REPORT OF THE COMMISSIONER.

A—GENERAL CONSIDERATIONS.

1—INTRODUCTORY REMARKS.

In presenting an account of the operations of the United States Fish Commission in 1877, it may be well to premise that while representing the sixth year of its work, it constitutes the fifth report of the series, that of two years having once been combined in the same report (1873–'74 and 1874–'75) for reasons referred to in the volume.

As heretofore, it has been found impossible to confine the record to the calendar—or even strictly to the fiscal year, it being considered desirable to give a full, connected, and complete account of the operations in each branch of fish propagation from the beginning to the end. Thus, while the work relating to the eastern Salmon extends from May to the following February or March, that connected with the Shad is begun in March or April, and generally extends only into June or July.

In volume IV of the series of reports will be found a running history of operations up to the beginning of 1877. The present volume takes up the thread and carries it forward in part into the year 1878.

It has already been explained in previous reports that while the labors of the Commission, as originally assigned by Congress in 1871, had reference more particularly to an inquiry into the condition of the sea-fisheries and the influences affecting them, they were largely increased and extended in 1872 by the order to include the general subject of introducing useful food-fishes into appropriate waters of the United States, or restoring them in already depleted rivers. While the first branch involves a somewhat active research during the summer season, when it is most convenient and practicable, the second requires constant activity throughout the year, both in the way of field-work and of extended official correspondence.

The increased appropriations by Congress have greatly increased the labor and responsibility, without any increase of staff, and with the exercise of the most rigid economy it is hoped that the results are becoming greater and greater in proportion to the expenditures.

It is gratifying to observe the constantly-increasing interest in the labors of the Commission, shown by the extensive correspondence induced at home and abroad and by the hearty co-operation of the State Fish Commissions in the common object, both of investigation into the condition of the fisheries and in their improvement.

The same system of subdivision of duty on the part of the *personnel* of the Commission has been continued as in previous years. The general subject of the propagation of food-fishes has been mainly in charge of Mr. James W. Milner, the Assistant Commissioner, while that of inquiry into the statistics of the fisheries has been prosecuted with the especial assistance of Mr. G. Brown Goode, curator of the National Museum. This gentleman, in addition to the statistical inquiry, has also had charge of the field-work connected with the vertebrates. Prof. A. E. Verrill, with his staff, has supervised the explorations and investigations connected with the marine invertebrates, and Professor Farlow those relative to the useful sea-plants. The special assistants in these various divisions will be hereafter mentioned.

B—INQUIRY INTO THE HISTORY AND STATISTICS OF THE FOOD-FISHES.

2.—OPERATIONS DURING THE SUMMER OF 1877.

It has been my pleasant duty, in all the preceding volumes of this series of reports, to acknowledge the hearty responses of the various departments of the government to that portion of the law organizing the United States Fish Commission which directs them to render to it such aid as lies in their power, all whose assistance has been invoked acting upon the spirit of the law, and without restriction to its mere letter. The Treasury, the War, and the Interior Departments all require especial mention in this connection. The co-operation of the Navy Department has been of the greatest importance by lending certain vessels not required at the time for the regular purposes of the department. These consisted of a small steam-launch in 1871, and the steam-tug Blue Light, a vessel of about 100 tons, in 1873, 1874, and 1875. No call was made upon the department in 1876, as no field parties were out during the summer of that year, my presence and that of my assistants being required in connection with the exhibits of the Smithsonian Institution, the National Museum, and the United States Fish Commission at the International Exhibition in Philadelphia. For the season of 1877, however, the assistance of Secretary Thompson, of the Navy, was invoked, and a larger vessel than the Blue Light was detailed by him for duty with the Commission. This was the steam-tug Speedwell, an iron propeller of 306 tons, with a powerful engine, and well adapted to her work. She was put in thorough order at the Portsmouth navy-yard, and reported for duty at Salem on the 31st of July. She had previously left Portsmouth, on the 20th of July, for New London, for the purpose of taking on board the stores of the Blue Light, the vessel previously employed, and of having the hoisting-engine of the latter transferred to her own deck. She also stopped at Wood's Holl, July 26, to take on board the other equipments and articles necessary for her service. The steamer was placed by the Secretary in charge of Lieutenant-Commander

A. G. Kellogg, with Dr. T. H. Streets, surgeon, Mr. A. V. Zane as chief engineer, and Mr. J. A. Smith, who had had much experience in scientific work on the vessels of the Coast Survey, as first mate. A detail of the necessary petty officers and seamen completed the *personnel* of the vessel.

The usual corps of specialists in science took part in the operations of the Commission during the summer. Prof. A. E. Verrill, of Yale, had charge of the marine invertebrates, assisted by E. B. Wilson.

Mr. G. Brown Goode, of the National Museum, assisted by Dr. T. H. Bean, superintended all matters connected with the fisheries. The laboratory and the dredging and trawling apparatus were in charge of Capt. H. C. Chester.

I reached Salem on the 3d of July, and was joined a few days after by the remainder of the force, the Speedwell not arriving, as stated, until July 31, before which date, however, a considerable amount of preliminary work was accomplished, especially in the collecting of statistics of the fisheries at Salem.

The Commission had a large number of visitors during the summer, many of them engaged in special research, for which ample material was furnished them by the collections of the Commission.

The usual routine of exploration was followed at the Salem Station, consisting of frequent trips of the steamer in various directions, during which the dredge and trawl were brought into requisition, and specimens secured of various marine animals and plants. Soundings were made, and their depth and character recorded, and an accompanying series of observations made upon the temperature of the ocean at various distances below the surface.

STATION AT HALIFAX.

On the 14th of August, for reasons to be referred to hereafter, I proceeded to Halifax, Nova Scotia, there to form a second station for the summer, arriving on the 17th. (I had previously dispatched Mr. Goode to that city to select suitable accommodations for the steamer and laboratory.) The steamer left Salem a few days later, and proceeded directly across, arriving on the 22d, and bringing with her the principal portion of the scientific corps. The occasion of the trip from Salem to Halifax was embraced to make numerous deep-sea investigations of the temperature of the water, the depth, and the animal life, resulting in the discovery of quite a number of new forms. A suitable berth and buildings for the service of the steamer having been engaged from Mr. Belcher, on Bennett's wharf, at Halifax, the sea work was continued with very little intermission until the 13th of October, when the vessel returned to Salem to complete some inquiries that had been commenced during the summer, and closing operations on the 24th of October, she proceeded to Portsmouth and went out of commission, having thus been in service since the 20th of July, or for rather more than three months.

At Halifax, as at Salem, there were numerous visitors to the laboratory and the vessel, and the aggregate of the work accomplished at the two stations was much greater than that of any previous season.

