuted in the colder waters of the ocean, frequently where the temperature varies from 35° to 42°, which of course serves to preserve the fish much longer than a warmer medium.

(5) The wastage of the fish by dropping off the hook before they can be taken into the boat. This accusation is based upon the alleged practice of using considerably smaller hooks than those required for the hand-lines; and while it is possible that this may happen occasionally, it is quite certain that the fishermen will graduate the size of the hook so as to obviate such a danger, and even if a considerable percentage be lost, as already explained, this is the concern of the fishermen and not of the general public, the fish thus slipping away being consumed by the scavengers in place of live fish in equal bulk.

(6) The capture of roe or spawning fish. It is difficult to know what weight to attach to this objection, although it is very generally asserted that a spawning fish will bite at a long-line when it will not do so at a hand-line, the fish at this time being much more cautious in its approaches. So far as the cod are concerned, however, and the *Gadidæ* generally, it is probable that the force of the objection is lessened by the fact that the long-line is used more especially at the time when the fish are not spawning. As a general rule the cod, haddock, and hake, &c., are known to spawn in the winter months, usually in January, February, and March, sometimes a little earlier and sometimes a little later. It is precisely at this time, when, in consequence of the inclemency of the weather, in North America at least, this mode of fishing is more or less intermitted, consequently allowing the spawning fish a sufficient opportunity for discharging its roe undisturbed. This explanation applies more to the offshore fish, however, as the winter inshore fisheries of the New England coast are almost exclusively directed to outside fish that have come in to lay their eggs.

When we bear in mind the very small percentage of deep-sea fish that can be taken by man at all, and the immense yield of eggs of most of the species (amounting to several millions for each female cod, and others in proportion), we can easily believe that an objection of this kind can have but little weight, even if the fish were harried to the utmost during their spawning season. If, however, as is most probable, they are comparatively undisturbed on many fishing-grounds at that time, the objection falls essentially to the ground.

To the subject of the prolific character of the fish of the sea and the number of eggs laid by some of the more prominent species, reference has been made in another part of this report (page 82).

There is another consideration which may be borne in mind in regard to the so-called lazy or logy cod which cannot be caught with the hook and line. Many of these are in reality past the period of bearing, as

there is every reason to believe that, like other vertebrate animals, after a number of years of service in this respect, the fish, whether male or female, becomes sterile. Sometimes this is the result of sickness or disease; at others the fish is in its best condition for food. A codfish of 20 or 30 pounds is probably as efficient for reproduction as one of 50 pounds, and perhaps more likely to furnish a healthy progeny, able to meet the exposures of the sea.

(7) The long-line fishermen, in their wholesale method of capture, in America, at least, clean their fish at sea and throw the refuse, consisting of the heads, entrails, &c., commonly called "gurry" in America, overboard. This pollutes the fishing-ground and drives away fish for a period of months or even years, and this in connection with the fish that break away from the line on being hauled up, or which are partly devoured at the bottom.

This, with the alleged destruction of fish by the use of the trawl-line, is the objection upon which the opponents rely as the most formidable and as carrying the greatest weight. This will be considered in considerable detail (in another place under the head of Disposal of Offal), as, if established, it would constitute a reasonable ground for regulating this fishery, even by its restriction, limitation, or total abolition.

Bearing now in mind that the objection to the trawl-line is based more exclusively on the injurious effect of throwing overboard the offal of the fish cleaned at sea, the matter of self-interest and the desire to economize waste products will doubtless in time regulate the subject. It is a very significant fact that in Europe, where the practice of trawling has been conducted for many centuries and on a scale greatly in excess of anything of the kind in the United States, and where the same ground has been fished over and over again by a much larger percentage of hooks than is ever seen off the coast of North America, there has never yet been any suggestion of injury from this mode of fishing. The controversy there has not been on account of the interference of the long-line with the hand-line fishing; but it has been in opposition to the use of the beam-trawl, and it never, apparently, has come into the mind of the hand-line fishermen that there was any evil whatever resulting from the other mode of fishing besides the advantage given by the fact of a greater proportionate yield. The drift and purse seine interest, too, antagonizes the beam-trawl, but not the long-line, and it is not to be imagined that any real objection to the long-line would have failed to be brought forward and to excite the animadversion of parties fishing in a different manner.

The largest lines used in America are far inferior to those used in the British seas, where they are sometimes over 8 miles long and carry between 6,000 and 7,000 hooks.

The experiences recorded in such works as that of Holdsworth on deep-sea fishing, and of other writers, all tend to show that notwithstanding the ever-increasing number of long or trawl lines in certain

localities, there is no reason to believe that the fish have decreased in number in consequence, the captures always being proportioned to the increase in the length of the lines and the size of the vessels and their crews. In some cases it is alleged that the cod, in its well-known voracity, swallows the head and backbone of its fellow as it is thrown into the water, and is thereby rendered ill and sometimes even killed by the feast. This can only result from the laceration of the gullet and stomach by the bones, a condition which must ensue very rarely in a fish which fills its stomach with large sharp-edged shells without experiencing any evil effect.

The digestion of fish is very rapid, and it is not an uncommon thing to find that when a fish has been seized by another and is too long to be swallowed entire, the portion near the stomach is digested while the fragment projecting from the mouth is fresh and sound.

Upon the whole, therefore, I am inclined to conclude, from all the considerations and the testimony offered, that there is no actual proof that the use of the trawl or long line in itself is injurious to the fisheries, so far as relates to the driving of the fish away from the grounds. It may render the desirable fish less eager to take the hook, or it may attract predaceous fishes, so as to frighten away the more noble for the time; but that any influences thus exerted can extend over a period of more than a few hours it is difficult to understand. If there be any evil effect, it is possibly from the gurry, but even this I am not willing to admit. This evil, if it be one, will be remedied in our waters, as it has been within a recent period in other cases, by a utilization of this material as a wasted product, the yield or profit therefrom and its conversion into oil or guano being greater than the cost of saving and delivering it on shore. At any rate, before any legislation is invoked, a more careful examination on the ground of the more important regions alleged to be affected should be made by scientific men. The question of refuse matter on the bottom at depths of 15 to 30 fathoms can easily be settled by the use of the water telescope, a well-known implement in scientific research.

In further illustration of the subject, I call attention to the fact that in the investigations in Norway as to the cause of the disappearance of the herring from accustomed grounds, it was maintained that the dead fish, dropping from the gill-nets, or remaining in the meshes of the nets, that had become lost and entangled at the bottom, had produced this state of things. The water telescope was brought into use and it was ascertained that the number of such fish was much less than was alleged and that after being dead one day they had entirely disappeared, and furthermore it was found there had been an entire abandonment of certain localities where the gill-nets had not been used at all, and fish had previously been taken wholly by drawing seines from the shore.

Captain Nathaniel Atwood, of Provincetown, while earnestly combatting the assertions in regard to the injurious effects of the trawl-line upon the fisheries, admits that they do appear to have a positive action on the abundance of the halibut, or at least those of the large individuals which are specially sought after for the market. He thinks that these large halibut are quite likely each to occupy a considerable area of ground, to the exclusion of others of the same species, and that when they are caught, it takes a considerable time for their restoration. He mentions a curious relation in the co-existence of halibut and haddock, the result of the capture of the halibut in the grounds conjointly occupied by them, being a very marked increase of haddock, so much so as to render them almost a drug in the market and reducing the price very materially. This is due to the fact of haddock being devoured in immense numbers by the halibut while present, and their consequent increase when their enemies are captured.*

I have already adverted to the fact that in the course of an extended and exhaustive investigation by Professor Huxley and his associates into the subject of the British sea fisheries, contained in a Blue Book of 1400 pages and involving the answering of 61,830 questions, there were but six witnesses of the entire number examined who made any objections to trawl-lines. One fisherman alone (vol. 2, p. 554, question 24,996) considered it a destructive mode of fishing in itself, his objection being that by using very small hooks they caught too many young fish, which, had they been allowed to grow up, would have furnished a more profitable yield.

One fisherman, in answer to questions 39,994 and 40,389, said he found a difficulty in getting bait of the right kind with which to supply the hooks, although approving of their use.

To No. 40,976, a fisherman replied that the trammel nets, such as he used, were liable to be torn by contact with the long-lines. Another trammel-net fisherman, in answer to question 41,023, maintained that the long-lines frightened the fish away from his net, so that he could not get all that he expected.

The net.—Having thus concluded the subject of line fishing, we come to the second of our principal divisions, namely, that of the use of nets. It is hardly necessary to go into any minute account of this mode of

*Another instance of this mutual interdependence of fish, as asserted by the fishermen, occurs on the coast of Nova Scotia, in this case between the lobsters and the starfishes. According to this the lobsters are destroyed by the starfishes in great numbers, and in the immediate vicinity of the canning establishments where the lobsters are taken and put up there is found to be an appreciable diminution of them from this cause. The starfishes are then said to multiply very greatly. The fishermen insist that the starfishes feed upon sea-weed, and that they devour this in such quantities as to clear the bottom of this covert, and that the food-fishes finding no means of concealment do not resort to what were formerly excellent fishing-grounds. The statement that starfish eat sea-weed is perhaps yet to be substantiated.

capturing fish, as I have already treated it at great length in the first volume of the Reports of the U. S. Fish Commission. I may simply remark that the use of the net extends back to a very remote antiquity, possibly as great as that of the hook and line, if it be not still older. That the inhabitants of the pile dwellings of Switzerland and Central Europe used the net is shown by the finding of many specimens of the netting and the sinkers. The employment of the net by all civilized nations proves that it has been handed down to them from a high antiquity. The seine was used in the pre-Columbian epoch by the Indians of North America, as it is not unusual to find on the rivers and shores large numbers of small rounded stones, notched on two sides, to serve as weights, of precisely the same character as those in use at the present time by the Indians of the northwest coast of America.

The principal forms of the net are the hand or scoop-net, the dip-net, the casting-net, the seine, the trammel-net, the gill-net, the purse-net, and the stake-net.

The scoop-net is familiar to every one. It has various shapes, and is used for landing fish caught with the hook, or capturing fish, particularly the small varieties, penned up in restricted localities.

The dip-net may be considered a modification of the scoop-net, being suspended at the end of a long handle.

The casting-net is largely in use by the Spaniards and Italians, both in Europe and America. This is circular, varying in diameter from 12 to 15 feet. It has leaden balls around the edge, and a long rope attached to the center. This is thrown very skillfully to a considerable distance in such a way as to fall flat upon the water, and dropping rapidly to the bottom incloses any fish that may happen to be beneath it. When the rope is hauled on, the leaden balls at the edge come together at the bottom, so that the net is pursed up when drawn from the water, and the fish are found therein as in a pocket.

The seine is also familiar to all. This is a continuous net, with floats of cork, glass balls, or light wood along the upper margin, and weights of lead or stone along the lower or bottom. Sometimes it has a bag in the center, for the greater facility of holding the fish. This net is sometimes worked from the shore, one end being held on or near it, and the other carried around so as to form a sweep when the two ends are hauled in simultaneously. Sometimes this is dropped in the sea and made to inclose a school of fish. This becomes a purse-net when there is some arrangement for bringing the lower edge of the net together, like the inclosure at the mouth of a purse, so that the fish find themselves closely confined, both laterally and below.

The trammel-net is a very efficient means for capturing fish in waters where dragging is not possible or convenient. This consists of three nets bound together at the edges, the outer ones on either side having a large mesh, and the central one a fine mesh and much fuller than the others. Fish swimming incautiously against this net pass through

the outer mesh and strike against the finer central net, carrying a fold of it through the large mesh of the net in the opposite side, and thus become pocketed.

The simplest of all nets, perhaps, is the gill-net, which is a webbing of usually very fine twine, made to float either from the surface or carried to the bottom. The fish, unaware of its presence, or careless in regard to it, in swimming against it pass the head and shoulders through the mesh and become entangled and held until removed, or until devoured by some predaceous fish or invertebrate. No mode of fishing is more economical than this, as the capital required is comparatively light. The nets can be managed by a few persons, and it is only the large fish that are taken, the smaller ones passing readily through the meshes.

The stake net will be found described in the report of the U. S. Fish Commission. It comes more properly under the head of weirs and pounds.

The beam-trawl.—The beam-trawl is not used in America for the capture of fish, although it has been a favorite piece of apparatus with the U. S. Fish Commission for capturing specimens of various kinds of fishes and other marine objects. It is, however, extremely probable that at no distant day it may come into use and our fisheries be prosecuted to a very considerable degree by its aid, although hardly to such an extent as it is employed around Great Britain and off the coasts of France, Holland, and Belgium.

It is essentially a large bag-net, the mouth of which is low and broad, and which is dragged along the bottom behind a vessel of suitable dimensions. This is kept in shape by means of a beam of wood resting at either end on iron runners, which hold it up at the proper distance from the ground and receive the friction of the bottom. As these runners are connected above to the beam, at the lower end they are united by a leaded rope, which constitutes the lower edge of the bag: This leaded line is very slack and forms a bend reaching nearly half way the length of the net, which is usually twice as long as it is broad and ends in a long, narrow apex. As it is drawn along the bottom with the tide, the fish, which usually are found lying with their heads towards the tide, are first dislodged by the lead line, and whether they head upward or forward, are met by the upper side of the net, extending behind the beam. By the continual motion of the trawl they are ultimately carried back to the opposite end of the net, and there, getting into the pockets, are prevented from returning.

The size of the beam varies considerably. By an old British enactment the beam was not to exceed 36 feet in length; but it is sometimes now made nearly 50. The length of the net for a 36-foot beam would be about 70 feet, and one for a 50-foot beam would be about 100 feet long. The net is made with meshes of suitable size, and is usually saved from abrasion on its under surface or posterior end by folds of old netting.

The beam-trawl is now used almost exclusively on the coast of Great Britain for the capture of the more important food-fishes, especially of the turbot and sole, few of which reach the markets captured in any other way. About nine thousand tons of fish are furnished annually from this source alone to the London market; and it is not too much to say that without its use it would be impossible to furnish the English markets with fish.

There are other modifications of the trawl in different countries, all, however, on the same general principle of the dragging of a bag of netting along the sea-bottom. Sometimes this is carried under the vessel, where it is used particularly for the capture of whitebait and other small fish. In other cases, as in Spain, two vessels are used. The simplest form, however, that in common use by the English, French, and Dutch trawlers, is as described. This is dragged behind the vessel at the rate of one or two miles an hour, always with the current, and is sometimes kept down for several hours in succession.

Many objections have been brought to the use of the beam-trawl on the score of its exhausting the grounds, destroying the spawn of the fishes, killing great numbers of small fry, &c. A royal commission was therefore ordered to investigate the whole subject of the methods of capturing fish in the British dominions, and to determine whether any of them were hurtful or not. This was composed of Professor Huxley, Mr. James Caird, and Mr. S. Le Fevre, who took up the subject, and after investigating it most thoroughly gave it as their opinion that, so far from being a destructive method of fishing, the use of the beam-trawl was one of the most commendable; that it involved no greater unnecessary waste to fish life than other methods, and less than most; that so far from destroying the spawn of fish, no one could show that an egg of a fish was ever taken in it, especially in view of the fact that cod, mackerel, the turbot, and the flat-fish generally, the eggs of which it was especially accused of destroying in great numbers, all spawn in the open sea, their eggs floating generally near the surface until hatched, and that, consequently, the beam-trawl could have no influence whatever upon them. It was also shown that the actual nesting-places of many of the fish, such as the herring, &c., are among the rocky portions of the sea-bottom, where the beam-trawl could not be used, requiring, as it does, a perfectly smooth, level sea-bottom for its action.