The work at Salem was greatly facilitated by help rendered by the officers and members of the Peabody Academy of Science and of the Essex Institute; the rooms, libraries, and collections of these establishments being freely at the service of the Commission, as also the special knowledge of the scientific members. Among these may be especially mentioned, Dr. A. S. Packard, jr., Mr. Caleb Cook, Mr. J. H. Emerton, Mr. A. L. Kingsley, Mr. John Robinson, and Dr. Henry M. Wheatland. A similar service was rendered at Halifax by the members of the Nova Scotia Institute of Science, among them Dr. Honeyman, curator of the museum, Mr. J. Matthew Jones, Mr. Morrow, and Mr. William Gossip. To Prof. H. Y. Hind, of Windsor, Nova Scotia, the acknowledgements of the Commission are specially due for furnishing for its use a number of the newly-devised deep-sea thermometers of Messrs Negretti & Zambra, and for aid in other directions. To the authorities, both of the Dominion and of the Province of Nova Scotia, and especially to the Hon. J. Burpee, minister of customs, the Commission is also indebted for many valuable courtesies, and especially in having the steamer and her apparatus placed on the same footing with Her Majesty's vessels of war, by means of which all necessary supplies were obtainable free of duty. Under this provision, all the alcohol required for the preservation of specimens was secured at a very moderate price, and all supplies and apparatus needed from the United States were imported duty free. Hon. W. F. Whitcher, Commissioner of Fisheries, Canada, also issued a permit authorizing Mr. Milner to make collection of specimens of fish for the United States Fish Commission in parts of Canada where the use of the seine is at present forbidden.

GENERAL RESULTS OF THE SEA-WORK OF 1877.

The field-work prosecuted by the United State Fish Commission during 1877, as usual, produced the usual variety of results, both theoretical and practical. The information obtained is believed to be of much value, although of greatest importance in connection with corresponding observations of other years, the digests of which are in preparation, and will be published as a series of final reports.

Perhaps the most important single fact ascertained by the Commission was that of the occurrence, off the whole coast of New England, of a large flounder (*Glytocephalus cynoglossus*), known in Europe as the Pole or Craig, and in the most extraordinary abundance, and, strange to say, entirely unknown to the fishermen. It proved to be most excellent as food, and, indeed, quite similar in gastronomic excellence to the Turbot, possessing, like that fish, a large amount of the same gelatinous fat along the fins, which gives the Turbot its peculiar excellence.

The Pole-flounder is rare on the coast of Middle Europe, but perhaps more abundant in the Scandinavian seas; but nowhere do they appear in such numbers as on the American coast. Indeed, we may almost assume that they have only straggled in small numbers from the new world to the old. It was found no nearer to the coast than from five to ten miles, in waters not less than about forty to fifty fathoms in depth, consequently belonging to the colder strata. Here, however, it was taken by the trawl in enormous quantities; so great, indeed, that a fifteen to twenty minutes' drag would sometimes furnish as many as 500 pounds of the fish.

The reason that this fish has not been known hitherto is due to the fact that the beam-trawl, the only apparatus by which it can be taken, is not in use on the American coast, as it is in Europe, for the supply of sea-fish to the markets. The mouth of the Pole is so diminutive, that a hook sufficiently minute to be swallowed would not sustain the weight of the fish, which, on the other hand, is unable to swallow an ordinary cod or haddock bait. There is every reason to believe that in time this fish will become an important article of food in the Eastern markets; but for taking it the beam-trawl must be employed.

Many facts of great scientific interest were also ascertained in regard to the distribution of the marine fishes, and the occurrence ascertained near or on our shores of species previously undescribed, or known only from more northern waters. We have every reason to expect that in time almost all the characteristic fish of the cold waters of Greenland and Scandinavia will be taken within two or three hundred miles of the American coast.

Copious and desirable information was gathered in respect to the occurrence and geographical disitribution of marine invertebrates and plants, some of them undescribed species, and others very far out of their previously-known range.

As already explained, the various questions relating to the history, condition, habits, and peculiarities of our more notable food-fishes have had much light thrown upon them by the labors of the summer. As in previous years, specimens were gathered and preserved in large numbers, not simply for the purpose of enriching the stores of the National Museum, but also for supplying very important educational cabinets to colleges, academies, and high schools throughout the country. There are no subjects of greater interest at the present day than those connected with the history and development of many forms of marine animals, life in the sea being vastly more varied than that of the corresponding orders on land; where, indeed, some are not represented at all. Material of this kind, however, is almost inaccessible to our best appointed museums, as it is not often that the services of a steamer, with a complete equipment of apparatus for research, can be commanded. On that account the Commission has considered it a duty to utilize the present opportunities, which cannot be expected to continue indefinitely, in obtaining enough material to meet all present and expected needs.

As in previous years, the marine invertebrates have been placed in the hands of Professor Verrill to be classified, and the duplicates arranged in sets for future distribution, and it is hoped that all proper wants can in this way be met. Of course, these collections must be carefully husbanded and given only to permanent institutions, able and willing to furnish the necessary alcohol and jars for their preservation. It is also expected that, by the exchange of some of these series with museums abroad, the National Museum may derive important additions to its collections of objects needed for research in America.

As heretofore, the fishes collected have been placed for identification in the hands of Mr. Goode, curator of the National Museum, aided by Dr. T. H. Bean, and with the co-operation of Prof. Theodore Gill.

C—THE HALIFAX CONVENTION.

4.—THE TREATY OF WASHINGTON.

Among the various subjects intrusted to the High Joint Commission held at Washington which prepared what is known as the Treaty of Washington (concluded and signed on the 8th of May, 1871), was the settlement of the difficulties in regard to the fisheries off the coast of British North America, which have been for many years a source of irritation between the two countries. The assumed rights of Great Britain in the waters adjacent to her American territory have always been maintained with great firmness, although with varying degrees of stringency; the crossing by American fishing vessels of the maritime territorial line for any other purpose than shelter being at intervals rigorously prohibited. At one time the seaward limit of jurisdiction claimed extended almost indefinitely off the coast; but ultimately the three-mile line was accepted, but made to include the distance between the headlands of all bays, the Bay of Fundy among the number; and quite a number of vessels were confiscated for violating the law by fishing within the prohibited line. It was, however, established in an English court that the claim to the Bay of Funday was untenable; and although no test case has since then arisen in regard to narrower bays, the United States maintain that the restriction can only apply to bays or portions thereof which are less than six miles from side to side.

During the period of the Reciprocity Treaty, American vessels had free access to all parts of the British waters of North America; but when this was brought to a conclusion the old difficulties were renewed, and although a system of licensing was adopted, by which, on payment of a certain sum per ton (at first fifty cents and afterward increased), the right of fishing was granted, many vessels refused to avail themselves of this chance, and so much ill-feeling was produced that it was concluded to add the fishery question in general to the other subjects to be determined by the Treaty of Washington of 1871.

By the Treaty of 1818 certain portions of the British shores were opened

perpetually to American fishermen, especially the south coast of Newfoundland from the Rameau Islands to Cape Ray, and the west coast from Cape Ray to the Quirpon Islands, the shores of the Magdalen Islands, and the southern coast of Labrador from Mount Joly to and through the Straits of Belle Isle, and thence northward indefinitely along the coast. By the Washington Treaty of 1871* the other shores

*ARTICLE XVIII.—It is agreed by the High Contracting Parties that in addition to the liberty secured to the United States fishermen by the Convention between Great Britain and the United States, signed at London on the 20th day of October, 1818, of taking, curing, and drying fish on certain coasts of the British North American Colonies therein defined, the inhabitants of the United States shall have, in common with the subjects of Her Britannic Majesty, the liberty, for the term of years mentioned in Article XXXIII of this Treaty, to take fish of every kind, except shell-fish, on the sea-coasts and shores, and in the bays, harbors, and creeks of the Provinces of Quebec, Nova Scotia, and New Brunswick, and the Colony of Prince Edward's Island, and of the several islands thereunto adjacent, without being restricted to any distance from the shore, with permission to land upon the said coasts and shores and islands, and also upon the Magdalen Islands, for the purpose of drying their nets and curing their fish; provided, that in so doing they do not interfere with the rights of private property or with British fishermen in the peaceable use of any part of the said coasts in their occupancy for the same purpose.

It is understood that the above-mentioned liberty applies solely to the sea-fishery, and that the salmon and shad fisheries and all other fisheries in rivers and the mouths of rivers, are hereby reserved exclusively for British fishermen.

ARTICLE XIX.—It is agreed by the High Contracting Parties that British subjects shall have, in common with the citizens of the United States, the liberty, for the term of years mentioned in Article XXXIII of this Treaty, to take fish of every kind, except shell-fish, on the eastern sea-coasts and shores of the United States north of the thirty-ninth parallel of north latitude, and on the shores of the several islands thereunto adjacent, and in the bays, harbors, and creeks of the said sea-coasts and shores of the United States and of the said islands, without being restricted to any distance from the shore, with permission to land upon the said coasts of the United States and of the islands aforesaid for the purpose of drying their nets and curing their fish; provided, that in so doing they do not interfere with the rights of private property or with the fishermen of the United States in the peaceable use of any part of the said coasts in their occupancy for the same purpose.

It is understood that the above-mentioned liberty applies solely to the sea-fishery, and that salmon and shad fisheries, and all other fisheries in rivers and mouths of rivers, are hereby reserved exclusively for fishermen of the United States.

ARTICLE XX.—It is agreed that the places designated by the Commissioners appointed under the 1st article of the Treaty between Great Britain and the United States, concluded at Washington on the 5th of June, 1854, upon the coasts of Her Britannic Majesty's dominions and the United States, as places reserved from the common right of fishing under that Treaty, shall be regarded as in like manner reserved from the common right of fishing under the preceding articles. In case any question should arise between the Governments of the United States and of Her Britannic Majesty as to the common right of fishing in places not thus designated as reserved, it is agreed that a commission shall be appointed to designate such places, and shall be constituted in the same manner, and have the same powers, duties, and authority as the commission appointed under the said 1st article of the Treaty of the 5th of June, 1854.

ARTICLE XXI.—It is agreed that, for the term of years mentioned in Article XXXIII of this Treaty, fish-oil and fish of all kinds (except fish of the inland lakes and of the

of the Dominion of Canada and of Newfoundland were included in the same privilege, the United States conceding a similar right of fishing from the latitude of 39°, or the southernmost point of New Jersey to the Bay of Fundy. The right of entrance of fish of either country to the ports of the other, free of duty, was also granted.

The river fisheries, especially of shad and salmon, as also those of shell-fish, were, however, expressly excepted from the provisions of the treaty, which was to continue for twelve years from the date of its ratification.

It having been asserted that the privileges granted to the United States by Great Britain were greater than those conceded by the former, the Washington treaty provided that commissioners should be appointed to determine this question, and that any sum of money awarded by the said commissioners should be paid by the United States in a gross

---

rivers falling into them, and except fish preserved in oil), being the produce of the fisheries of the United States, or of the Dominion of Canada, or of Prince Edward's Island, shall be admitted into each country, respectively, free of duty.

ARTICLE XXII.—Inasmuch as it is asserted by the Government of Her Britannic Majesty that the privileges accorded to the citizens of the United States under Article XVIII of this Treaty are of greater value than those accorded by Articles XIX and XXI of this Treaty to the subjects of Her Britannic Majesty, and this assertion is not admitted by the Government of the United States, it is further agreed that Commissioners shall be appointed to determine, having regard to the privileges accorded by the United States to the subjects of Her Britannic Majesty, as stated in Articles XIX and XXI of this Treaty, the amount of any compensation which, in their opinion, ought to be paid by the Government of the United States to the Government of Her Britannic Majesty in return for the privileges accorded to the citizens of the United States under Article XVIII of this Treaty; and that any sum of money which the said Commissioners may so award shall be paid by the United States Government, in a gross sum, within twelve months after such award shall have been given.

ARTICLE XXIII.—The Commissioners referred to in the preceding article shall be appointed in the following manner, that is to say: One Commissioner shall be named by Her Britannic Majesty, one by the President of the United States, and a third by Her Britannic Majesty and the President of the United States conjointly; and in case the third Commissioner shall not have been so named within a period of three months from the date when this article shall take effect, then the third Commissioner shall be named by the representative at London of His Majesty the Emperor of Austria and King of Hungary. In case of the death, absence, or incapacity of any Commissioner, or in the event of any Commissioner omitting or ceasing to act, the vacancy shall be filled in the manner hereinbefore provided for making the original appointment, the period of three months in case of such substitution being calculated from the date of the happening of the vacancy.

The Commissioners so named shall meet in the city of Halifax, in the Province of Nova Scotia, at the earliest convenient period after they have been respectively named, and shall, before proceeding to any business, make and subscribe a solemn declaration that they will impartially and carefully examine and decide the matters referred to them to the best of their judgment, and according to justice and equity; and such declaration shall be entered on the record of their proceedings.

Each of the High Contracting Parties shall also name one person to attend the Commission as its agent, to represent it generally in all matters connected with the Commission.

amount within twelve months after the award should have been given. The commissioners were to be three: one appointed by the President of the United States, one by Her Britannic Majesty, and the third by the two conjointly; and in case the third commissioner should not have been named within three months of the appointment of the others, he was to be designated by the Austrian minister in London.

The court so constituted was also to meet at Halifax at the earliest convenient period. An agent was to be appointed respectively by Great Britain and by the United States for the purpose of conducting the proceedings.

The treaty having been ratified by all the parties interested in 1873, its provisions commenced in that year, but it was not until 1877 that the convention referred to met at Halifax.

Governor Clifford, of New Bedford, Mass., was appointed the American commissioner by the President of the United States; but his death prevented the organization of the convention, and it was not until some time afterward that Mr. Ensign H. Kellogg, of Pittsfield, Mass., was chosen and arrangements initiated for holding the convention. Sir Alexander T. Galt, of Montreal, was appointed commissioner by Her Britannic Majesty, and the third commissioner, who was also president of the court, was Mr. Maurice Delfosse, the Belgian minister at Washington. The American agent was Hon. Dwight Foster, a prominent lawyer of Boston; the British, Mr. Francis Clay Ford, some years ago secretary of the British Legation at Washington, but at present Her Britannic Majesty's minister at Darmstadt.