The masses of so-called fish spawn taken up from the bottom by the beam-trawl, has proved, in all cases to belong to one of the lowest forms of sea animals, either the *Alcyonum digitatum*, or so-called dead man's fingers, on the English coast, or to the compound ascidian, very abundant in America.

The report of the commission states emphatically as the final result of its inquiries that this mode of fishing has been prosecuted in many localities from fifty to a hundred years, not only without diminishing the supply, but indeed showing increased captures, in consequence of the increased number and size of the vessels employed.

As the beam-trawl can only be used to advantage in the capture of the flat-fish and flounders, what it may take of cod and other fishes constituting but a small percentage of its catch, it is not likely that its use will be introduced into the United States until these fish assume a greater proportional value. With the great number of more or less desirable species of the flat-fishes in our waters there is no doubt that immense catches could be made by this means, and the day is probably not very distant when we shall find trawlers at work along Vineyard Sound and off the coast of New York, New Jersey, and the States farther south. Here there are thousands of square miles of sea-bottom admirably adapted to its use, where a rich harvest awaits its introduction.

Weirs and pounds.—The various forms of this most wholesale mode of taking fish will be found fully figured and described in the first report of the U. S. Fish Commission. I may, however, briefly recapitulate some of the more prominent varieties. These are, the floating trap or madrague, the heart-net or pound, the stake-net, and the weir in its various forms.

These all depend upon the movement of the fish in bands, and are sometimes worked in deep water, in which the apparatus is constantly immersed, sometimes depending upon the retention of the fish which come in at high water until the water runs out, leaving the fish high and dry, or else concentrated in small inclosed pools.

The Seconnet (Rhode Island) traps consist in a succession of inclosures held by anchors, and are similar in general character to the madrague of the Mediterranean. While in America the nets scarcely take anything else but scup, sea bass, tautog, and similar fish, those of the Mediterranean are especially used for the capture of tunnies or horse-mackerel. A corresponding difference in the size of the net and in the thickness of the netting is to be found. The heart-nets, or pounds proper, are principally in use in Vineyard Sound and Buzzard's Bay. In these a wall of netting supported upon stakes extends perpendicularly from the shore and ends in a heart-shaped apartment, the pointed end of which passes into what is called the bowl. The fish, in their movements along the coast, come to the wall of netting and are arrested and turned seaward. Their course along the line of netting brings them to the main inclosure, which is so constructed that in circling round in schools they cannot readily find their way out, owing to their indisposition to turn an abrupt corner. Their only escape is into the bowl, which constitutes a second apartment having a bottom of netting. Here they remain until the fishermen come on the scene, and closing up the narrow entrance to the bowl secure whatever it may contain. They proceed to lift the netting of the bowl in which are the living fish, and throwing away the refuse, the desirable varieties are put in a boat or smack, or else placed in what is called a pocket, another inclosure, in which they can be kept until marketed. Of this apparatus there are many varieties.

The stake-nets are used more particularly in the waters of the Dominion for the capture of salmon. The weirs are more generally to be found on the north side of Cape Cod and on the coast of Maine and the Provinces. In these northern localities their use is principally confined to the capture of the herring. On Cape Cod, however, they take immense numbers of sea herring, alewives, and other species.

Many minor varieties, and some of considerable prominence of both pounds and weirs, are to be met with in different parts of the world. I have, however, mentioned those in more general use in the United States.

Other methods.—The remaining methods of capturing fish most usually employed are narcotics, poisons, and explosives. The narcotics and poisons are essentially of a simple character, in some cases the fishes being merely stupefied, and in others actually killed. These are not used in sea fishing, but many an owner of a trout pond or stream has had reason to deplore the dishonesty of the age in the loss he has experienced in a single night by the poacher who has resorted to poisons for securing his bag of fish. Vegetable substances are generally used for this purpose, some of them of a character very easily obtained. It is not necessary for my present object to mention them.

Explosives as a means of capturing fish have come into use quite recently. The explosion of dynamite and other cartridges by means of a time fuse or a wire often results in benumbing or killing large numbers of fish. It is frequently employed by poachers upon trout or other ponds. In the mining regions of California very great destruction to trout and salmon in the rivers and pools has resulted from this practice. In the sea not unfrequently the involuntary result of submarine explosions, for the removal of sunken wrecks or rocks, is the destruction of great numbers of fish, which show themselves on the surface soon after the explosion. In some cases, as on the coast of California, where schools of fish have been thus exposed, great slaughter has been produced in this way. This method of destroying fish is highly objectionable, on the ground that it kills many more fish than can be utilized, as they are washed away by the tides and lost.

D.—BAIT USED IN THE SEA FISHERIES OF EASTERN NORTH AMERICA.

Baits and allurements.—Having thus presented an account of the more effective apparatus by which fish are captured, I proceed to indicate the more common baits and allurements to the hook or the net employed by the American fishermen. These are of various kinds, the simplest consisting of the naked hook, which by its rapid motion through the water induces many fish to snap at it, and to be caught thereby. The bluefish, bass, pickerel, and many other varieties are caught with a hook having some bright substance forming part of the shank. This may be a piece of bright pewter, tin, bone, iron, or other substance, and presented in the form of a plate, a cylinder, a spoon, or else a screw,

by which a rapid rotation or whirling motion is caused when drawn through the water. Not unfrequently an eel-skin or similar substance is stretched over the shank of the hook, and answers an excellent purpose. A bait of white cloth is sometimes quite sufficient in taking mackerel. The efficiency of a piece of red flannel fastened to three hooks, placed back to back, in taking frogs is well known to boys in the country.

Vegetable substances are not much used, as few fish are attracted by them. Bread crumbs, corn, cabbage leaves, &c., may be employed in the capture of carp and other vegetable feeders.

Animal matter is generally employed as bait to attract fishes to the hook or into a net, other substances being considered of little account in comparison, almost every animal of any kind or description being available to a greater or less extent for the purpose. In sea fishing mammals are not used very extensively. Portions of meat of almost any kind are used by the fresh-water angler for the capture of catfish, eels, the percoids, &c. At sea the flesh of the porpoise and other cetaceans is not unfrequently relied upon for the capture of cod and halibut when other bait fails.

Few persons realize the extent to which birds are sometimes employed as bait in the great offshore fisheries, the banker, when other bait fails, being able frequently to take large numbers of fish by the use as bait of the *Procellaria*, including petrels, fulmars, &c., as also of gulls, murres, &c. Most of these forms are easily caught on the hook, sometimes as many as a thousand birds, and especially of the petrel family generally (*Puffinus major*), have been taken and used for bait by a single vessel on the Grand Bank. The gannets, penguins, cormorants, &c., are also taken in some parts of the world for a similar purpose.

On this subject, Capt. J. W. Collins says: "A few years ago, when many of the Grand Bankers went "shack fishing" and depended to a considerable extent on catching birds for bait, many thousands (mostly *Puffinus major*) were caught and used by the crew of each vessel on a single trip. As these trips were sometimes three or four months in length, and it was often possible for the crew to catch several hundreds in a single day—indeed I have known of one man taking nearly a hundred in a few hours—it will readily be seen that an enormous amount of these birds must have been utilized in a single summer for this purpose."

There is but little, if any, use of the reptiles in the sea fisheries of the United States, although the frog is called into play in certain forms of fresh-water fishing.

The various kinds of marine *vertebrates* constitute the chief portion of the sea-fisherman's bait, partly in consequence of their more ready availability, and partly because the fishes sought for are more accustomed to fish as food, and are more readily attracted to it. The other kinds of bait just mentioned come into play as *substitutes*, but can hardly be considered as representing the regular resources of the North At-

lantic fishermen, and I therefore proceed to a more detailed consideration of the standard articles of supply for bait, consisting especially of fishes, crustaceans, and mollusks.

In the portion of the report devoted to the methods and apparatus of fishing practiced in the Eastern United States and the British Provinces some allusion has been made to the subject of bait for the hand and long lines, but it may be well to review the subject in a more systematic manner, beginning with the enumeration of the following as the more prominent substances used:

1. Menhaden.
2. Alewives.
3. Sea Herring.
4. Mackerel.
5. Capelin.
6. Sundry species of less note.
7. Roes of various fishes, especially of cod and mackerel.
8. Squid.
9. Whelks.
10. Clams.
11. Mussels, oysters, and scallops.
12. Lobsters, crabs, shrimps, and other crustaceans.

Other varieties of animal substances are used as bait under particular circumstances and in particular localities; but those just mentioned are of most economical value, and the possibility of obtaining one or other of them in greater or less abundance constitutes a very important factor to the fisheries of the mackerel, the cod, the halibut, and other species.

Of the species mentioned, the menhaden is at present peculiar to the shores of the United States, while the fifth, or capelin, is found only about Newfoundland, on the coast and islands of the Bay of Saint Lawrence, and the coast of Labrador. Dr. Gilpin refers to the occurrence of capelin in Halifax Harbor one season; but it is unknown as a regular visitant there, nor has it ever been positively noticed even as an occasional visitant of the Bay of Fundy.

The special details in regard to the natural history and character of the fishes just enumerated belong in the chapter on the natural history and economy of the several American species, and are merely alluded to briefly in this special connection as bait.

In the very great variety of fish bait, and its occurrence at the various seasons of the year at different points, all portions of the United States and the Provinces may be considered as equally well provided in this respect; and although circumstances may render the procuring of this bait in a particular locality a convenience, yet it can be easily shown that whatever be the restrictions upon either country as to particular localities, there can be no question as to the possibility of securing an ample supply in some other, although possibly at somewhat greater trouble and expense.

(1) *Menhaden.*—Of all the species mentioned as used for bait the menhaden is probably that of most importance, whether we consider its wide extent of distribution, its overwhelming abundance along the

coast at different times, or its attractiveness to other fish. Wherever it is met with, at different seasons of the year, from Florida to Penobscot Bay, it is always in request for bait. It is, however, only in the northern part of the United States that it is "slivered" and put up in large quantities either in ice or in salt and carried on distant voyages for the purpose of catching cod or mackerel. There is a peculiar toughness of the flesh and rankness of flavor which seem to constitute an appetizing attraction, not to be resisted by fishes generally, and the possessor of menhaden bait will be able to entice mackerel and cod, striped bass, sea bass, and other fishes, when a fellow-fisherman near by finds other bait valueless in comparison.

The earliest appearance of schools of menhaden off the coast of the Middle States is the signal for securing a quantity for the cod fishing banks; and until their disappearance from the North they are in constant request, this application of the fish, of course, being entirely independent of its use in the preparation of oil and guano.

(2) *Alewives.*—The two species of alewives, taken together, have a still greater range than the menhaden, being found from Florida to the coast of Labrador, and are, if anything, more abundant in the Middle and Southern States than at points farther north. They enter the mouths of all the rivers from the sea in vast schools, beginning in the early spring in each latitude, and can be taken for a few weeks in any quantity. They can be obtained as early as January in the Saint John's River, Florida, and in March or April in the Potomac, and would, undoubtedly, if other fish were unprocurable, be used for the spring cod fishery, serving a very excellent purpose in this respect. It is probable that the numerous schools of adult fish, coming in from the depths of the ocean to the shores in the spring, and of the young that pass out seaward in the autumn draw the larger sea fish into the vicinity of the land, and there can be no reasonable question that the great decrease in numbers of the latter, within the last fifty or one hundred years, has been caused, in large part, by human agencies, which have rendered it necessary to change the location of the fishing-grounds and to greatly limit the capture in ordinary boats of cod, haddock, hake, and the like in the bays and on the shores of New England, which was formerly so extensive and profitable.

As will be shown elsewhere, it is entirely within the power of man to restore, in a great measure, the previous abundance and greatly to improve the general fisheries of the coast.

The attractions of the young shad and salmon are doubtless to be added to those of the alewife and herring in drawing the larger fish towards the shore, but they are of less moment in this respect in view of their inferior abundance.

(3) *Sea Herring.*—Next to the menhaden, and indeed in advance of it in some parts of British North America, is to be mentioned the sea herring, which is to be found in one locality or another throughout the entire

year, the fishes now spawning in one vicinity and then feeding in another. Without the sea herring the fisheries of the northeastern coast of North America would be very indifferent, and it is a subject of great congratulation that it is to be had at nearly all seasons, especially when most needed as bait.

Both the menhaden and the herring are used either entire for baiting the hooks, or chopped up fine in a bait-mill as chum for attracting the mackerel within reach of the hook and line or into the net. The sea bass of the New England coast finds during the summer season the chum of the menhaden an irresistible attraction, bringing them within reach of the angler whenever its influence is experienced.

Menhaden and herring are usually cut in pieces for bait for cod and for many other varieties of fish; only the small herring, "spurling," are used whole.

(4) *Mackerel.*—The mackerel is used very frequently as bait, generally the smaller and inferior individuals, or those less valuable for salting being employed. They are also sometimes chopped up as bait for mackerel when cheaper material is not to be had.

(5) *Capelin.*—Allied if not identical forms of capelin occur on both sides of the North Atlantic, and are everywhere eagerly sought after as bait for cod during the period of its presence. Unfortunately on the American coast it is found for only about six weeks. It is then in overwhelming abundance, coming in for the purpose of spawning, the eggs being sometimes washed on the shore in great windrows, and frequently in the edges of the sea forming beds several inches deep. When perfectly fresh no fish can resist its attractions, and for shore cod-fishing during the season nothing better can be had. It is, however, not considered especially advantageous for the bank fishing. The capelin is kept fresh in ice by the American bankers from 8 to 10 days, and occasionally a little longer. The French fishermen use immense quantities of salt capelin in the Grand Bank cod-fishery, though by Americans they are not considered good bait when salted.

In Norway the capelin is used very largely in the spring cod fisheries of Finmark, and its approach is hailed with the greatest satisfaction by the fishermen.

(6) *Sundry fishes used as bait.*—The sand-launce (*Ammodytes*) may also be referred to as specially useful as a bait, as it can be obtained in certain localities along the coast of the United States and the Provinces in vast numbers, and is frequently used as a substitute for other kinds of bait, and the corresponding European species is equally satisfactory, being used by the fishermen on a large scale. Although less in size than most of the species just enumerated, it can be used entire and constitutes quite a tough, desirable bait. This fish lives mostly in the sand, where it buries itself with great rapidity and is entirely concealed from view.

Other baits are frequently used both in the large and small fisheries,

eels and lampreys, portions of the bellies of cod and mackerel, the eyes of these and other fishes, and indeed almost any form of refuse fish. Dead fish of any kind are also used to constitute bait for taking lobsters.

(7) *The roe of fish.*—There is no question but that the roe of fish constitutes a very large percentage of the food of the inhabitants of the sea, as it is only by the provision for the destruction of the large proportion that particular species are prevented from increasing in undue and overwhelming numbers. It is rarely that any fish can resist the attractiveness of fish roe, the eggs of trout and salmon being used largely in California for this purpose when nothing else has any attraction.