5.—THE MEETING AT HALIFAX.

After some time spent in collecting evidence and in preparing for the case, the meeting finally opened at Halifax, on the 15th of June, 1877, and the period of six months, within which the treaty required that the operations of the court should be concluded, was appropriately parcelled out. The proceedings commenced with the adoption of rules of procedure, followed by the presentation of the British case, in which a claim was made for $12,000,000 in behalf of the Dominion of Canada and of $2,400,000 for Newfoundland, after which an adjournment of six weeks was had to permit the American agent to make up his reply.

When the convention again met six weeks were allowed for the presentation of testimony on the British side, followed by six weeks for that of the American. A week was then given for rebuttal, after which the American agent and counsel summed up for their side of the question, and were followed, after a suitable interval, by their opponents.

The decision was rendered on the 23d of November, closing the operations within the six months limited, which would have expired on the 15th of December.

The American agent, Hon. Dwight Foster, had as associate Mr. Rich-

ard Henry Dana, jr., of Boston, the well-known author of "Two Years Before the Mast," and a specialist in matters connected with maritime law, and Mr. William H. Trescott, who had been Assistant Secretary of State under Buchanan, and was well versed in all matters of diplomatic routine.

The British agent was assisted by leading lawyers from all the British Provinces of North America: Mr. Joseph Doutre, of Montreal, representing Quebec and Ontario; Mr. Louis H. Davies, of Charlottetown, Prince Edward's Island; Mr. W. V. Whiteway, of St. Johns, Newfoundland; Mr. R. L. Wetherbe, of Halifax, Nova Scotia; and John S. R. Thompson, of St. John, New Brunswick, for those provinces respectively.

Many hundreds of witnesses were produced on both sides, their testimony, as might be imagined, being very opposite as to the value of the privileges conceded by the two contracting parties. An immense mass of evidence was taken and printed day by day, embodying a great deal of valuable information respecting all subjects connected with the fish and fisheries of the northern seas. After a full consideration of all the evidence presented to the court and elucidated by the arguments of the counsel respectively, an award was made by Mr. Alexander Galt and Mr. Delfosse of $5,500,000, as representing the excess in value of the privileges conceded to the United States for the period of twelve years from 1873. Mr. Kellogg, however, dissented from this, and gave it as his opinion that the United States received less than she gave, and entered a protest against the payment of the awards by the suggestion that this could only be binding by a unanimous decision of the commissioners, the words of the treaty being "that any sum of money which the said *commissioners* may so award shall be paid by the United States in a gross sum within twelve months after such an award shall have been given," and without specifying that an award might be made by a majority of the commissioners. After some correspondence, however, of the State Department with the British Government on the points at issue, Congress made the necessary appropriation, and the full amount awarded was paid to Great Britain before the expiration of the year from the date of the award.

6.—RELATIONS OF THE UNITED STATES FISH-COMMISSION TO THE HALIFAX CONVENTION.

Having been invited by Mr. Evarts, the Secretary of State, in June, 1877, to assist the American counsel in the collection and preparation of data to be used before the Halifax Commission, I was enabled to find in the material gathered during the inquiry into the condition of the food-fishes for the last six years, very many important facts bearing upon the case.

One special point to be determined, was the value of the inshore sea-fisheries of the United States from the Bay of Fundy to Delaware

Bay.* The absence of any system on our part for collecting facts on this subject was never more fully appreciated than when it was needed to protect the United States against an unjust award. Everything possible, however, was done to supplement the deficiency. Lists were obtained from the Post-Office Department of all post-offices along the Atlantic coast situated within three miles of the shore, and a circular was prepared and mailed to the postmasters, asking for the names and addresses of all persons within their knowledge, who were interested in fishing or the fisheries, whether as principals or accessories. A circular was then prepared specifying the nature of the information desired, the main points being the kinds of fish taken, the seasons, the mode of capture, and the proportion of the whole, caught within three miles of the land.

Special information was asked in addition as to the character and quantity of the fish taken off the shores of the British Provinces, especially within the three-mile limit.

Competent agents were also dispatched to visit the principal fishing stations in Vineyard Sound, Buzzard's Bay, Long Island Sound, &c., and the services of a number of the leading fish-dealers in New York were secured. A number of persons, also, able to give particular information were either visited personally or invited to attend at some suitable point for further conference.

The result of these labors was that by the time the information was needed it became possible to present to the commission, through the American counsel, quite a satisfactory series of tables which answered an excellent purpose.

After spending the necessary time in Boston, Salem, &c., in gathering a portion of this information, I proceeded to Halifax, as already explained, under the division of "The Halifax Station," arriving, as there mentioned, on the 17th of August.

I immediately placed myself in communication with Judge Foster, the American counsel of the commission, and remained until the 22d of

* The value of the sea-fisheries of the United States, east of Cape May, was ascertained to be $13,030,821, against $6,418,663.25, the value of the Canadian sea-fisheries, as shown by the official reports of 1876.

The length of the Dominion coast-line in miles is 2,865, the yield of fish to mile of coast-line amounts to 160,934 pounds, valued at $2,938.10.

The United States has 1,112 miles of coast-line, east of Cape May, the yield of fish to the mile averaging 287,392 pounds, valued at $3,655; this is for the inshore fisheries alone, while the estimate for the Dominion of Canada includes all the sea-fisheries. The total yield of the in and off shore fisheries of the United States, for the region between Cape May and the Bay of Fundy, amounted for each mile to 940,510 pounds, valued at $11,718.

The table, which was prepared to illustrate the marine-fisheries of Southern Massachusetts and Rhode Island, exhibited still more astounding totals. Within a stretch of coast-line 250 miles in length, the weir-fisheries alone yielded an average return of 137,097 pounds to the mile, with a mean value of $4,642, while to each man employed in the fishery the yield amounted to 78,610 pounds, with a mean value of $2,661.

October. A number of hours was spent each day in the court room listening to the testimony and rendering such assistance to the American commissioner as circumstances made necessary. I was myself called as a witness, several days being spent under direct or cross-examination. The progress of the investigations of the commission involved not merely points relating to the violation of the fishery laws and the injury done to fisheries of the two countries respectively, but also all imaginable conditions attendant upon their prosecution, and especially certain alleged improper modes of pursuit and capture. The use of the trawl or long line by the Americans on the British shores had been made a source of grave complaint and constituted one of the charges in the indictment against the United States, as also the employment of the purse-seine for the capture of mackerel. The question, therefore, of the actual influence of these engines on the fisheries had to be considered very minutely, and a great deal of argument was expended on opposite sides in the discussion.

Many interesting points as to the habits of the food-fishes, their migrations generally, their mode of spawning, period of development, &c., were also elicited; and although the evidence given was very contradictory, it has been possible in sifting it to get out a large number of facts of great biological and practical importance. Much noteworthy information in these respects was obtained from Capt. Nathaniel Atwood, of Provincetown, and Mr. Simeon F. Cheney, of Grand Menan; these two gentlemen having for a long period of years carefully noted and recorded many facts previously unknown to naturalists. The migrations of the mackerel were made the subject of special study, and a large map was prepared and exhibited in the council chamber in which the meeting was held, showing the periodical movements of the mackerel schools, the location of the spawning-grounds, and the dates of the season of reproduction. Most of the data for this were furnished by Capt. R. H. Hulbert.

The data obtained at the Halifax Convention and otherwise will be used hereafter in preparing a systematic and methodical account of the sea-fisheries of Eastern North America, and will include, first, the natural history of the fish themselves; second, an account of all the methods of pursuit and capture; third, the mode of preparation for market and for shipment; and fourth, the general statistics of the whole subject.

As already intimated, the American side labored under a serious disadvantage for want of methodical and regular statistics of the fisheries of the United States. The case was quite different, however, with the other party. The authorities of Canada had for many years kept and published annually an extremely exhaustive account of everything taken in their fisheries, giving the number of each kind of fish taken and preserved in each province, county, and district, as also the exportations to foreign countries, including the United States.* The Minister of

* The minuteness with which this method is carried out is illustrated in report of Mr. Whitcher, commissioner of fisheries for the Dominion of Canada, which, for the

Marine and Fisheries, Mr. A. J. Smith, was present much of the time, while Mr. William F. Whitcher, superintendent of fisheries of Canada, with one or more assistants, was constantly on hand to render any explanation or give any further information in his power. It is greatly to be hoped that, whether with reference to future conventions of this kind or not, the necessary steps will be taken by the United States to secure data corresponding to those taken regularly and systematically in Canada. While it may only be practicable for the States to secure information in regard to the detailed catch in rivers, ponds, and other inland waters, there certainly need be no difficulty on the part of the United States in obtaining the facts necessary to a full understanding of the coast fisheries. All vessels above a certain size must be licensed for the fisheries, in return for which they obtain certain privileges in the way of free salt. It will be entirely proper as a return, to require information as to the nature and magnitude of the catch of each vessel, the precise field of operations, and especially as to the quantity of fish taken within three miles of the shore of either the United States or the British provinces.

Having referred to the information furnished by Captain Atwood and Mr. Cheney, it is proper to state that very important statistics in regard to the sale of fresh fish in the New York market were obtained through the instrumentality of Mr. E. G. Blackford, the well-known fish-dealer of Fulton Market. Mr. Vinal N. Edwards, of Wood's Holl, an employé of the United States Fish Commission, secured a great amount of information by personally visiting the fishing-grounds of Vineyard Sound and Buzzard's Bay.

The labor of compiling and digesting the statistics furnished to the Commission, and obtained from various sources, was in charge of Mr. G. Brown Goode, whose faithful and comprehensive services in this respect entitle him to the heartiest acknowledgments

D.—STATISTICS OF THE SEA-FISHERIES.

The necessity of having at hand more accurate statistics of the great fisheries of the United States, both sea-coast and inland, so urgently

year ending December 31, 1877, contains a series of very exhaustive tables showing in detail the results of the fisheries in every province of the Dominion. Too much cannot be said in commendation of the very thorough method in which the Canadian Government regulates and protects its fisheries. Accurate statistical information is the one essential foundation upon which protective legislation must rest. This is obtained by a system, not very cumbersome and not very expensive, which, under the direction of Mr. Whitcher, seems to be very efficient. The number of men employed in the staff of fishery officers in 1877 was 601, 595 of whom are observers and wardens, with salaries ranging from $20 to $500; the others, officers of steamers or inspection officers, with salaries of $800 to $1,500. The total amount paid to fishery officers for the year ending June 30, 1877, was $54,251 in addition to the expense of maintaining the fisheries' protective steamer, $17,059 more; in all, $71,310. This is exclusively for the protection and regulation of fisheries, which yielded in this same year products valued at $11,422,502.

demonstrated at the Halifax Convention, and the impossibility of judicious legislation without them, has called my attention especially to the importance of organized action to that end on the part of the government. The Treasury Department is especially concerned in this effort, and indeed it has for many years published an annual statement of the fisheries, which is, however, so imperfect as to be really worse than none. This, however, is not its fault, as there is no provision of law by which these facts can be procured. The attention of the department has, however, been called to this question, and the assurance is received that the proper legislation from Congress will be invoked to make it imperative for the owners and masters of vessels to furnish the desired returns.

I have considered it my duty, as United States Commissioner of Fisheries, to gather as much of the information in question as possible, it being strictly and legitimately connected with the work intrusted to the commission at its original organization by Congress. During the present year my attention has been more urgently than ever turned to this direction as shown in the article on the Halifax Commission. It is now my desire, in co-operation with the Treasury Department, to procure and furnish, *first*, as complete an account as possible of the natural history, including the migrations, movements, rate of growth, character of development, etc., of our principal food-fishes; *second*, the general statistics of the American fisheries, giving the character and amount of catch, number of vessels and men employed, the amount invested, the proceeds of the fisheries, &c. For the better accomplishment of these results the series of circulars, indicated in the foot-note,* and reproduced in full in the Appendix, has been printed by the Treasury Department and circulated in very large numbers. As explained in the article on the Halifax Commission, the first step was to communicate with all the postmasters along the coast, within three miles of salt-water, asking the names of persons known to them as interested in the fisheries. This request met with prompt and general response and furnished a series of

*1. Circular regarding tagged fish in Lake Michigan 1871
2. Memoranda of Inquiry 1872
3. Questions—Food Fishes 1872
4. Circular to accompany "Questions—Food Fishes" 1872
5. Statistics Menhaden Fisheries—Circular 1873
6. Statistics of the Whale Fishery 1875
7. Statistics of Fishery Marine—Circular 1875
8. Blank tables to accompany Circular 1875
9. Statistics Menhaden Fisheries. 2d ed 1875
10. Questions—Food Fishes. 2d ed 1877
11. Statistics Mackerel Fishery, etc. (To accompany "Food Fishes, 2d ed.") 1877
12. Statistics Cod Fishery, etc 1877
13. Statistics Mullet Fishery, etc 1877
14. Statistics of Coast and River Fisheries 1877
15. New York Market Blanks 1877
16. Ocean Temperature Blanks 1877

names that was classified by states, counties, and towns, and to which the circulars were then distributed. Copies were sent also to all the collectors and inspectors of customs, inspectors of light-houses, light-house keepers, and other officials of the government.

The long experience of the Smithsonian Institution in collecting information has shown that it is not well to ask for too much at one time, and that a new circular should not be distributed until the responses to its predecessors have in greater part been received. The result in the present case was even more satisfactory than had been anticipated, though, of course, a large precentage brought no answers whatever. Out of a considerable number a few were so complete and exhaustive as to cover the whole ground, while those of less extent served to give greater minuteness and precision to the details.