Besides the use of the roe of fishes as food for man it constitutes an important element on a large scale in the sardine fisheries of Europe. The salted roe of the cod and of the mackerel is prepared for this purpose and shipped, to the extent of many millions of pounds, about 9,000,000 pounds of cod roe (worth $600,000), and one or two millions of that of the mackerel, having been furnished in one year by Norway. Small shipments have been made from the United States to Europe for the same purpose.

These eggs are used especially for attracting schools of sardines into the vicinity of the gill-nets, and for that they are considered almost indispensable.* It is a question whether this same roe could not be employed advantageously in the mackerel fishery as a toling-bait of a more satisfactory character even than the finely-chopped flesh of fish It keeps much more readily than any other, and its use, if not already attempted, should be experimented upon, as the roe both of the cod and the mackerel until recently has been a refuse product. It is worth considering whether it may not be prepared and used to advantage for the purpose in question.†

(8) *Squid.*—The squid, one of the cephalopods, a group of the mollusks, is also a highly important element in the question of bait for the capture of deep-sea fishes, especially the cod and its allies, and occurs in overwhelming numbers along the entire coast of the eastern United States and of the Dominion. Of this there are two principal forms

*According to De la Blanchère, Le Pêche et les Poissons, 1,500,000,000 of these fish are brought into the port of Concarneau alone, this being only one of many from which the industry is carried on in France, Spain, and elsewhere.

†All bait as above referred to is used fresh whenever it can be done. It is, however, preserved in various ways, sometimes by drying, more frequently by salting. The use of ice of late years has come into play very extensively and constitutes a necessary element in most fisheries whether for the preservation of the bait itself or of the fish when caught. For the most part the bait is preserved by keeping ice in contact with it. It is probable, however, as already suggested, that hard freezing may more advantageously be substituted in many cases as being more likely to retain the same attractiveness that freshly-caught bait presents. It is quite probable that by using special apparatus and adjustments the hard freezing may be conducted at very little expense.

equally attractive to the fish, and occurring in very great numbers, the more northern, the *Ommastrephes*, being found about Newfoundland and other portions of the Dominion, and the *Loligo* in increasing numbers from Cape Cod south and westward. They are used either fresh, immediately after being caught, or sometimes kept in ice; being very largely salted, however, in which condition they maintain their attractiveness for about three weeks.* They are usually taken at sea by means of the jig, and inshore the weirs and pounds are sometimes found to contain them in immense numbers.

The squid, of one species or another, is found off the coast throughout the greater part of the year, in Newfoundland more especially in the spring and summer, and on the Massachusetts coast at almost all times. It occurs more rarely in winter, apparently passing off into the warmer waters. It is probable that by exposing the squid to the cold of a freezing mixture and rendering them specially hard, they may be kept indefinitely or until wanted. Among other pounds where squid have been taken in large numbers, that at Waquoit, Mass., captured more than 6,000 in a single day; and at the same pound, the captures for the first twenty-five days in May alone amounted to 35,000. (Rep. U. S. F. C., 1871–'72, page 174.)

(9) *Whelks.*—As already mentioned when discussing the subject of the long or trawl line as used in Europe, the whelk or *Buccinum undatum* was referred to as the principal bait for that mode of fishing; and although captured every year in immense numbers for use by quite a large fleet of boats and vessels, it still appears to be as abundant as ever. Here we have another indirect illustration of the influence of man in producing a balance of power in the sea, the whelks being notorious enemies of the oyster and other mollusks and destroying them in great numbers. The drain, therefore, upon the increase of the whelk doubtless has a material effect on the supply of these other objects.

In England whelks are taken on long-lines, on the snoods of which the common shore crabs are fastened or threaded, no hooks being employed. When laid down, the whelks seize this bait and, retaining their hold with great tenacity, are hauled up.

Another method of taking them is by means of baskets baited inside with pieces of fish, a net being stretched over the end, with the basket in the center. The whelks enter this, and when the baskets are drawn up, they remain in them.

Shallow hoop-nets, too, are baited with fish for this purpose, and the incidental advantage of their capture, as already stated, is in the diminution of an inveterate enemy of the oyster. Each smack requires

* Squid can usually be kept from 2 to 3 weeks in ice, and for months when salted. While the French use salted squid almost exclusively on the Grand Bank, the Americans and Provincials prefer to have them fresh, and use but few salt ones, and those only in the fall when no others can be obtained.—J. W. COLLINS.

as bait for a voyage from fifteen to twenty-five bushels of whelks. These are preserved in bags made of netting and may be kept for a long time in the wells of the smacks. When wanted, the shells are broken and the animals extracted.

The whelk is especially common in the United States from Portland to the Bay of Fundy, and extends to the south of Cape Cod, although rarely. It is usually known in America as the winkle, and is so abundant on the coast of Maine that it could readily be used as bait for cod.

There are many other of the univalves that may be employed as bait, such as the *Busycon* and *Pyrula*, which though seldom used are capable of the same application.

(10) *Clams.*—The clam in its various forms constitutes a very important portion of the bait used on a large scale in the United States and belongs especially to the following species:

The soft clam, *Mya arenaria.*

The common hard clam, *Venus mercenaria.*

The most important of these is perhaps the soft clam, *Mya arenaria*, which occurs in immense numbers along the entire eastern coast of the United States, and is consumed both as food and as bait. For the latter purpose it is collected very largely on the clam flats of Massachusetts and Maine, in some localities the plow being used at low tide to turn up immense numbers. An especially favorite locality is near Ipswich, Mass., where the immense size of the aboriginal kitchen-middens attest the antiquity of the abundance of this species, these being rivaled, however, by the piles of recent shells heaped up by the clam-diggers. About forty barrels of salted clams constitute an average fare for a cod fishing-vessel, and there appears to be no special difficulty in furnishing any number that may be called for, as notwithstanding the demand, the price at which they are sold now is little more than it has been for many years.

The so-called hard clam is more southern in its distribution than the *Mya*, and is less extensively used as bait, in view of the great demand for it as an article of food. On the sea coast, in a small way, however, it is used to a considerable extent.

The hen clam, or *Mactra solidissima*, is also a species which furnishes a valuable bait, and is especially abundant at present in the vicinity of Nantucket, Mass., where large numbers are taken out and used by the cod-fishermen.

In the Gulf of Mexico and the vicinity of Mobile and New Orleans the *Gnathodon cuneatus*, a so-called clam, is also employed largely in the minor fisheries, but has no prominence at all as a bait for the more important enterprises.

According to Mr. N.B.Nutt, collector of customs at Eastport, clams are not collected to any great extent in that vicinity as bait, but they are gathered along the shore from Machias to Mount Desert and sold by dealers at Deer Isle, Booth Bay, and Portland. Forty barrels rep-

resent the allowance for an ordinary voyage of a vessel of from 50 to 75 tons. Of late years clams have been less in demand for cod-fishing, fresh herring purchased near the grounds or pickled herring being more extensively used.

(11) *Mussels, Oysters, and Scallops.*—Of the mussel there are two distinct species, both known under the same name, and, although generically distinct, having a very close external resemblance which prevents their being distinguished by the ordinary observer. One of these is the *Mytilus*, the other the *Modiola*. These are well-known inhabitants of the waters, being found attached in great numbers to the piles of piers, and to rocks, gravel, mud, and any other object to which their byssus will adhere. They are a favorite article of food in some parts of the world, being used largely in Europe for this purpose; but they are less esteemed in the United States. Occasionally very grave inconveniences result from poisoning, of greater or less intensity, being produced by them. In view of the well-known fecundity of the mussle, it may be imagined that the spat in regions where they abound constitutes a very important element in the food of young fish, and the contents of the towing-net are very frequently composed largely of extremely minute mussels, which are greedily devoured by a great variety of species.

The oyster is not often used as bait. It is almost too valuable to be wasted in this way, and is of so soft and delicate a texture as to break away from the hook with but a slight touch.

The common scallop, *Pecten irradians*, which is extremely abundant off the coast of the Middle and Northern States, is largely utilized for food, and only occasionally used as bait for fish.

(12) *Lobsters, Crabs, Shrimps, etc.*—The lobster constitutes a very attractive bait in the small fisheries; but it is too valuable in itself as an article of commerce, to be employed to any great extent. Frequently, however, young lobsters, not marketable, or falling within prohibited limits of the legal enactments of certain States, are used for capturing shore fishes.

Along the coast of the South Atlantic and Middle States a very favorite bait for the ordinary shore fishes is the common blue crab (*Callinectes hastatus*) a species occurring in enormous abundance, and constituting a favorite article of food, whether as hard or soft shell. This is a great resource to the fishermen, few fish resisting its attractions, especially when the old shell has been thrown off, leaving only a soft skin behind. Diminishing in abundance towards Cape Cod, its place is supplied, thence northward, by what is there called the common crab (*Carcinus mœnas*). This appears to constitute an especial attraction to the tautog, and doubtless constitutes its food in the sea in very great part.

Shrimps also are used all along the eastern coast of the United States in sea fishing.

E.—Methods and routine of fishery.

The necessary limitations of space in the present essay require me to defer the consideration of this subject to another occasion, especially as it will come naturally within the investigations of the forthcoming census of 1880.

F.—Preservation of fish and bait.

The subject of the preservation of the products of the fisheries is one of very great importance, and is receiving more and more attention every day. In the earlier period of the American Republic the abundance of animal life in the waters was so great that there was little difficulty in taking the needed supply of food whenever it was wanted, rendering the question of its preservation comparatively unimportant. Of course, the methods of salting and drying were in vogue, but the long-continued preservation of fish in a fresh state was of comparatively little consequence. The circumstances have changed very greatly in this respect. The abundance of fish, &c., has diminished to a greater or less extent, while the population of the country has increased enormously. The demand for fresh fish, too, has increased more than in proportion to the increase of population. The great extension of the system of communication with the seaports, both by steamboats and railroads, has been such as to render it practicable to carry the products of the sea fresh to a great distance. The same methods are available both for keeping bait for use in the fisheries as are employed in keeping the products of the fisheries themselves, and it will therefore not be necessary to discriminate between them.

We may consider this subject of preservation under several heads: (1) As fresh, without any special treatment; (2) as fresh, by means of ice; (3) by drying; (4) by salting or the addition of some chemical substance; (5) by smoking; (6) that of immersion in alcohol or some saline substance, for scientific purposes, which properly does not enter into the plan of this paper.

Fish may, of course, be preserved for a greater or less time for purposes of food or bait without any treatment whatever, this depending upon the amount of moisture in the atmosphere and the temperature. In the colder seasons of the year of any locality an object of this character can be kept for many days, especially if the entrails are removed, the adherent blood washed from the inside, and the inside surface allowed to dry in some way. In warmer latitudes and periods, however, the flesh corrupts rapidly. The difficulty is that in the tropical or sub-tropical latitudes a fish will acquire a taint of corruption or decomposition within a very short time after the capture, so that even before the boat's load can be landed and subjected to the treatment of salt, or otherwise, it will have passed beyond the stage when this can be applied with any success.

Of course, when fish are taken in cold weather and frozen they will remain in good condition as long as the cold lasts;* and the absence of a definite continuance of this condition suggested the use of ice in some form in the warmer season of the year. The simplest method of using ice is, of course, to lay the fish on it, and thus keeping down the temperature. The more common method of employing ice, however, is to pound it up and arrange it in layers with the fish, one alternating with the other until the given receptacle is filled. This, however, has the very serious disadvantage in the quantity of moisture necessarily held in contact with the fish, the ice melting very rapidly and the fish becoming saturated with the resultant water, from which in time comes an acidity or mustiness of the fish which is not at all palatable. In some cases, indeed, fish will keep better by being immersed in water kept cool by means of floating pieces of ice than when packed away in pounded ice itself. Fish thus treated become unpalatable when kept some time after removal from the ice. About two weeks represents the limit of time during which, under ordinary circumstances, fish may be kept by the method indicated. After that period the fisherman finds that his bait ceases to be attractive, and the necessity for a renewal occurs.

Icing of fish and bait.—The fishermen at New London and Noank, who are almost exclusively occupied in furnishing fresh fish to the New York market, by the exercise of special precaution are able to keep their fish and bait fresh a much longer time than is the experience at Gloucester. They exercise very great care in the preparation of the bait, which is opened and thoroughly washed and cleaned, the adherent blood along the backbone being especially removed.

Their bait pens are in one large apartment instead of three or four smaller ones, as is the practice at Gloucester, and are carefully lined with some non-conducting substance. The bottom is paved continuously with ice, to the original thickness of the block, whatever that may be. On this is placed a layer of fish three or four inches thick, and above this a layer of equal thickness of finely-pounded ice, snow answering a very good purpose if this can be had. On this is another stratum of fish, and then pounded ice, and so on until the whole is filled. The atmospheric air is excluded very thoroughly in this way, and the amount of melting is comparatively trifling. The resultant water is immediately absorbed by the porous layers of pounded ice and held as by a sponge, so that the fish are kept comparatively dry.

In the other method of breaking up the ice with a hammer and sliding in layers over the fish there is much greater exposure to the air, and the water from the melting ice sinks to the bottom and keeps the fish or bait saturated throughout. In this way two weeks is usually

* I am informed that the first to commence the business of freezing herring and bringing them from Newfoundland was Capt. Henry Smith, of Gloucester, in 1856. In 1857 Capt. Sylvanus Smith went into the same business and continued it for some time.

the limit during which bait can be kept fresh, instead of six or eight weeks, as claimed by the New London fishermen, who see no difficulty whatever in carrying enough fresh bait for a long voyage to the banks, supplemented, should it be necessary, by soft clams, and thus obviating the necessity of going into Newfoundland or elsewhere for a fresh supply.

Ice can be applied much more advantageously for cooling fish (independently of freezing them) in specially constructed apparatus, known usually as refrigerators. The refrigerator, however, furnishes the most economical mode of applying cold to the fish. In some cases the function of the refrigerator is simply to prevent an unnecessary waste of ice by melting away, so that a given quantity will last a much longer time. Other forms of refrigerators have a very different function, the simplest of which consist of an arrangement by which a current of cold, dry air is made to circulate through a provision chamber, taking off the excess of moisture and allowing it to be condensed upon the ice itself. This desiccation may be so rapid and excessive as to bring it under the head of "preservation by drying." It is not at present used to any great extent in the sea-fisheries for the preservation, on a large scale, of fish for a long time. This is most effectively accomplished by the hard freezing process, which is destined to take the place of all others before long, as preserving the animal fiber indefinitely, or as long as the freezing is maintained at the proper temperature, and with a comparatively small consumption of ice and salt.

According to Mr. E. G. Blackford, the eminent fish-dealer in Fulton Market, New York, a room, 10 feet each way, or of 1,000 cubic feet, with properly constructed non-conducting walls surrounding it, can be kept in effective operation in the summer weather of New York by the use of 2,000 pounds of ice and 2 bushels of salt per week, with less in colder weather. This would be, for a room of that size, 4½ tons of ice and 9 bushels of salt per month. As, however, all the bait necessary for a trawling expedition to the banks for cod could be kept in a room of half that size, it is likely that three-fourths the amount of ice and salt would be sufficient, or about 3½ tons of ice and 7 bushels of salt per month. With all the fresh bait on board required for a voyage to the banks and the filling up of the vessel, the amount for two months should not exceed at the outside 7 tons of ice. Allowing as much more for wastage, 14 tons would probably be an ample allowance. During 1877 ice cost $2 a ton at Gloucester and $12 a ton at Newfoundland.