The first result of this series of inquiries into the history and statistics of particular fisheries is seen in the report of the United States Fish Commissioner for 1871–'72, in articles upon the bluefish and scup, made by myself; the next appears in the report for 1875–1876, in a memoir upon the American whale-fishery, by Alex. Starbuck, intended to serve as a record of a century's progress in this industry. The historical portion of the work was prepared entirely by Mr. Starbuck himself. His statistics were, however, supplemented and extended by the answers to Circular No. 6, of the series just referred to. In the Appendix to the present report, Vol. V of the series, will be found a monograph upon the history of the American menhaden by Mr. G. Brown Goode. This is a work of 539 pages, and is based almost entirely upon the information furnished in MS. in response to several successive circulars sent out by the Commission. Circulars have also been distributed in regard to the cod, mackerel, halibut, alewife, and smelt; and monographs upon all these species may be looked for in future volumes of the Fish Commission reports. A great deal of information has also been gathered in reference to the natural history of other fishes, among the most important of which is the southern mullet, a fish which in the future is destined to rival the mackerel in industrial and commercial value, and a detailed report upon which will be published at an early day.

In addition to the methods of obtaining information just referred to much has, of course, been gathered by personal inquiry on various portions of the coast, either direct or through agents of the Commission. The results obtained in this relation by Vinal N. Edwards, of Wood's Holl, Mass., have already been mentioned under the head of Halifax Commission.

A proper knowledge of the methods of fishing practiced in other countries having been deemed desirable, I have had translations prepared of sundry articles containing otherwise inaccessible information in reference to the fisheries of Norway and other parts of Europe most closely related to our own. To such as appear in the present volume I proceed to refer.

NOTICE OF ARTICLES RELATIVE TO THE SEA-FISHERIES PUBLISHED IN THE APPENDIX.

Although the United States are not so exclusively occupied with the fisheries as are Norway, Newfoundland, and some other countries, yet, in view of the extent to which the population along the sea-coast and on the lakes is at present engaged in the prosecution of this industry, and considering the enormous aggregate of capital invested and the material results, it is surprising that so little has been done, either by the governments, general and State, or by individuals, in placing the theory and practice of matters connected with our fisheries on a methodical and systematic basis.

Most nations, with the exception of the United States, have the necessary machinery for obtaining statistics of results. Norway, however, is the only nation that has a scientific commission occupied officially in the supervision of the fisheries, and in devising methods by which they may be carried on and extended with the least possible waste. To the labors and observation of such men as Dr. Boeck, Professor Sars, and others is due much of the present efficiency of the Norwegian fisheries.

The United States Fish Commission now proposes, as far as the means are furnished by Congress, to do what it can to place the American fisheries on a proper footing, and to make such observations and suggestions from time to time as may appear to be desirable. With this view it has gathered models of the apparatus used by other nations in its fisheries, some of which embrace features that may be reproduced by the fishermen of the United States to very great advantage.

The fisheries display of the Commission at the Centennial was a first step in this direction, and it is proposed to make this as complete as possible in the reproduction of the exhibition on a much larger scale, whenever Congress furnishes the necessary accommodations.

For the purpose of bringing to the notice of persons in the United States interested the methods and general plans adopted by foreign fisheries, and especially so far as they are novel to our people, I have taken much pains to obtain official information of other nations; and as this relates for the most part to the experience of Scandinavian countries, I have had translated a number of interesting statements and statistical accounts, some of which have been presented in earlier reports, and others will be found in the Appendix to the present volume.

The extent to which this information has hitherto been locked up by the medium in which it has appeared, will be shown from the fact that quite recently Prof. Milne Edwards, an eminent naturalist of France, in publishing an article upon the fisheries of Norway and Sweden, acknowledged his indebtedness to the reports of the United States Fish Commission as containing the only accessible rendering of this important information.

Of all the European fisheries with which the United States is related that of the Loffoden Islands off the northwestern portion of Norway is

the most important, and I therefore have given several articles on this subject. The first of these is a translation, illustrating the general character of these islands, their physical features, and their natural history. This is followed by the report of Professor Sars of his obervations during the years 1864 to 1877, inclusive, upon the fisheries of the Loffoden Islands, this containing by far the greatest body of information ever published in regard to the habits and natural history of the cod, and its relations to the fishermen and fisheries. It is a storehouse of information of the most important character, and upon its revelations have been based many of the plans of the United States Fish Commission in regard to the artificial propagation of that species.

An article on the general sea-fisheries of Norway, their methods, results, &c., as practiced in 1877, also forms a portion of the Appendix. The original of this pamphlet was distributed at the Paris Exposition as a companion to the fisheries display made by Norway on that occasion.

An article on the geographical distribution of the *Gadidæ* or codfish family, from the German of Dambeck, is also given in the Appendix. This, being mainly a compilation from published records, has many errors, some of which have been corrected; others of less moment have been allowed to pass unchallenged. It gives, however, a very readable and interesting history of the distribution of the cod and its various allied species throughout the various portions of the globe.

The article upon the history of the first five years of the Emden Joint Stock Herring Fishery Association, by Dantzing, contains many important suggestions, which may profitably be borne in mind by American companies organized for a similar purpose. Numerous mistakes made by this association in its early operations, and acknowledged as such in the article, may readily be avoided after being pointed out.

A paper on the sea-fisheries of a portion of Sweden, by von Yhlen, is also instructive. These fisheries are less important than those of Norway, and, while possessing similar characteristics, also have diversities which may be noted by American fishermen to advantage.

In the Appendix also will be found details of a series of experiments made by Commander Beardslee upon the time of exposure needed for correct observations by the Casella-Miller thermometer. I have already explained in previous reports the importance of indications of the temperature of the water at various depths from the surface and the bottom, as illustrating the variations in the appearance of different food-fishes along the coast. It is well established that the movements of the herring, cod, mackerel, and other fishes have a direct relationship to the question of the temperature, and that the occurrence of these fish may, in many cases, be readily anticipated and proper arrangements made for them by studying indications of the thermometer for a considerable time previous. It is therefore of importance to know the method of treatment of the thermometer used in this work; and the experiments of Commander Beardslee have given us the means of making a proper and very necessary allowance for instrumental errors.

F.—PROPAGATION OF FOOD FISHES.

10.—GENERAL CONSIDERATIONS.

A patient whose constitution has been undermined by disease of long continuance is unreasonable in expecting good results and a radical cure after a short application of approved remedies, yet he and his friends may be disappointed if the recuperation from the excesses or lesions of many years is not manifest in as many days. In reality, the reverse is rather the rule, the time of recovery being more frequently much longer than that of the continuance of the morbific influences. The expectations in regard to the results of fish culture are of somewhat the same character. Although decades of years, perhaps even a century, may have witnessed the continuance of agencies for the diminution of fish in our waters, the public mind is unsatisfied, and perhaps inclined to severe criticisms if the recovery of a supply is not appreciable within the first two or three years of effort.

We are, however, clearly entitled to maintain, in view of the experience of foreign countries and our own, that no reasonable anticipation in this respect will be disappointed, and that the proper measures of legislation and of artificial propagation will exhibit a marked result long before the end of the present generation.