A patent has been recently introduced to the notice of fish-dealers, by which fish are arranged conveniently in vessels which are filled up with water, and the whole then frozen into a solid cake, and kept in this condition until used. This process is claimed by those interested to keep the fish perfectly fresh indefinitely without the evaporation and loss of savor so frequently found in the dry-hard method.

In freezing animals hard and stiff care must be taken to extract the

heat slowly in proportion to their size. It is a common occurrence for moose, reindeer, and other large mammals when killed in a very cold atmosphere to become putrid internally in a few hours, although the exterior may be frozen stiff. The remedy here is probably immediate disemboweling. It is said that halibut cannot be frozen stiff and dry to advantage from the tendency to spoiling in the interior.

It is not an uncommon thing for fishermen on the banks to renew their supply of ice for bait from the floating icebergs. They do not usually venture on a large berg for this purpose; but generally there are to be found in its vicinity fragments of greater or less size which have been broken off from the main mass and are easily secured. The supply of fresh water, too, is not unfrequently obtained in a similar manner.

Desiccation.—Desiccation, or drying, comes next to cold, either natural or artificial, as a method for preserving fish for food or bait, and, indeed, is sometimes more available. This consists, in the simplest form, in the exposure of the fish, usually split to some extent, to a dry atmosphere or the sun, causing the evaporation of the moisture to a greater or less degree. Sometimes this process is accelerated by the application of artificial heat, which causes a more speedy evaporation of the moisture. A current of air, either warm or cold, made to play over the fish, carries on the work very rapidly. Quite recently the production of this current of dry air by cold has been called into service, and with very excellent results, the flesh not being altered in any way, and the desiccation being rapid and thorough. Of late years artificial processes of desiccation have been multiplied, and are being applied to all forms of marine products, including oysters, clams, lobsters, shrimps, &c., as well as fishes themselves. Of course the use of a similar method for preserving vegetables and the flesh of land animals is familiar to every one. The preservation of bait by drying has not been very general; but it seems probable that when the application of the desiccating process comes to be more economically applied, it can be called into play to very great advantage.

A writer in the Newfoundland Chronicle for September, 1877, speaking of squid bait, remarks that during the squid season, which usually lasts about six weeks, there is no other bait so attractive to codfish, and that even when salted it is preferred by the fish to fresh herring. He suggests that the proper method of preparing the squid so as to be available under all circumstances and at all seasons is to wash and dry it as soon as possible in the sun and without salt. He does not state, however, whether the experiment has actually been tried.

If the bait thus prepared proves to be attractive to the fish there will be no difficulty, if it cannot be readily dried in the atmosphere of New England, in doing this by means of some of the patent desiccating processes.

Considerable quantities of squid are dried on the coast of Newfound-

and, the bodies being first split open and the heads and entrails removed. I secured a few of them in the fall of 1876 and tried them on the Grand Bank, but under such unfavorable circumstances that nothing definite could be learned as to the relative value of squid bait prepared in that manner. The Newfoundland fisher men, however, claim that, when soaked for several hours before it is used, it nearly equals for bait the squid that are just caught.

The method of preserving fish and bait by salting is of course familiar to all, and need not be discussed here to any great length. It will be sufficient to mention that the principal subdivisions consist of salting by sprinkling salt on successive layers of fish, which are piled up in masses, known as kench-curing; of immersion in a saline solution, known as pickling; and of salting for a certain length of time by either of these processes and then drying by exposure to the air and by smoking, all of which have their advantages under particular circumstances.

Salting, etc.—The salt used in the preservation of fish in the methods indicated is, for the most part, the common chloride of sodium, or table salt. The quality of this, however, varies in different regions, some varieties being considered preferable for special applications, and others much less satisfactory.

A very troublesome affection of salted and dried fish is that known as "reddening," where patches of red color make their appearance on the surface of the fish, and rapidly extending, soon render it unfit for food. This is usually met with in the foggy August or dog-day weather. A careful examination of this substance by Dr. Farlow has shown that this redness is due to a minute algous plant abounding in the shallow sea-shores and not unfrequently included in the crystallized salt made by solar evaporation. Its presence is indicated by a slight pink or rosy tint in the salt, and at any rate it appears that fish treated with this salt is more liable to the affection than where the salt is obtained from mineral deposits or else is perfectly white sea salt.

Other saline substances are used in some cases; and quite recently borax, in one form or another, has been warmly recommended as securing the proper preservation of the flesh by the use of a much smaller quantity of mineral matter. A favorite Swedish preparation, called aseptin, used for keeping milk and other animal substances without imparting a saline taste, consists essentially of borax.

Quite recently other chemical substances have been suggested, and among others is one lately communicated by D'Amélio to the Academy of Sciences in Paris. For this purpose the meat, either raw or boiled, is cut into sections (if the action is to be very rapid) and immersed in a solution of citric acid in water in sufficient proportion to render it decidedly acid. After two or three hours the meat is withdrawn and subjected to a moderate degree of artificial heat, or exposed to the air until dry. With the artificial heat the result should be accomplished in an hour, and in the open air in five or six days. This meat can be kept for

years. To restore it to softness and flexibility it is only necessary to plunge it three or four days into fresh water. In time it acquires the hardness of wood, and the fatty portions have a tallowy odor.

Smoking.—A remaining method of preserving fish for food, if not for bait, is that of smoking, which has been used from time immemorial. This consists merely in exposing the flesh, either fresh or after being salted to some degree, to the smoke produced by burning bark or wood. This changes the texture of the fiber apparently by the action of pyroligneous acid or some creosote product, at the same time preserving it and giving it a very agreeable taste. The celebrated Finmark haddies consist of the haddock slightly smoked to a moderate degree, not enough to keep them for a long time, but involving a less amount of salt and of smoking than usual. Other fish, of course, are readily prepared in the same way.

G.—Disposition of offal or "gurry."

The question of a convenient or economical disposition of the offal of fish, especially of the heads and entrails, is a serious matter to the fisherman, especially when the cleaning or preparation for market is conducted at sea. This waste matter constitutes a large percentage of the entire mass (about a third), and what is thrown away every year by fishermen of any considerable fishing station may amount to hundreds of tons. Men fishing in small boats, however, usually have no other convenient alternative.

The objections made to this disposition of offal are of two classes, one on the score of waste, the other on the ground that the capture of fish in that locality is greatly interfered with. In the same connection I may refer to the question of waste of fish by means of the trawl-line, or the purse and gill net. As already mentioned, a severe complaint brought in North America against the apparatus referred to, is that large numbers of fish are lost from the trawl-line or from the nets in consequence of storms or otherwise; and that apart from the waste, these fish falling to the bottom, contaminate the fishing-grounds by their decomposition and drive other fish away, as shown by the inability to make successful catches until after a period sufficient to allow this matter to be decomposed or removed in some manner.

The assertions of injury to the fishing-grounds in consequence of the gurry being thrown overboard or of the number of dead fish dropping from the lines or partly devoured by other fishes, apply most generally to the localities of the capture of the *Gadidæ* or members of the cod family, especially the true cod, haddock, hake, cusk, as well as of some other species, including also the halibut and others of the flat-fish family. It must be remembered, however, that these grounds are always in the colder portions of the sea, not unfrequently where the temperature of the water is but little above the freezing-point of fresh water, and always where it is as low as 50°. In regions where such temperatures prevail the year round, the cod and its allies are found

continuously. In others, as in the south side of New England, the fish come in as the waters at the bottom of the sea assume the temperature which they affect.

So far as the cleaning of fish at sea and the throwing overboard of the offal or so-called gurry are concerned, the practice is highly reprehensible in an economical point of view; and as representing an enormous waste of material capable of being devoted to useful purposes, the practice should be frowned down and prevented by legislation if possible.

On the coast of Norway all such materials, which formerly were wasted, are now carefully husbanded and add very greatly to the percentage of the yield of any fishery. Sometimes this material is boiled and made to furnish a large amount of oil and scrap. At others the heads are assorted and dried as a special food for animals. The actual yield of guano alone from the Norwegian fisheries has in a single year amounted to 7,700,000 pounds, a very notable element in the productive resources of the country. Whether this material be injurious to the fisheries or not, its preservation and utilization is too important to be neglected; and for this, instead of enacting a prohibitory law, which could not be enforced, it might be better to offer a bounty or drawback of some kind, in proportion to the amount of this material delivered on shore. In this event, even if the fish were more conveniently cleaned at sea, the refuse might be saved in barrels and put on shore at a convenient point. If the solid parts were for the most part saved, the juices and small particles might be poured into the sea without any detriment.

In regard to the allegation, however, that this offal or the dead fish falling from the hooks, in whatever quantity this may be present, affects the fishing-ground, it is extremely difficult to comprehend how this can have any serious effect. In the first place, the cold water in which the fishes of the cod family occur abound to an enormous degree with marine crustaceans, the self-appointed scavengers of the ocean. These are largely a species of *Gammarus* and allied forms very varying in size and in overwhelming and almost incredible numbers, and their efficiency in their appointed task is so great that a large fish placed in a box or suspended in a bag of netting, will frequently be picked to a most perfect and complete skeleton in from twelve to twenty-four hours; indeed, not unfrequently the fish on the trawl-lines are brought up skeletonized in this way.

The same waters in which these shrimps are to be found abound very largely in lobsters, which are baited by precisely the same offal which is considered so detrimental to the fishing. There are also immense schools of small fish such as cunners, and more particularly the Cyprinodonts, which are as active and prompt in their attacks upon dead matter as the crustacea; as witness the experience of those who find a large and valued bait cleaned entirely from the hook by these smaller fish before it has been down more than a very few minutes. The wolf-fish or catfish (*Anarrhichas*), the sculpins, the sea-ravens, the goosefish,

&c., may also be mentioned among these scavengers, the latter especially finding no difficulty in swallowing entire the largest masses of offal that are likely to be thrown overboard. There is no doubt whatever that all such substances scattered in or floating through the water are promptly seized by the lobsters, dogfish, and other species of sharks, and numerous others of the finny tribe that are always on the watch for such material, and it is altogether incredible that with all these agencies working together there should be any appreciable quantity of dead fish or its refuse left at the end of twenty-four hours.

A large part of the gurry is probably carried off from the grounds by the tides and thus distributed over a wide extent of the sea, the chances of its reaching the bottom and remaining there for any time being still further diminished. Even supposing the skeletons and bones to be thoroughly cleaned and left, and that by their whiteness or other quality they should terrify the fish, another series of scavengers comes into play, namely, the sea-urchins, or sea-eggs. These, which swarm in enormous troops in the same waters, concentrate themselves in a very short time upon a bone and devour it as perfectly as the sea-lice do the flesh, leaving nothing whatever. It has been suggested that these sea-fleas and sea-urchins only carry on their operations in shallow water. This, however, is a great mistake, as the dredgings of scientific investigators in the vicinity of Grand Manan and elsewhere show that no portion of the sea-bottom, even to several hundred fathoms in depth, is without them, and, indeed, if there is any difference it is probably in favor of the colder and deeper water.

The inquiry naturally arises, why, if the chopped fish, including entrails and roe, constitute an attractive bait to the mackerel sufficient to draw them many miles out of their intended course, and dead fish can be used to bait perch pots, should precisely the same material, in not quite so minute a state of division, terrify and drive away the inhabitants of the deep sea? It is, of course, possible that a great abundance of animal matter floating in the water, or for the moment lying on the bottom, may affect the actual fishery in consequence of the preference on the part of the fish to this matter over the more doubtful attractions of a baited hook. This, however, would be only temporary, and the interruption would soon cease. Possibly, too (and perhaps this is a powerful agency), the presence of this offal may attract the dogfish, sharks, and other predaceous species, so that they may drive away the weaker and comparatively defenseless cod.*

*At one time the practice of the French fishermen of throwing overboard the gurry was bitterly complained of by the English on the ground that it materially affected the fishing. The explanation given was probably the true one, namely, that this offal attracted an immense number of sharks, dogfish, and other predaceous fish, which concentrated in unusual numbers, and not only devoured the offal, but drove out all the fish from the ground. Nothing was suggested as to any defilement of the sea bottom itself by the accumulation of decaying animal matter. (British Fishery Commission Report, p. lxi.)

The fact that the throwing overboard of offal does not in itself drive away fish generally is illustrated in the fishery for the small dog shark about Provincetown. Great numbers of these are taken annually for the livers, which are removed, and the rest of the fish thrown overboard. The result is apparently to increase the number of these fish, and make the catch of a larger number practicable.

The number of skates is greatly increased in any given locality, on the banks where they abound, by throwing overboard large quantities of gurry. This is especially noticeable to the trawl fishermen, who often find after remaining in one berth or position for several days, that the ends of the trawls next the vessel have on them an increased number of skates.

In further reference to this subject of gurry on fishing-grounds and to the alleged wastage of fish by dropping from trawls and gill-nets, it is not a little remarkable that the question of the injury of the use of the trawl-line to the fish and fisheries of the locality where practiced, should at the present time be for the most part confined to North America, while European writers now scarcely refer to any inconvenience likely to result from this cause. The practice of line fishing is considered in its two divisions of hand-line and trawl, or long-line, but this is merely a question of comparative expediency and the cost of the investment.

In the question at issue between the fishermen of Great Britain in 1866, the case lay for the most part between the trawls on the one side and the hand-line fishermen on the other, the latter making no charge of any injury to the fishing in the rejoinder against the long-lines.

It is perhaps less the practice in Europe than it is in America to clean the fish at sea, and to throw the refuse overboard, a wasteful practice, which of course is to be discountenanced. In Norway, on the great fishing-grounds, the sale of the offal to companies organized for utilizing it is a matter of very great importance. It is sold at a fair price, the dried head of the cod being in part prepared as food for cattle, but for the most part converted into guano, which has an established position in the European markets, as might be expected, allowing it to constitute one-third of the total weight of nearly 20,000,000 codfish.

In England the codfish taken are for the most part sold entire or dressed in the fishmongers' establishments.

If a considerable percentage of the fish taken on the long-line or trawl is necessarily lost by dropping off from the hooks by their excessive weight on being hauled up, the injury, if it be one, of their decay on the sea-bottom would in all probability have impressed itself upon the minds of observers in England; but the only allusions I have been able to find to this subject of dead fish on fishing-grounds is in connection with the herring fishery on the coast of Norway, where it was alleged that the dead fish which were lost from the gill-nets polluted the water and tended to drive the herring away.

According to Feddersen (Rep. U. S. F. C., 1873–5, p. 183), neither this nor the discharge of oil into the ocean from factories on shore proved to have any deleterious influence, the fish coming year after year even in increasing abundance to localities infected as mentioned, while they were just as likely to disappear capriciously and suddenly from waters where no such complaints could be alleged; indeed, as stated on page 118, a careful examination of the bottom of the sea, by means of the water telescope failed to reveal a persistence of dead fish, the appointed scavengers of the sea very soon removing them effectually. It was only occasionally in the crevices of the rocks and apparently sheltered from convenient approach that the dead herring or their skeletons were known to remain even for a few weeks, subsequent examinations failing to indicate the presence of any dead animal matter.

H.—Review of the American fisheries.

The time when a faithful presentation of this subject can be made has not yet arrived, and its discussion must be deferred until an exhaustive canvass of the country has been made. As a slight contribution to the subject the following tables are given:

Fishery products of Gloucester in 1876.

Cod, 425,000 quintals	$2,295,000
Mackerel, 101,032 barrels	909,000
Herring, 30,000 barrels	127,500
Dry-fish, other than cod (pollock, cusk, haddock, and hake, about equal proportions), 40,000 quintals	120,000
Shell-fish	10,000
Fresh fish, 11,000,000 pounds	745,000
Fish oil (cod-liver nine-tenths at least), 275,000 gallons	132,000
Fish manure (herring), 8,000 tons	25,000
Miscellaneous	10,000
Smoked halibut (three-fourths made from catch of "fresh" vessels), 2,750,000 pounds	275,000
	4,648,500

40 per cent. of flitching from halibut.
405,000 quintals, pickle-cured.

The following table shows the value and extent of the fishing business of the port of Gloucester for the year 1875:

Bank codfish, 177,473 quintals	$998,628
George's codfish, 185,758 quintals	1,021,669
George's halibut, 2,462,364 pounds	172,365
Bank halibut, 7,248,423 pounds	507,389
Hake, 4,257 quintals	12,774
Cusk, 2,349 quintals	7,047
Pollock, 9,417 quintals	32,964
Herring, 38,292 barrels	153,168
Shore fisheries, the work of dory fishermen:	
Fresh fish	89,738
Cured	185,697
Oil	8,945

Mackerel:	
18,172⅜ barrels No. 1	$327,112
7,065½ barrels No. 2	184,780
21,763 barrels No. 3	174,104
4,039⅜ barrels No. 4	24,205
Pickled fish, 31,750 herring	13,494
163 barrels cod, 40½ barrels swordfish	1,097
410⅜ barrels trout, 75⅝ barrels fins and napes	4,042
21⅜ barrels salmon, 205 barrels tongues and sounds	2,282
Shell-fish, clams, &c	10,000
6,500 tons manure	20,000
All other fish	8,000
Oil, other than above	100,000
	4,059,500

III.—ECONOMICAL APPLICATIONS OF THE PRODUCTS OF THE FISHERIES.

The inhabitants of the sea which occupy a more or less direct relation to man in their economical application are usually classed by the common name of fish, the term fisheries being applied to the methods of their capture. This, however, is to a certain extent a misnomer, as in addition to what are properly known as fish we have to consider the cetaceans, such as the whales and porpoises; the crustaceans, as the crabs, lobsters, and shrimps; the mollusks or shell-fish, such as the clams, oysters, and the like; the corals, sponges, and many other forms of animal life.

The uses to which the various marine animals are put are very various, although by far the most important application is in the way of food for man, and to some extent for the lower animals.

The objects of the fisheries and the applications of the animals of the sea when caught may be considered under the following heads:

(1) *Food.*—For the direct use by man himself; and, second, as bait for the prosecution of the fisheries.

(2) *Oil.*—For food or medicine; for illumination; for use in the arts, as in the manufacture of soap, the dressing of leather, &c.

(3) *Manure.*—Applied in a fresh state directly to the soil; as dried and subjected to chemical manipulation and combination with other substances.

(4) *Utility and ornament.*—A systematic account of all the uses in their minutest detail to which the inhabitants of the sea are put by man would go far beyond the limits of the present article, and it is possible but briefly to refer to some of the more important, concentrating attention hereafter upon those which bear most closely upon the subject of the value of the fisheries in the United States and the Dominion of Canada.

For the present it is necessary to leave out the consideration of the cetaceans and other marine mammals, as well as the corals and sponges,

and some of the applications even of the fishes and crustaceans; and to furthermore restrict our consideration to the fishes proper, introducing other forms only so far as they relate to the question of bait.

1. *As food for man and animals.*—By far the most important application of fish is as sustenance for man; a large proportion of the population of the globe deriving its support more or less exclusively from this source.

Although the fresh-water fisheries in many countries are of great importance, and supply a notable percentage of valuable food, it is from the sea that not only the great portion of the fish found in our markets is derived, but also the bulk of that which is preserved by various methods for a greater or less length of time, and for transportation to distant markets.

Fresh fish can, of course, be kept in a cool climate for a considerable time without any special preparation; but the simplest mode of treating it for preservation is that of drying, by exposure to the sun, either with or without a certain amount of salting.

Next to the drying we have the smoking either of the fresh meat or when it is more or less salted. The salt may be applied either dry or in solution, when the fish are to be used almost immediately (which process is known as corning), or else kept for a longer period. Salt, being a substance found universally, is the cheapest and most convenient medium. The use of borax has already been alluded to on page 137. Salicylic acid, too, in solution can be used to keep fish fresh for a considerable length of time.

Until quite recently the ice has been used by itself, without the addition of any salt whereby to produce the so-called freezing mixture, the fish being kept in boxes or bins in the holds of vessels, in contact with ice, reduced to a greater or less degree of firmness, and drainage being provided to carry away the water. Sometimes the fish are packed with ice and a non-conducting substance like sawdust, which greatly retards the rapidity of melting and permits the shipment in large quantities.

A much better method of using ice alone consists of its application in some of the modern circulating refrigerators, in which it is placed above the receptacle containing the fish or other meats, and a circulation so established which, while keeping the temperature of the air surrounding the meats at a low point, extracts all the moisture from the atmosphere, leaving it perfectly dry, and furnishing an atmosphere corresponding to that of an ordinary clear cold winter's day. The flesh of fish thus treated is very much more palatable than where there is a direct contact with the ice itself; in the latter instance the fish, while not undergoing decomposition, becoming stale and sometimes more or less sour.

The greatest improvement, however, in the preservation of fish for food is by the use of freezing mixtures. Under no circumstances by the use of plain ice at melting temperatures, in an ordinary summer's at-

mosphere, can the temperature be kept below 40°, and where the fish are not actually in contact with the ice, possibly not below 50°. This involves a tendency to become stale, as above referred to. If, however, the fish be frozen hard and stiff immediately after being caught it may be kept in this condition for an indefinite period of time, and when carefully thawed out and used immediately after, will be very little if at all inferior to a fresh fish. For this purpose the fish are now exposed as soon as possible after being caught to the proximity of a freezing mixture of ice and salt; and as soon as well frozen they are transferred to a much larger chamber in which the temperature is kept by the same means at about 12° to 16°.

These apartments have double walls, with some non-conducting substance interposed, as charcoal or sawdust, and usually have several iron cylinders passing through, which are kept filled with a mixture of ice and salt, provision being made for their introduction above the chamber and for the drainage of the melted liquid below without the necessity of opening the room. Here immense quantities may be kept in a state of absolute unchangeableness as long as the condition of the market requires. This method is now employed in New York and elsewhere for the preservation of all kinds of fish, salmon, striped bass, cod, Spanish mackerel, bluefish, &c., being piled up by the cord.

A very important result of these processes consists in equalizing the market, preventing a glut at one time and an excessive cost at another. Any one of the fish just mentioned, with numerous others, can now be obtained without any difficulty, at any season of the year, from such dealers as E. G. Blackford, Middleton, Carman & Co., and others, in Fulton Market, New York.

There seems to be no reason why dry, hard freezing may not maintain animal matter in a sound and wholesome condition for any period during which it may be applied without interruption; and as a case in point, I adduce certain well-substantiated facts in regard to the occurrence of a carcass of the mammoth in Siberia. It is well known that at one time, probably during the interglacial period, the mammoth, or fossil hairy elephant, was extremely abundant in arctic Asia and America, in the former especially, and that even now a large percentage of the ivory of commerce is derived from the tusks of these animals found in the soil, in the river-beds, or dredged up in the Arctic Ocean off the mouths of the Siberian rivers. It is probable that herds of these animals, in crossing the rivers, were drowned and carried out to sea by the powerful current, when the meat soon decayed or was devoured, and the bones decomposing in time left only the tusks to reward the gatherer. Some years ago a merchant of St. Petersburg, in visiting Northern Siberia in the course of his trade, came across the carcass of a mammoth that had been washed out from a frozen gravel bank along one of the rivers, and lay on the beach, where it had been for many months the prey of dogs and of wolves and

other wild animals. At the time he found it a considerable portion was left, although most of the meat had been consumed. It was even then not offensive at all, and the dogs were devouring it with great eagerness. He obtained the skeleton and a portion of the skin, which are now to be seen in the Museum of the Academy of Science of St. Petersburg. The natives assured him that the meat was fresh and fine, and in no way disagreeable. Here we have a case of meat preserved in a natural ice-house through a period, the antiquity of which we cannot readily measure, but certainly an estimate of many thousands of years is entirely within the mark.

The animal was imbedded in the frozen soil below the point where the surface would thaw in the short summers of that country, and remained all that time, with all tendency to decay or deterioration absolutely suspended.

All these processes mentioned for the preservation of fish for food are applied to a greater or less degree in keeping fish to be used as bait in the fisheries, namely, salting, keeping in ice, and hard freezing; drying is less available. They have been discussed under that heading at page 133 *et seq.*

Next in importance is the method of the preservation of fish in oil of one kind or another. Here the fish, after being treated properly, are sealed hermetically in metallic vessels of smaller or larger size. This method of preservation is applied more particularly to the sardines, but is also used in the case of the imitation of sardines, as the pilchards, menhaden, &c. In France, Italy, Spain, and Portugal, however, where olive oil is inexpensive, nearly all kinds of fish are preserved, as the tunny, bass, perch, mullet, &c., and various mollusks. Specimens of such preparations were exhibited at Philadelphia in 1876. In the United States, where olive oil must, for the most part, be imported at a heavy cost, other vegetable oils, especially that of cotton-seed, have been found very satisfactory substitutes.

A novel, and what promises in time to become an important, preparation of food is the result of a process for obtaining the extract from the flesh of the menhaden, as invented and patented by Mr. S. L. Goodale, of Saco, Me. The value, both in a hygienic and dietetic point of view, of the beef extracts of Liebig and other inventors, is now well known and established, and the fish extract of Mr. Goodale, strange to say, has no fishy taste whatever, and is scarcely distinguishable from the meat extract. He claims that an immense amount of this substance can be obtained during the ordinary process of utilizing the menhaden, adding greatly to the profits of the business and without interfering with the preparation of oil and scrap. Samples of this extract were presented at the Philadelphia Exhibition, which were considered very excellent, promising a satisfactory future. In his opinion at least 20,000,000 pounds of this extract can be obtained from the menhaden annually without interfering with the yield of oil and scrap, and possibly of nearly equal money value.

It was first brought to notice at the Centennial Exhibition, and received the high commendations of the jury on the fisheries and foods. The fish are first thoroughly cleaned and washed, and then immersed in boiling water for a short time for the purpose of removing the skin. They are then subjected to a subsequent treatment by which 3 pounds of extract are obtained from each barrel of menhaden, or 4 pounds if the entire fish is manipulated without separation from the bones. This process does not in any way affect the value of the fish for the production of oil or manure, and therefore constitutes an important utilization of a waste product, the proceeds of which will probably in time much more than pay all the increased cost of treatment.

The same method can be applied to other fishes of sufficient size to warrant their evisceration, although it is hardly likely that any fish but the menhaden can be profitably treated in this manner, being actually shipped to Italy for the purpose of adulterating the genuine olive oil. There are other modes of preserving animal substances, especially fish, in use in various parts of the country, but those already given are the most important.

In addition to the consumption of the flesh of fish as food, other parts of the body are used for a similar purpose, the most important being the livers and the air-bladders. The livers of many fish, especially the *Gadidæ*, of some of the sharks and some other species, furnish oil in very great quantity; and those of the cod especially, and other fish of the cod family generally, are used as food, particularly as nutriment for invalids affected by consumption or other wasting disease. The oil is also used for industrial purposes, which will be referred to hereafter.

The air-bladders or sounds of fish are very extensively employed in the preparation of so-called isinglass, of which the most esteemed is that from the sturgeon and the hake.

Of late years an excellent glue is made from the skin as well as the air-bladder of fishes, but this has mostly technical applications. The isinglass of fish when used as food is usually employed for the most part in the preparation of jellies, gum-drops, &c., as well as in the refining of beer and other beverages.

Under the head of the application of fish as food must be included their use as bait for the fisheries, as also their destruction by their fellows for their sustenance. These subjects will be referred to hereafter.

Besides the use of the meat of the fish, either fresh, salted, dried, smoked, pickled, spiced, in oil, &c., there are certain portions of the body which are considered more or less delicacies. Among these the heads of many species are preferred to the rest of the body. The boiled head and shoulders of the cod, the striped bass, and some other species are considered especially excellent, as are the fins of the halibut. Indeed, in the earlier history of the country the head and fins only of the halibut were utilized, the rest being thrown away. The tongues and

sounds, too, of the cod, hake, and other gadoid fishes are very highly valued for food, and are usually put up salted separately. The air-bladders or sounds of fish have already been referred to as of special commercial value, those of the sturgeon furnishing the well-known Russian isinglass, and being utilized for the same purpose.

Of late years the air-bladders of the hake have been collected very assiduously, and are worth more than all the rest of its body. They are gathered especially on the coast of Maine and in the Bay of Fundy, where vessels are in the habit of visiting the different fishing stations and buying these sounds for from 50 cents to $1.25 a pound. The drum, squeteague, and, indeed, almost any other of our species in which the walls of the air-bladder are thickened, and that organ is of considerable size, are valued for the same purpose. Several fresh-water fish in South America are also utilized in the same direction. There are establishments in Massachusetts where the business of collecting the air-bladders of fishes of all kinds, and of working them up into marketable products, is carried on.

The skins of many fishes, too, are convertible into a coarse gelatine or tenacious glue. In Russia the cartilaginous backbone of the sturgeon is highly prized as an article of food, and is collected and sold in bundles like whips.

The roes of a great many fish are used as a special article of food, sometimes with the rest of the animal, as of the herring; at others separate from it. The roes of the mullet of the southern coast of the United States are salted and barreled and consumed largely throughout the interior of the adjacent States, the meat itself being less prized.

The caviare of the sturgeon is a well-known article of commerce, and is now being put up in the United States in large quantities, particularly for export to Europe.

I have already referred to the extent to which the business of putting up fish in oil and spices and inclosing them in hermetically sealed tin cans is carried on abroad, particularly by the inhabitants of France, Spain, Italy, and Portugal, this process having been until recently scarcely known in the United States; but it now bids fair to become an important element of our industries. Few persons realize the extent to which the menhaden is utilized in this direction, several establishments in New Jersey finding it really difficult to secure a sufficient supply of fresh fish to meet their demands. Here they are put up in oil under name of American sardines, or spiced and known as ocean trout. The herring is also put up both in oil and spices in New York and at Eastport, in Maine. Mackerel are preserved to some extent in Canada in pound cans, like the canned salmon, several thousand pounds being included in the returns of the proceeds of the Canadian fisheries for 1876.