In no instance can even the beginning of a success be achieved in a shorter period than four or five years, as the young, especially of the anadromous fish, such as the shad, the alewife, and the salmon, require that period for arriving at maturity. The parent fish are first obtained, the eggs extracted and fertilized, and after being hatched out the young are finally deposited in the waters to take their chances. Whatever be the extent of time during which the progeny remain in the river, they are more or less withdrawn from observation, and it is only when the young fish has reached full maturity and revisits its place of deposit for the purpose of spawning that its presence is appreciated. It sometimes happens, too, that, for one reason or another, the first deposit of young fish proves to be a failure. They may be introduced while in a sickly condition, so that a difference of temperature causes them to succumb; or else in such small numbers that in the presence of an unusual abundance of enemies they may all perish. What special agencies there may be in the ocean after they reach it we are unable to say; but from their wider dissemination their chance of escape is greater.

Again, we may misunderstand the period required for the maturity of certain species. While four years may be considered the general average for cod and herring, five are probably required for the Eastern salmon, and it is not impossible that the California salmon will show itself only after the lapse of six years from its birth. I hope, however, to introduce enough illustrations of even partial success to warrant the attention of Congress and of the States towards the operations of the United

States Commission and those of the respective State commissions. It is very gratifying to note the rapidly increasing interest in the whole business of fish protection and fish propagation shown by the citizens of the United States and culminating in the measures taken by national and State legislatures for fostering whatever looks towards the increase of the fish supply. At the time when the United States Commission was authorized by Congress and organized, the only State fish commissions were those of Alabama, California, Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont, eleven in all, and of these a small number only were provided with funds and power to enforce legislation taking definite action in regard to the increase of a supply. The list now amounts to twenty-six, all provided with intelligent and able commissioners, for the most part with appropriations sufficient to enable them to survey the ground and take the proper steps towards future action. Quite a number of these have their own hatching-houses, in which are hatched out not only the local species, but also such eggs as may be supplied by the United States Commission, especially of the Eastern salmon, the land locked salmon, and the California salmon.

As already remarked, these State commissions, in the aggregate, accomplish a very great deal towards the protection and restoration of their fisheries respectively, and especially in the way of distributing trout and black bass in their local waters. Both of these are fish with which the United States Commission have nothing to do, as they come more particularly within the province of the State organizations.

The states bordering on the great lakes have also accomplished a still greater work in the hatching out and introduction of the young of whitefish and lake trout, the former being by far the most important species of the lakes, and one for the multiplication of which, on a large scale, every effort should be made.

The hearty co-operation of these State commissions with that of the United States is a subject of especial gratification, there being, so far as I can learn, no jealousy whatever, but all working harmoniously towards a common end. This co-operation of the State commissions with that of the United States is exhibited in two ways, direct and indirect. The former is shown in the work of the propagation of the *Salmo salar*, or the salmon of Maine, which has been carried on at Bucksport, on the Penobscot River, by the United States, aided by an appropriation of money by the States of Connecticut and Massachusetts, each receiving its share of eggs in proportion to its investment of $500. The State of Maine has, I believe, made no actual appropriation, but is concerned as requiring by law the introduction into its own waters of one-fourth of all the fish hatched out by foreign co-operation within its borders.

A similar arrangement has been made with Massachusetts and Connecticut in the propagation of the land-locked salmon, both at Sebec, in 1873 and 1874, and at Grand Lake Stream, for several years up to the present.

The State of California has also assisted in the propagation of the California salmon by appropriations made for the most part by public spirited citizens in sums of one or two thousand dollars, in order that the supply, especially intended for the Sacramento, might be increased in proportion, and hatched out at the United States establishment on the McCloud.

The organization of a new establishment on the Clackamas, a tributary of the Columbia River, will be referred to hereafter. All the expense of preparing the building, dam, and apparatus was met by voluntary contributions from the canners on the river, although the actual work was superintended by officers of the United States Fish Commission detailed for that purpose.

The State of Maryland, too, by its fish commission, has also for several years carried on its operations of shad-hatching in connection with the United States Fish Commission, Mr. T. B. Ferguson, the accomplished head of that commission, having placed at the command of the United States Commission the important apparatus devised by him for hatching out eggs, and aided in its practical manipulation. He is also the head of the establishment in Baltimore where the eggs of the California and land-locked salmon have been hatched for distribution by the United States Commission to such points in the Southern States as were without proper facilities for the work.

The indirect aid rendered by State commissions in the planting of fish is also of very great importance.

The present production of the eggs of the California salmon is on so enormous a scale that it would be impossible for the United States Fish Commission, even with a considerably larger appropriation, to undertake the business of hatching them out, or of placing them in the waters of the several States. It is also impossible for the officers of the commission to have a proper appreciation of the character of these waters, which will alone permit a judicious planting. Very great aid is therefore experienced in the general work by the present arrangement of forwarding the eggs of the salmon, of the various species, California, land-locked, and Eastern, to the State commissioners, who receive and hatch them out and personally superintend their introduction into appropriate waters, at the same time making a report of their action in the matter. In many cases, too, the commissioners of one State will agree to receive and hatch out eggs for the waters of an adjacent State which has no hatching-house.

The messengers of the Fish Commission also frequently deliver their young shad to the State commissioners, who take charge of them and see that they are properly deposited, a selection of points being made by correspondence with these officers.

APPLICATIONS FOR FISH.

The applications for the services of the United States Fish Commission, in supplying eggs or the young of fish, may be arranged under two

classes, domestic and foreign, both increasing very rapidly from year to year. All requests of this kind are entered on proper blanks, giving the date of application, the character of fish desired, name of applicant, member of Congress or other person through whom the request is conveyed, the region or spot to be supplied, instructions as to route, railroad or otherwise, by which they are to be shipped; all being information necessary to a proper response.

It is, of course, impossible to meet every call, and a selection of recipients is sometimes necessary, the object being to diffuse the benefits of the commission over the greatest possible extent of country. Accordingly, if an application comes from a locality near the mouth of or low down a current or stream, the actual planting is made at the headwaters of the river, so that the entire stream will receive the benefit. This policy is based on the fact that an anadromous fish, introduced at a given point in a river, is not likely to ascend above that point, on its return from the ocean.

An accompanying table will show the number of calls, and the proportion of the demand for the different species. By this it will be seen that the carp is rapidly becoming the favorite, as its culture is more within the reach of individuals than that of the salmon or shad.*

It is customary for the Commission to request that all applications for fish be made through some member of Congress, who can vouch for the standing of the applicant and the character of the locality to be supplied. It is, of course, impossible for any one resident in Washington to know the persons asking for fish, whether they are responsible parties, and whether they want them for the benefit of the community or for some merely personal end.

The demand from foreign countries for eggs or young fish is also increasing very rapidly and has been met as far as practicable, without affecting the interests of the United States. In most cases, especially that of the California salmon, the only limit to the home applications is, in the first place, the amount of the Congressional appropriation for it, and second, the extent to which the State commissions or clubs devoted to the stocking of particular waters can meet the expense of hatching out the eggs when received, and of introducing them into the waters. For several years past a much larger demand might have been easily met.

Number of applications for fish.