There is no doubt but that there is a wide field in America for the utilization of fish in this way, and that a large market could soon be

built up, not only in this country but abroad. In 1876 the value of the sardines and anchovies, prepared in oil and imported from abroad, amounted to $595,901, each year showing a considerable increase. The only advantage that foreign countries have over us in this matter is in the price of oil; and if the cultivation of the olive in California proves to be a success this will furnish the finer material, although the best quality of purified cotton-seed oil is believed to be equally wholesome and can be furnished at a very low figure.

2. *As oil.*—We have already referred to the use of the oil of the livers of fish as an article of food or medicine, but it is in its industrial applications that the oil of fishes merits the principal consideration. While there is a great difference in the amount of oil furnished by the livers in different species, almost any will yield it in greater or less abundance on being boiled and pressed, varying in amount with the species. The most of the fish-oil is, however, derived from the body generally. In one fish abounding on the northwest coast of America, known as the candle-fish (*Thaleichthys marinus*), closely allied to the smelt and capelin, which, indeed, it resembles, the dried fish is used for the purpose of illumination, the amount of oil being such that it furnishes no mean substitute for a candle, being capable of ignition and burning for a considerable time. As this fish is very abundant, it is not improbable that it will hereafter constitute an important source of oil, parties in British Columbia and Alaska being now engaged in the business on a small scale.

It is from the menhaden or pogy of the Atlantic coast of the United States, however, that the greatest quantity of oil is obtained.

Next to the menhaden or pogy the sea herring is probably the most extensive source of supply in the United States, the fish as caught in weirs in the Bay of Fundy and elsewhere being treated for this purpose. It is not improbable that the offal of cod and other fish will after a time be largely utilized in this direction, as it is on the coast of Norway, where very little is wasted.

A further extensive source of oil for technical purposes is found in the liver of the dog shark (*Acanthias*), a small species scarcely more than one or two feet in length, but occurring on the American coast in immense numbers.

As almost any fish will furnish oil when boiled or steamed and subjected to great pressure, other species are treated for this object from time to time, according to their abundance or the immediate necessities, but those mentioned above are probably the most important. The capelin, it is true, furnishes an excellent source of supply, but it is found for so short a time on the coast of Newfoundland and the other regions inhabited by it, that it would hardly pay to put up permanent establishments for operating on a large scale.

The limitations of my subject exclude the consideration of oils as obtained from whales, porpoises, blackfish, grampuses, &c., the supply of

which is of course very great, although diminishing in quantity, while that from the true fishes appears to be increasing.

The use of fish-oil as food or medicine is comparatively limited. Its application is more generally to the manufacture of soap, and in the dressing of leather, for purposes of illumination, and, to some extent, in painting. During the late civil war in the United States, when the supply of turpentine was limited, the oil of the menhaden was employed as requiring less turpentine in its service.

3. *As manures and fertilizers.*—The refuse, or so-called "scrap," left after the expression of oil from boiled or steamed fish, is used very largely as a fertilizer, for which it is especially valuable in consequence of the large amount of phosphorus contained in the bones, and of the nitrogenous matters. This is used either directly or after being subjected to chemical treatment, and, for the most part, mixed with the phosphatic earths found on the coast of South Carolina and Georgia, with the mineralized guanos of the Sombrero Island of the West Indies, or with the well-known guano of Peru or of the islands of the Pacific.

4. *Other purposes.*—The remaining applications of fish are of much less moment than those to which we have already adverted, being usually exceptional and confined to limited areas.

Although the skins of fishes have been utilized in various ways by different nations for a long period of time, within a few years this industry has become prominent, and will in time represent a very important element in the total products of the sea. Although the skins of cod, salmon, and other fishes are not unfrequently used as clothing for both the feet and the body by the tribes of the northwest coast of America, it is only of late that such skins promise to come into use among civilized nations. A patent has been taken out in the United States for the manufacture of shoes from the skin of the cusk (*Brosmius vulgaris*). The skins of various species of sharks are now very carefully saved in the Red Sea, the Mediterranean, and the Indian Ocean, and constitute a considerable article of commerce, the best material being furnished by the genera *Scyllium*, *Scymnus*, *Spruax*, *Acanthias*, *Sqatina*, *Squalus*, &c. These are used largely for polishing wood and metal, for covering boxes, spectacle and spy-glass cases, &c.

The skin of the burbot or ling (*Lota*) is employed in Russia and Siberia for trimmings of dresses and for the windows of dwellings, instead of glass. It is also made into bags for holding clothing, &c.

The skins could be taken off from many fish which are now entirely wasted, and from others the meat could be employed in some form or other. When tanned or dressed the skins could be converted into articles of clothing or ornament, and could be used in polishing wood or metal.

As already explained we are far from deriving all the benefit that we might from our sea fisheries, not only neglecting, as we do, a large part

of our actual catch, but failing to secure what is in other countries considered a source of national wealth. Apart from the increase in quantity of the well-established preparations of fish by drying, salting, smoking, &c., there is a large field open in putting up fish in hermetically sealed cans, either in oil, pickle, or spices.

The Centennial Exhibition of 1876 afforded an opportunity for the presentation of vast numbers of preparations of fish, as made and consumed in large quantities in France, Italy, Spain, and Portugal, which could be readily imitated in the United States, and find a market either here or in foreign countries. Indeed, almost every fish of the Mediterranean in the various preparations, notably the mullet, the mackerel, the tunny, the perch, bass, &c., and even squids or cuttle-fish, were found to constitute no inconsiderable item.

Of herring there are many preparations greatly in demand in Europe, of which we know nothing. A reference to some of these will be found in the Report of the U. S. Fish Commission, Vol. III, page 183 (Widegren on the Herring and its Preparation as an Article of Trade).

The carcasses of sharks, skates, and other now refuse fish could be converted into food for dogs, poultry, and even used in feeding young trout or salmon, &c., in piscicultural establishments. Even if they could be sold at from 1 to 3 cents a pound for the dried meat, in the large demand that could readily be developed for the various purposes mentioned, a satisfactory profit could be derived. The meat could be chopped fine or converted into meal, as with the well-known fish-meal of Norway.

IV.—MAINTENANCE AND IMPROVEMENT OF FISHERIES.

CONSIDERATIONS RELATIVE TO THE BEST MODE OF MAINTAINING AND INCREASING THE SUPPLY OF THE SEA FISHERIES.

This subject may be best treated under the following heads: First, legislation in the way of regulation and prohibition; second, the increase of the absolute number and variety of fish; third, equalizing the supply of fishes and bringing them from distant points within easy or convenient reach of the fishermen.

1.—LEGISLATION.

The history of the fisheries for many centuries past has been largely a record of attempts either to give monopolies to favored individuals and companies, or well-meant, but in most cases ill-judged, endeavors to protect the fish from destruction and to secure the rights of the people in their capture. The tendency, however, of later years, has been materially to relax and in many cases to abolish these regulations, and it is now becoming generally conceded that, so far as the sea fisheries are concerned, the less the obstacles we place in the way of the prosecution of the fisheries the better. It very rarely happens that the enact-

ments for the protection and regulation of the fisheries are based upon a thorough knowledge of the habits, migrations, and general relations of the fishes themselves, and even while removing or preventing a difficulty in one direction, they bring about a still greater one in another. In many cases action, when taken, is the result of the unfounded clamor or jealousy of fishermen using one kind of apparatus against those employing another, or, in some instances, it results from the influence of the wealthier classes, who wish to preserve the fishing as a sport and relaxation, as against the interest of those who depend upon it for a living. In considering the complaints, therefore, in regard to a particular mode of fishing, and the invocations for its restriction, due caution should be exercised in determining how far the personal element comes into play and how far the interests of the great mass of the community and the world are at heart.

Legislation on this subject is usually included under the following heads: First, the places of fishing; second, the season; third, the time of day; fourth, the size and length of the nets, and the size of the mesh; fifth, the distance apart of nets, weirs, pounds, &c.; sixth, the number of fish that may be taken; seventh, the police and regulation of the boats and men; and, eighth, regulations in regard to the preparation of the fish, and for securing to the purchaser a proper knowledge of their character and quality.

It will, of course, be understood that legislation can be properly enforced against foreign nations at least only within the territorial limits of the country; and as the three-mile line is usually accepted as defining the boundary between the inshore and offshore fisheries, it is usually the space within that limit to which the local laws apply. In some nations the particular areas of the fishing-grounds are assigned to the inhabitants of certain districts, those adjacent to it not being permitted to enter, and severe conflicts sometimes result from such an attempt.

How far one of the United States can enforce any fishery regulations at sea, outside of the three-mile line, or indeed even within it, is a question not to be discussed here; that the United States can do so is perhaps more certain, the vessel being considered a part of the country and carrying into it the conditions of its shore.

In accordance with a convention consummated in August, 1843, between France and England, the exclusive right of fishing by the fishermen of either nation was given within 3 miles of its own coast, the intermediate space being common ground. A provision was made for the employment of cruisers by both nations, not only to protect the rights of their own fishermen, but to see that they obeyed the laws made for their regulation. Cases were specified in which the vessels of one nation might enter the territorial limits of the other, but in no part of the treaty was there any prohibition, when once within the limits, to purchasing bait, or supplies, or of deriving any other commercial advantage.

This treaty is referred to in the Report of the British Sea Fisheries Commission, where it is expressly stated that the vessels of Belgium, with which there was no such treaty, were not bound by it, and that there was nothing to prevent their fishing if they were so minded, indicating that the submission to a restriction must be a matter of joint agreement between two contracting parties (p. lxiv).

With reference to the difficulty of estimating the extent of the three-mile limit, Prof. George F. Barker, writing from Brookfield Center, Conn., September 7, 1877, said:

"With reference to the question you propose, *i. e.*, whether the probability of an accurate judgment of distance is greater when the estimate is made by an observer standing on shore or by a person in the vessel, I would say that in my opinion the probability of a correct estimate of distance is considerably greater in the latter case. Distance, according to the present theory of vision, is always estimated by the eye from the magnitude of the visual angle under which the distant object is seen. Now, since any given object, placed at a suitable distance, will subtend any angle whatever, it is obvious that size and distance are both variables in the calculation, and that if neither is given the problem is indeterminate. A man who does not know how large the object is which he sees, cannot, from this datum alone, form any accurate idea of its distance. Hence, to estimate the distance of any object accurately, the size of the object which subtends the given visual angle must be accurately known. A man of average height placed a mile off will subtend an angle of about two minutes, and if two miles off, of about one minute. To tell that he is two miles off, and not one mile, the eye must accurately appreciate this slight difference of one minute of arc. The human height is so well known that persons are often introduced into art compositions to assist in judging of distances. But at three miles distance, a man is too small an object by which to estimate distance by the unaided eye, the limit of error being so large as to render the estimate of no value. Hence, other familiar objects larger in size must be chosen. If a person on the shore, accustomed to this kind of estimate, sees a vessel which he is familiar with at the landing, he can tell approximately her distance, if she is not too far off. So a person sailing away from the shore may estimate quite accurately his distance from it, provided he be familiar with the size of the objects on shore. If neither person knows by personal inspection the size of the object looked at, the one in the vessel has the advantage, because the sizes of houses and their parts, windows, doors, &c., and also of well-known trees and animals, vary much less than the sizes of vessels. But there is another advantage on the side of the man in the vessel. He forms his judgment not by a comparison with a single object, but from a large number of objects, whose sizes are well known; and his estimate is, therefore, the mean of a large number of separate judgments, and so more reliable than any single one. Moreover, if these objects are successively back

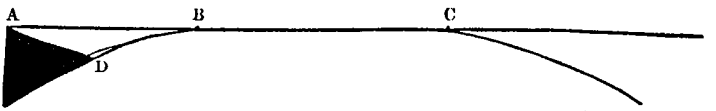
of each other in the line of sight, another advantage is gained, as any one must admit who notices how much larger, because apparently further off, the sun is when on the horizon, where there are objects of comparison, than in the zenith, when there are none. Moreover, as a rule, seafaring men have trained their eyes to estimate distance from a vessel."

To the above may be added the views of C. P. Patterson, Superintendent of the U. S. Coast Survey, given under date of August 31, 1877, as follows:

"From my experience, I conclude, and have always safely acted upon that conclusion, that persons on board a vessel, with rare exceptions, judge the vessel to be nearer the land than she actually is, and this arises in a measure from the fact that the eye rarely recognizes the *foreground*, as it were, of the distances, but is apt, unconsciously, to begin estimating the distance from an imaginary line at some distance from the vessel, the higher the eye above the water the greater being this distance, and the greater the real distance of the vessel from the shore than that estimated. This is particularly seen in handling a vessel in a harbor, or running close in along a shore.

"If the eye is placed at the mast-head of a vessel, the horizon rises, as it were, with the eye, the sensation created being that the vessel is at the bottom of a bowl and the eye on a level with the rim, and from this position estimated distances to objects are almost invariably too short. My own custom was to increase estimated distances accordingly. If a man at the mast-head estimated the distance to an object, unseen from the deck, to be 20 miles, I concluded at once that it was 24 or 25 miles.

"From the shore the eye recognizes a marked foreground (there always being a very decided one, even on a sand-beach of the edge of the breakers or water), which it cannot ignore, and from which it at once begins to estimate distances. The eye being filled with this 'foreground' takes cognizance but indifferently of the object itself, as well as the distance intervening between the outer edge of the foreground and the object, as shown thus:



A being the elevation of eye above the water, D the edge of the breakers and foreground, B limit of foreground, and C the position of object. The angle which the eye instinctively measures is D A B, and this is equal to D A C, be the object wherever it may on the horizon. Then the distance B C is measured only by the greater or less distinctness of the object, there being nothing with which to compare it. From the want of a foreground, if A was the mast-head of a vessel the distance the eye would endeavor to measure is B C, almost entirely ignoring A D B, and

in addition the shore being much more prominent to the eye from the vessel, than the vessel from the shore.

"If the eye on the shore is placed where it can take in a long stretch of coast, it will nearly always underestimate the distance of a vessel from it.

"Of course, the cupidity of commerce sways the judgments of the best people in the direction of their own interests, but I give the results of my own experience for what they are worth.

"The matters stated in your letter also have an effect in the general estimate of a distance over the water from the land to a vessel or from a vessel to the land.

"My conclusion is that as a general rule the distances of the land from vessels and the distances of vessels from the land are usually underestimated. In one case the eye ignores the nearer part of the distance, and in the other the more distant part.

"In this I am confirmed by the experience and opinion of Commander E. P. Lull, U. S. N., Hydrographic Inspector, United States Coast Survey."

The season of fishing, too, is also a subject of legislation. The Government of Norway determines with great care the time when the nets and long-lines shall be set, the introduction of the latter into the water not being permitted at the Lofoden Islands fisheries before 12 o'clock m., their lifting being imperative before noon of the following day. France, England, and other nations have made regulations in regard to the size of the mesh, specifying the minimum for the beam-trawl and for the drift-net, the object being to secure to the young and unmarketable fish a chance to escape. This precaution, however, is of little value in the case of the beam-trawl, where many fish are taken which would have passed through the meshes of an ordinary net without difficulty.

The distance apart of nets, so as to prevent interference, has also been provided for; as also the restriction of particular kinds of fishing to certain grounds, in Great Britain trawling being sometimes limited to certain areas, to prevent interference in the use of the long-lines.

Nearly all nations have regulations in regard to the boats and vessels to be used, among others requiring them to be numbered in certain ways, so that they may be more easily designated and identified in the event of their attempting to evade the law.

The preparation of fish for the market has also been the subject of legislation. Many nations which pay no particular regard to the times, places, and circumstances of the sea fisheries, have considered it expedient to secure the interest of the purchaser by regulating and restricting the mode of preparation and of packing, this being the case, perhaps, more especially in Holland and the Scandinavian countries than elsewhere. The herring fishery in Holland was formerly kept, in all of its stages, under the control of the Government, although of later years this is more particularly confined to the packing and inspection. In

Norway, however, the Government requires that the herring which are found to have in their stomachs certain kinds of food shall be kept alive, inclosed in the nets until this food is absorbed, as otherwise the fish cannot be preserved for any length of time, thereby affecting their quality as food. Still more generally is there an inspection of fish by the State after they have been put up, the packages being marked by Government officials, who are supposed to be beyond danger of any corrupt influence in making the distinctions as to quality.

There is, perhaps, no nation in the world where there are fewer regulations and restrictions in regard to the sea fisheries than in the United States, no response having been made either by the General Government or by the State to the numerous appeals to take the subject under their jurisdiction, and to prevent what is claimed to be improper methods, or unseasonable times of capturing fish, or undesirable modes of preserving them.

There are, however, in several of the States, especially of New England, State inspectors of fish who brand the packages, in accordance with the quality of the fish, these marks guiding the purchaser in his selection and in the price to be paid by him.

Although the propriety of maintaining such restrictions has been questioned, on the ground that all these matters should be subject to the general law of demand and supply, and to individual reputation, yet it is not likely that any change will be made. While it is comparatively easy in many cases to enforce regulations in regard to fishing and the treatment of fish near the shores and under the jurisdiction and supervision of officers, it becomes a much more difficult matter when the fishing is prosecuted at a distance, as in this country on the George's Bank, the Grand Bank, &c. It is, of course, possible to send Government cruisers to accompany the fishing fleets, to see that the fishermen obey the laws in this matter, and this is done to some extent by the Norwegian, Dutch, English, and French Governments, the two latter maintaining a sea police, more to prevent encroachments by the opposite nation upon the fishing-grounds, or injury or outrage upon their own vessels. Great Britain, too, has during some years maintained a certain number of armed vessels within her dominions in North America to prevent the encroachments of the American and French fishermen. The United States, however, has never had any provision of this kind, but has allowed the sea fisheries to regulate themselves entirely. Some of the States supply armed protection to their oyster fisheries, both Maryland and Virginia having now, or until quite recently, such a provision.

The propriety of international agreement in regard to certain modes of fishing has not unfrequently been urged, and more particularly it has been proposed that the United States and Great Britain have an agreement to prohibit the use of the trawl or long-line on the Banks of Newfoundland and in other portions of the high seas. Apart, however, from

the questionable propriety of interfering with this mode of fishing, there would be the consideration of enforcing such rules, as it could only be done by means of a fleet of Government vessels of both nations, stationed in different portions of the high seas, involving, of course, the danger of irritation at any attempt at enforcement, especially by the vessel of the opposite nationality.

Again, even if this could be effected and enforced by the United States and Great Britain in respect to their own subjects, there is no probability that other nations would enter the convention or consider themselves bound by its provisions; and without the co-operation of armed vessels of other nationalities, any attempt at regulating the fishermen of the same would be resented by their respective Governments, and danger of war ensue. If there were no interference with the subjects of other Governments, the effect would be simply to give them the monopoly of capture by the prohibited apparatus, or during the prohibited season to other parties, and thus a season's loss would be inflicted upon the subjects of the consenting nations. It might also be a question how far any Government could pretend to interfere with the fishing operations of its own subjects on the high seas; provided, of course, these did not involve any criminal action, or such as is, by common consent, allowed to be a matter of jurisdiction. Of course, the vessels and their catch might be controlled on their entering port; but there would seem to be nothing to prevent the taking of the fish to a foreign nation. It is for these and other reasons, that need not here be detailed, that most careful consideration should be given to any proposition looking towards the restriction or regulation in any way of the sea fisheries of the United States, whatever may be the practice and policy of other nations.

There is, however, a plea for the interference of the Government, in certain cases, in regard to the fisheries that belong to the rivers, or are near the shore, and thereby most specially related to the adjacent commonwealth. Nearly all civilized nations have looked with more or less care after their interior or river fisheries; and quite a number of the States of the American Union have their own special enactments on this subject. This refers more generally to the times when fishing may be authorized; the character of the apparatus, whether lines or nets; but more particularly to the protection of the fish during the spawning season, especially of the trout and salmon. In States possessing shad and alewife fisheries there is usually a definite date when the fish are supposed to have reached their spawning beds or the condition of spawning, and at that time all fishing is interrupted. This varies according to latitude, being earlier in the South and later in the North.

Again, the question of the pollution of rivers is one that comes up for consideration, in many cases the introduction of sawdust or the refuse from gas or manufacturing establishments being prohibited or controlled. Other States, again, require from the proprietors of artificial dams the introduction of some device by which shad, salmon, and

other fish may ascend, and thus be enabled to reach their spawning-grounds. There is also an inspection in the markets, in nearly all the larger cities, of the quality of fresh fish, so as to prevent the introduction for sale of any that are not considered wholesome and fit for food. All these provisions are wise and beneficent, and tend, when judiciously and properly enforced, to protect the fish against decrease and to secure their multiplication, as well as to benefit the purchaser. If the anadromous fish are prevented from access to their spawning-beds, it is within the power of a single person to destroy fisheries of immense value and to deprive a large portion of the community of a wholesome food and an important means of support.

These conditions of protection and regulation, while they cannot be said to apply at all to the deep-sea fisheries, have comparatively little reference to the inshore sea fisheries. But even here we readily imagine that State action, if not that of the General Government, is desirable. The most important point in this connection is the protection of the spawning-grounds (when they can be definitely ascertained) from pollution by the introduction of noxious substances and from the disturbing influences of fishing or other operations. A notable instance of the advantage of regulation in this case is to be found in the matter of the herring fisheries of the Bay of Fundy. The spawning-ground for this fish is remarkably limited in extent, being for the most part situated immediately around the southern extremity of Grand Manan, or what is known as the Southern Head. Here, during the months of June, July, and August the herring resort in immense numbers to deposit their eggs; and limited as they appear to be in distribution at that time, the great number of vessels that followed them to that region took immense quantities of spawning fish, and apparently broke up the schools and prevented them from depositing their eggs under proper conditions. The result appeared, at least, to be a very great diminution of the fish, and the threatening of their practical extermination. Under these circumstances the Province of New Brunswick passed a law establishing the months of June (?), July, and August as a close time, during which no fishing was to be allowed, and appointed an officer to enforce the regulation. For several years many attempts were made to violate the law, with more or less success; but gradually the power of the Government, and perhaps an improved public sentiment, succeeded in breaking up this encroachment, and of late years the protection of these spawning-grounds has involved but little difficulty. It would appear, as the result of this action, that shortly after the enactment the fish began to increase in number, and they are now said to be as abundant in the Bay of Fundy and its vicinity as they were ever known to be since the earliest history of the country. It is of course barely possible that there is some fallacy in this conclusion, and that it was one of these alternations of decrease that invoked the legislation in question, and that the subsequent increase would have taken place, even if the practice of fishing during the spawning season had been continued.

All the European herring fisheries, especially the most important, as those of Norway and Great Britain, are without restriction as to time of catch, and indeed it is when the herring are fullest of ripe roe that they are the most esteemed. At the Magdalen Islands the herring are taken principally during their spawning season without any restriction or suggestion of diminution. The question, therefore, as to the actual importance of the measure referred to may be considered as unsettled, although I can hardly believe that the provision in regard to the herring fisheries at Grand Manan has not had a beneficial influence. It will not, however, do to prohibit the catch of herring when they are filled with roe, since it is when they are in this condition that they are most highly prized and most marketable, the roe of the sea herring being universally considered a very great delicacy.

There are, however, some fish on the coast of the United States for whose protection during the spawning season I have already urged in a previous report that some provision of legislation is desirable. I refer more particularly to certain fish on the south side of New England, especially the scup, sea bass, and the tautog. These fish appear to come to the coast in well defined bands of immense numbers, at a particular season, following generally a definite line of migration and proceeding to their spawning-grounds, where the operation of reproduction is conducted on an enormous scale, in this respect closely resembling the anadromous fish, such as the salmon, shad, and alewife, and apparently almost equally susceptible to any interference by human agencies. Legislation is expedient here, too, both for the protection of the fish and of the fishermen themselves, since after a few weeks' fishing the glut is so enormous as to bring down the price to a mere nothing, involving the necessity of wasting immense numbers of the catch, the best use to which they can be put being their conversion into manure.

In this case, however, I simply suggested an intermission of capture from Friday night until Monday morning, or if this be too long a period, from Saturday night until Monday morning, so as to secure the escape of a sufficient number of the school and an opportunity to deposit their eggs, this weekly intermission to be continued only for the limited period during which these particular fish are on the move. They move in so close and solid bodies and in so limited an extent that it is by no means impossible to imagine the capture of the greater part of the school and the cutting off of the rest of it from reaching a suitable spawning-ground, or disturbing the individuals so that their eggs are not deposited at the proper time or under proper conditions.

The other fish taken during the same period, especially the mackerel and menhaden, are not affected, as it is only a portion of the migrating bands, and that which happens to be nearest the shore, which is taken under such circumstances, enough possibly passing outside to maintain the supply of eggs and young fish.

As to the conclusions at which I arrived in 1871 in regard to the pro-

priety of a partial close time, I still maintain the same opinion, and am fully satisfied that a fair trial for four years would show such a positive increase in the number of these most important and valuable fish as to satisfy the most skeptical. Unfortunately, in this particular case concurrent legislation of two States is considered desirable, since the migrations and spawning-grounds are partly in Rhode Island and partly in Massachusetts, the fish for the most part passing through the waters of the first-mentioned State before they reach those of the latter. So far, neither State has shown a willingness to legislate either separately or conjointly, and the abundance of the fish referred to will probably be determined by the number of the bluefish that visit the same waters. I think, however, that if protected in some way there would be a decided increase without reference to the presence of this wolf of the seas.

I have found a decided unanimity of opinion among fishermen as to the expediency of such a close time, even among those who do not consider it necessary, in order to maintain the supply of fish, the prevention of a glut of the market, and the securing of time for the proper repair of the nets, and for the needed attention to home business, being important and well-accepted arguments with all classes concerned for the proposed close time.

In many cases it would seem that fish, after they have deposited their eggs, become sickly and unfit for food, and no one can examine a male salmon under these circumstances and appreciate the alteration in appearance and condition without realizing the impropriety of using it as an article of food. For this reason a close time is proper, not only to secure an opportunity for undisturbed spawning by the fish, but also to prevent the consumption of unsuitable fish.

In the New England States the alewife fisheries were formerly, and are still in some degree, taken under the protection of the towns, the catch within the jurisdiction of each town being considered as belonging to its inhabitants, to be distributed pro rata among them, or else sold for the common benefit. Sometimes each individual was authorized to take a certain number of fish; at others officers were appointed to capture them and apportion them suitably. Regulations were made to secure free access from the sea of the fish to the pounds or other spawning-grounds, and for the escape to the sea again of the fish, both young and old, during the summer.

How far it will be desirable, now or hereafter, to regulate the size of the meshes of nets used in our inshore fisheries it is hardly necessary to take into consideration at present, for the reasons already mentioned.

2.—INCREASING THE NUMBER OF FOOD-FISHES BY ARTIFICIAL MEANS.

There are two methods by which this can be accomplished: (1) By the actual transfer of fishes from one region of the globe to another, or one part of the coast to another; (2) by the artificial propagation and multiplication of fish found in a particular region.

Many instances are on record of the successful transportation of fishes, both fresh and salt water species, to localities previously uninhabited by them, and very extended efforts are now being made, promising the fullest measure of success, to carry the shad and the eel of the Atlantic coast to the Mississippi Valley and the Pacific slope, as well as the tautog, the lobster, and the oyster, and to transfer the California salmon and trout to the Mississippi Valley and the eastern coast of the United States, the carp from Germany to America, &c. Less has been done in this direction with the sea fishes, although even here there is something to record. It is said that the *Scarus*, a well-known labroid fish of the Ægean Sea, was brought, in the time of the Emperor Claudius, to the coast of Italy and planted near the mouth of the Tiber. They were protected from capture for five years, at the end of which time they swarmed in enormous abundance and constituted an important element in the Roman fisheries, being considered one of the greatest delicacies. (Report U. S. F. C., III, p. 10). In the United States the scup is said to have been carried in a smack from Vineyard Sound to Cape Cod Bay, and that a similar experiment was made in a transfer of the tautog both to Massachusetts Bay and the South Carolina coast.

The attention paid by the early Romans to securing an ample supply of fish is well understood, as also the enormous expense of their operations in the construction and maintenance of fish ponds, &c. Among the most highly esteemed species were the red mullet (*mullus*), and the sea eel, the latter being kept in tanks constructed for the purpose, and fed, in some cases, it is said, with the flesh of slaves, as imparting an added delicacy. The introduction of fish from distant points was there practiced to a greater or less extent.

The limitations of temperature, however, and appropriate food, will probably determine what may be accomplished in the way of exchanges between the northern and southern coasts of the United States; and there are a few species in European waters the introduction of which it will be well to attempt, especially if brought into waters of the same general physical conditions. Among such desiderata may be reckoned more especially the turbot and sole, which constitute the most important element in the beam-trawl fisheries, and which, as already explained, always command a high price. There seems no good reason why these fish might not become, in a few years, after a successful transfer of a few individuals, as abundant as they are on the European coasts. An ample supply of suitable food and of the necessary external conditions could be assured to the new-comers. The experiment would perhaps succeed best on the eastern coast of Massachusetts, where the conditions are quite similar to those of their native habitat. If they were found to thrive in the region south of Cape Cod, an enormous fishery might in time be assured in view of the adaptation of the waters to successful beam-trawling.

As a return to Europe for the contribution of the turbot and sole

the alewife might be offered, a fish which should thrive in all the rivers, ponds, and lagoons connected with the sea, whether in the warmer or colder portions; and as they move in well-defined bands of vast numbers of individuals, within narrow limits, it would add greatly to the food resources of the country. A very considerable expenditure of money on the part of European Governments, especially that of Germany, where the ordinary sea fisheries are restricted, would probably be amply justified in a few years, the fish being by far more valuable and worthy attention than the salmon and trout, and perhaps not excepting the shad.

From present information on the subject there are no other European sea fish, excepting the turbot and the sole, that would be especially important in America; possibly the fresh-water sterlet of Russia and the hucho salmon of the Danube might be introduced to advantage. This last-mentioned species remains throughout the year in the Danube River and its tributaries, and constitutes and excellent article of food. It might, perhaps, be quite advantageously planted in the Mississippi, where it would find an ample supply of the poorer sorts of fish, for the most part not considered worth anything for market purposes.

The artificial propagation of sea fishes has not yet been attempted on any experimental scale, although there seems to be no particular reason why a vast increase cannot be accomplished in this direction, as with the anadromous or interior species. There is no question as to our ability to multiply salmon and shad to any desired extent, and the same general treatment might readily be applied to many of our coast fishes. The principal difficulty in the way would be the construction of the proper establishments, although the recent experiments of the U. S. Fish Commission, and that of Maryland, point out a reasonable method of accomplishing this, as will be referred to hereafter. It would be quite impossible to undertake to feed the young fish when hatched, as is done with trout; but the methods used for shad and in most cases for salmon hatching, could be made use of, namely, that of introducing the young fish into the water and leaving them to their own resources so soon as the yolk-bag is absorbed and the fish is able to feed itself.

According to reliable estimates, not more than 1 egg in 200 hatched naturally in the waters produces a fish capable of feeding itself, this representing by far the greatest expectancy of destruction in the number of eggs laid by the female.

On the other hand, artificial impregnation and propagation should give us not less than 175, or even more yet, of the 200, a vast difference, which could not fail to tell in the result. In other words, the proportional result of artificial hatching is 175 fold that by the natural spawning of the same number of fish. The young, when ready for introduction into the water, could readily be placed in sheltered bays and coves, and possibly fenced off for a time from the intrusion of larger fish, and kept there until they had attained a sufficient size to protect themselves to a considerable degree.

This experiment of artificial hatching could be adopted very readily on the south coast of New England, in connection with fisheries of scup, tautog, and sea bass, especially as all these fish are greatly in demand and are taken in great numbers in the fish pounds and traps of the southern coast during the months of April, May, June, and July. The sea bass especially spawn very largely during the latter period. An ample supply of scup could easily be obtained during the spawning season, and if necessary the tautog and sea bass could be kept in pens until ripe. These fish are very frequently kept for weeks, or even months, waiting the call of the market, and as they are very hardy, it would not injure them at all for market purposes to strip them of their spawn at the proper time. The eggs of this fish probably hatch out very quickly; in the tautog, indeed, an embryonic development of the egg is said to take place before it is laid, so that not unfrequently some of the eggs squeezed out into a bucket of water will hatch out almost immediately. In an experiment of artificial impregnation and hatching of the sea bass, prosecuted at Noank, Conn., in 1874, there was reason to conclude that the period of development did not exceed one week.

The pound-nets frequently take great numbers of spawning mackerel, which might also be manipulated; and there is no reason why the sheepshead might not be treated in a similar manner, nor, indeed, why the process might not be extended to such species as the cod. The striped bass is a fish that promises ample success in such an experiment as soon as we can succeed in taking it in sufficient numbers. At least some spawning fish are found in the rivers at the same time with the shad and herring; whether simply in pursuit of this prey or in search of a spawning-ground is not yet ascertained. In 1873 the parties of the U. S. Fish Commission engaged in hatching shad in the Roanoke River succeeded in taking several ripe striped bass, from one of which 100,000 eggs were successfully taken and hatched. The eggs are smaller than those of the shad, although similar to them in being non-adhesive and in being hatched out in a short time.

The principal difficulty in regard to the multiplication of the sea fish by artificial means is in the arrangements necessary for the care and preparation of the egg. The ordinary hatching establishments used for trout and salmon are not available since salt water is required for the purpose. It is true that this might be pumped up by means of a wind-mill or otherwise into tanks, and allowed to trickle into the hatching troughs, and thus produce the necessary current. Even if this could be done, however, the limits of space and the comparatively small number of fish that could be obtained will probably render it expedient to adopt some other method.

The first suggestion would be the employment of the floating-box, as constructed by Seth Green, E. A. Brackett, and others, and used in the hatching of shad. A serious difficulty, however, is in the danger of

having them upset and the contents spilled out, or else greatly injured by the action of the waves, experiments made in this direction nearly always resulting disastrously.

Much more wholesale and efficient methods of accomplishing this important object are, however, at our command, as suggested by the success of experiments prosecuted during the spring of 1877 at Havre de Grace in hatching eggs of shad on a large scale, in connection with the operations of the U. S. Fish Commission and of the Maryland commission. Mr. T. B. Ferguson, the efficient and accomplished Maryland commissioner of fisheries, has devised a method by which the hatching of shad can be prosecuted in tidal waters and by which not only a great number of eggs can be hatched in a very small space, but also the danger of losing the eggs in consequence of the upsetting of the hatching boxes in stormy weather can be prevented. This device consists in a series of buckets, with wire-gauze bottoms, which are alternately depressed and raised by means of an axis rotated by steam-power. The buckets dip into the water, the eggs floating in them, and the gentle motion of elevation and depression through the space of five or ten inches, the extent and rapidity of which can be varied at pleasure, gives the eggs that agitation and the continual contact with a new supply of water necessary to their proper condition. Nine million eggs were thus hatched with a much less expenditure of labor than heretofore; and instead of some hundreds of floating boxes being called into play, six to twelve buckets, worked along the edge of a floating scow, answered all the purpose.

Still other methods can be used, possibly in some cases to even greater advantage, namely, the placing of the eggs in funnel-shaped vessels, with a stream of salt water pumped up through the bottom, giving the eggs a constant agitation. A wire-gauze screen prevents the eggs from dropping into the mouth of the funnel, and the constant overflow of the water carries off all the dead offal matter. It would, of course, require a considerable expenditure to start such an establishment. A small engine, of four or five horse-power, with the necessary accompaniments, however, would probably be large enough. With such an apparatus in connection with some of the great fisheries, like those in Seconnet River at Rhode Island, or at Menemsha Bight on Martha's Vineyard, results of incalculable value might and probably would in time be obtained. Instead of counting the yield of the fisheries by the hundreds of thousands, millions could be estimated for, and it would not be difficult to guarantee the propagation of one hundred millions of young fish as the result of a single season's work. These, when the yolk-bag was absorbed, could be scattered or sown along the coast in different localities so as to increase the opportunity of finding suitable food and of escaping the ravages of their enemies.

3.—EQUALIZING THE SUPPLY OF FISHES.

A third subdivision of the subject of maintaining the supply of sea fish along the coast, and of increasing it, may now be considered. The connection between the fresh-water or rather the anadromous fisheries of our coast and the sea fisheries has been dwelt upon in previous reports, and while not assenting to the possibility of diminishing the supply of sea fish by ordinary human agencies, I have been satisfied of the disappearance of certain fish from our shores for the want of suitable food, and their migration elsewhere. Of the possibility of attracting fish from great distances by suitable food we have numerous instances. Thus the mackerel fishermen have been in the habit of throwing chopped bait overboard, which was carried a distance, possibly of miles, by the tide. When the school of mackerel strikes this stream of food it follows it up an indefinite distance and comes in immediate proximity of the source of supply, where the fishes can be captured by the hook or the net. Where many vessels are engaged in this business, it is said that the schools of mackerel are brought from a distance of many miles and held in the vicinity, against their ordinary instinct of migration. On the occasion, some years ago, of the lamentable falling off in the autumn mackerel fishery on the coast of Nova Scotia, involving considerable destitution and distress among the fishermen, the cause was believed to be in the immense amount of mackerel bait thrown overboard in the Bay of Saint Lawrence by the mackerel smacks, which kept the fish in the bay a long time beyond their usual period of leaving it, so that when they once commenced their autumnal migration they passed directly out to sea, without stopping, as was their custom, in the shores.

The effect of gurry, too, on fishing-grounds may probably be explained by the attractions of this stream of animal matter carried by the tide over a distance of many miles to the dogfish, sharks, and other predaceous species, these following it up and concentrating in the vicinity, where they drive away the food-fishes which form the more special subject of the attention of the fishermen. A similar instance is found in connection with the salmon in the Gulf of Saint Lawrence, where the fish are taken in quantities for salting, smoking, or other modes of preparation. Here immense quantities of offal are thrown into the water, where, however, instead of attracting the destructive fishes, has the effect to bring in such species as the cod and render them capable of capture. At one time this practice of throwing offal overboard was considered very objectionable, and an enactment was passed requiring it to be brought on shore and buried or utilized there in some manner. As the result of the diminution of this supply of animal matter the fishes abandoned the ground entirely, and great complaint was made as to the absence of the food-fishes, even of the salmon itself; and subsequently a compromise was effected by which this matter was placed in perforated boxes and the softer portion allowed to pass out and wash away. This, in connection with the great numbers of maggots of the blue-bottle fly

which also passed into the water, in a short time restored the previous ample abundance of the fishes. In view, therefore, of these circumstances we can readily understand how much the movements of the sea fish along the coast may be influenced by the enormous schools of salmon, mackerel, shad, and alewives, the adults coming in during spring and summer and returning with the young at other seasons of the year, and upon which they prey to a greater or less extent. It is now the general impression that the anadromous fishes just mentioned pass the period of their growth in the sea at no great distance from the mouth of the river in which they were hatched, possibly extending their movements outward 5 to 50 or even 100 miles, but still occupying a certain relation to the rivers in question. A proof of this generalization is found in the fact that in a cruise made by Mr. G. Brown Goode in a mackerel vessel off the coast of Maine, in 1873, young shad, probably one or two years old, as well as alewives, were found in considerable proportion among the mackerel taken in nets 25 to 30 miles off the shore, and he was assured by the fishermen that this was a very common occurrence. Such fish are not brought in, as they are not considered marketable, and are generally thrown into the water when taken from the nets, where they become the prey of other fishes.

It is only necessary to bear in mind the enormous mass of these anadromous fish one hundred years ago, and even later, to appreciate the influence they can exert in attracting fish from the outer waters to the shores and keeping them there for a considerable part of the year, and the lamentable result of the destruction of this source of supply, not only on its own account but also for its influence upon the sea fish. It is well known that while these anadromous fish were present there was an ample supply of cod, haddock, halibut, hake, and various other species close in to the shore. On the whole New England coast, as well as in many parts of the Dominion of Canada, the fisherman, in an ordinary open boat, could go out and catch a full fare at a short distance from the land, both for use as fresh fish and for purposes of commerce, and that it was not until this source of supply was cut off that it became necessary to resort, to so great an extent, to distant parts of the sea. We may therefore hope, as the result of methods now being practiced and their future extension, that the old state of things will be renewed to our great advantage.

As an illustration, both of the loss to our own industries by the destruction of the supply of anadromous fishes, and of the amount of attraction that would be furnished from a single river to the incoming fishes and the retention on the coast of the outside fishes, I may again refer to the quotation on page 50 from Martin's Gazetteer of Virginia. Omitting here any considerations as to the enormous value of this fishery, but bearing in mind that this was only one of at least forty rivers where an almost equal catch might be looked for, let us proceed to consider the amount of food and bait available for the sea fish, re-

sulting from the herring alone. For the 750,000,000 actually captured we may suppose that this was not more than one-fourth of the total number in the river during the season, which would give 3,000,000,000 for the Potomac River only. From Florida to the Bay of Fundy, without any reference to Dominion waters, we may safely assume the number to be at least one hundred fold, a calculation probably far within bounds, five times that amount and more, possibly, being the more reasonable. We have, therefore, 300,000,000,000, representing a weight of not less than 200,000,000,000 pounds. The progeny of these herring in their various stages of growth from the first year to the fourth, may certainly be estimated at twice the aggregate weight of the parents, or 400,000,000,000 pounds, giving us 600,000,000,000 pounds of fish along our coast of this one species. It may safely be assumed that at present not more than one-tenth of 1 per cent. of these fish now inhabit the waters specified, or only 600,000,000.

I have made no reference to the adult and young of the shad, the tailor herring, the gizzard shad, the striped bass, the various *Cyprinidæ*, and other fishes running in from the sea at about the same time with the other fish, and tending to swell the aggregate in the waters. But I think it will be readily understood what a loss we have experienced, not only in the way of direct food, but in the inducements to other fishes to come within our reach; and in the Dominion in the numbers of anadromous fish.

It is, therefore, very encouraging to believe that, even though from the changes in the physical condition of the land, water, artificial obstructions, &c., we may not look for the old-time abundance, we may yet hope for a very considerable increase; even if we get back to one-fourth the original supply, we may well be satisfied.

A comparison of the statistics of the number of shad and alewives caught in the Potomac River in a single season of six weeks' time, and salted, to the extent of 995,000 barrels,* with those of the sea herring in any part of the world, will show the insignificance of the latter; while the fishery on the Potomac during the period referred to equaled the total yield of the Scottish salmon fisheries in 1873, prosecuted throughout the year, and employing 15,000 boats and 45,594 men, and equaled nearly twice the entire number of barrels of the sea herring put up in the Dominion of Canada in 1876.

* It is proper to say that the accuracy of Martin's figures has been disputed by some recent writers. Even if they are, however, twice as large as the fact would justify, the general argument would not be invalidated.

V.—POLITICAL CONSIDERATIONS.

MEMORANDUM OF POINTS ATTEMPTED TO BE ESTABLISHED IN THE CASE FOR GREAT BRITAIN, BY GEORGE M'KENZIE AND OTHERS.

Mackerel.—Mackerel keep close to the shore. All mackerel fishing, therefore, must be near shore, within the three-mile line.

The proportion of mackerel taken outside this line, usually one-third or less of the catch.

The American average catch of fish, six or seven hundred barrels.

Shrimps and small fry are the food of the mackerel. Not found out at sea, but close inshore.

Americans pay no attention to the three-mile line, after the abrogation of the reciprocity treaty, keeping outside only when cruisers were in sight, and returning when they went away.

The universal testimony of the Americans is that unless permitted to fish within the three-mile line, it would not pay to come into the bay.

According to their own statements two-thirds and even more of their catch are always taken within the three-mile line.

Seining for mackerel will soon clean out the fisheries of the Gulf of Saint Lawrence.

The presence of Americans is injurious to the body of the fishermen of the Dominion.

Would be willing to pay the whole duty imposed by the United States, and even more, if Americans could be kept entirely outside of the three-mile line; the Dominion catch would be much greater.

Gurry.—Throwing gurry overboard drives the fish away. This practice is exclusively American. Dominion fishermen clean their fish on shore.

Transhipping is a benefit to the Americans, enabling them to make more trips in the same time.

No Dominion fisherman ever goes to American waters in a British vessel to fish. Reason (according to McKenzie, p. 121), the Americans would run them off.

Americans tranship at Charlottetown and the Gut of Canso.

Codfish (Thomas Bennet, Newfoundland, p. 134).—The cod fishery on the coast of Newfoundland is entirely inshore.

Americans obtained bait illegally on the coast of Newfoundland before the Washington treaty.

Newfoundland has reaped no benefit from the Washington treaty; the exports to the United States are lower than when there was a heavy duty on Newfoundland products.

The amount exported to the United States is too trifling to have any appreciable effect on the commerce of Newfoundland.

Americans fishing off the Newfoundland banks derive a great profit by selling the small fish, under 22 inches, in the Newfoundland markets.

Thinks the remission of duty by Newfoundland on these far larger than the remission on all the products sent by Newfoundland to the United States. The remission of duties by the United States on Newfoundland products of late years is only $49,000, while the amount remitted by Newfoundland is $78,000.

Never knew a Newfoundland fisherman to go to the coast of the United States to fish.