1873	19	1876	174
1874	42	1877	254
1875	52		

The following are the different species applied for in 1877:

Shad	37	Trout	12
California salmon	81	Carp	53
Land-locked salmon	56	Tench	6
Whitefish	9		254

When, therefore, requests are received from foreign governments the stipulation made of paying the actual cost is cheerfully complied with by them, and a graceful act of international comity is thereby made practicable.

It will not be forgotten by those who have read the reports of the Commission from the beginning that before the home establishments for procuring the eggs of salmon were in operation, the German Government presented 250,000 eggs of the Rhine salmon to the United States, and sent them over in charge of a special messenger. Those that survived were hatched out at the establishment of Dr. Slack, at Bloomsbury, N. J., and introduced into the Delaware River, where some of them are believed to have returned as mature fish to their original starting point.

A portion of the correspondence with foreign governments on this subject will be found in the Appendix under the respective heads of distribution of fish, and the amount of service rendered in reply to applications.

The applications, for the most part, were for California salmon and whitefish from the different provinces of New Zealand, from Australia, Ecuador, Germany, France, and the Netherlands. All have been responded to excepting that from Ecuador, which has no waters suitable for any of the fish included in the operations of the United States Commission.

Apart from direct applications for the fish, numerous requests are on file for help in other ways. I have already referred to the co-operation of the States of Connecticut, Massachusetts, California, Maryland, &c., in the way of joint work in the production of shad, salmon, and the like, and have given the details to a sufficient extent.

A noteworthy instance is shown in connection with the operations for the propagation of salmon at the Clackamas fishery on the Columbia, where an association of canners combined to furnish the sum of $27,000 with which to start a hatching-station in order to maintain the supply. At their urgent request I detailed Mr. Livingston Stone, superintendent of the McCloud River hatchery, to start this establishment by furnishing plans of a hatching-house, dams, &c., and supervising their construction. This was done in the summer of 1877, and a thorough organization was effected, from which it is hoped the yield of salmon on the Columbia River will be continued at its present average. A further account of the enterprise will be found in a subsequent part of the report.

The great success of the methods adopted by the United States Commission for the hatching of fish and of securing the ready return of the fish from the sea to their spawning-grounds, by means of artificial fish-ways, has induced a large correspondence with foreign establishments, especially with the Deutsche Fisherei-Verein of Germany, the great organization which has in charge the interests of all the German fisheries and composed of some of the most eminent specialists in Germany, and having its headquarters at Berlin. Application was received in the

autumn of 1876 from Mr. J. Bancroft Davis, at that time minister of the United States to the German Empire, requesting that models of certain apparatus be furnished at the expense of the Verein. This was promptly attended to under the supervision of Mr. James W. Milner, and the articles forwarded gave great satisfaction.

A similar application was received from the Japanese Government, to include models, not only of hatching apparatus, but of fishways, to be applied to the waters of that country; and a full series of models, a reproduction of those exhibited at Philadelphia at the Centennial, was accordingly made and presented to the Government of Japan in return for the very valuable donation of the whole of its fishery exhibit at the Centennial.

Mr. A. Eisendecher, of Valdivia, Chili, applied for a statement of probable expenses of placing California salmon and other fishes in the waters of Southern Chili; the United States consul in Ecuador also sought similar information for that country.

Applications have also been received from parties in British Columbia for information as to the best mode of utilizing the refuse and waste of the salmon-canning establishments. Several firms engaged in the canning of lobsters in New Brunswick embraced the occasion of the presence of the Fish Commission at Halifax to call attention to certain difficulties in the preservation of lobsters in cans, some establishments being unable at certain seasons of the year to prevent the entire decomposition of the canned meat, in spite of all precautions. Information in response to this query has been furnished as far as it was at the command of the Commission.

As already explained in earlier reports, the United States Fish Commission endeavors to occupy ground not covered by State commissions or by private enterprise; and whatever species are fully cared for by other organizations are not treated by the United States Commission.

Two favorite fish in the United States, the trout and the black bass, are propagated by hundreds of establishments throughout the country, both State and private, which attend fully to them. They are, however, available only for local waters, private fish ponds, or streams, and there would be a manifest impropriety on the part of the United States Fish Commission in catering to the interest of a few individuals. Both species are of comparatively little account in the food production of the nation, and it is only those who can afford to devote an abundance of leisure to their capture, or those whose means enable them to purchase at a high price, who are benefited by their cultivation. Of course, if the question were as to the introduction of some new variety of these fish that should have some special qualification, and which could only be brought to the notice of the people by the United States Commission, the argument would be very different.

As already explained, the only species that have received special at-

tention on the part of the United States Fish Commission, up to date, are the sea salmon of the Atlantic, *Salmo salar;* the sea salmon of the western coast, *S. quinnat;* the land-locked salmon, a local race of the *Salmo salar;* the whitefish, *Coregonus albus;* the shad, *Alosa sapidissima;* the fresh-water herring, *Pomolobus vernalis* and *æstivalis;* and the German carp, *Cyprinus carpio.* It is intended, however, to devote more or less attention to the cultivation of the smelt, especially the very large, land-locked form found in certain waters in Maine. At no distant day it is hoped that specimens of the Oriental Gouraṃi, a fresh-water fish with many valuable peculiarities, will be added to the list.

It is also proposed to take some measures to introduce the California brook trout to the Atlantic slope, on the ground that this fish will resist successfully a higher temperature of water than the Eastern trout; and although of no great comparative economical value, yet it will furnish to the citizens of the more southern States of the Union a pleasant sport in their capture. The instinct of mankind appears to be to catch fish under all circumstances and conditions, and the introduction of a brook trout into the warmer waters of the United States will be a very popular move.

II.—FACILITIES AND ASSISTANCE RENDERED.

The prompt and hearty compliance with the requirement of the law of Congress, directing the various departments of the government to render such aid as might be in their power to the service of the United States Fish Commission, has been a subject of great gratification, reference to such aid being made in various portions of the present report.

As already stated, the Navy Department furnished the iron steam-tug Speedwell, with a full equipment of officers and crew for summer service off Salem and Halifax. As will be seen by Mr. Stone's report, at one time during the operations at the McCloud River hatching-station, General McDowell, commanding the Department of the Pacific, furnished a detail of one officer and four men for the protection of the fishery against threatened violence. The co-operation of State fish commissions has been mentioned.

I am gratified in being able to say that there has, so far, been manifested no jealousy in regard to the United States Fish Commission, but that everything has been done to strengthen the hands of the Commissioner and to enable him to do efficient work.

Very important aid has been rendered by railroad companies in the transportation of eggs and fish to various parts of the country, there being scarcely an exception to the willingness to grant the facilities asked for in the accompanying circular. Among the earliest companies to extend this aid were the Baltimore and Ohio, the Philadelphia, Wilmington and Baltimore, and the Pennsylvania Railroad Companies. During the year 1877, similar authority was received from forty-two com-

panies according to the list given in the footnote.* The special points asked for were, permission to have the cans containing the young fish transported in the baggage-cars of express trains and to allow such access of the messengers to the same as might be necessary. The provision that no charge was to be made for extra baggage was offered by the companies themselves, and gladly accepted, while an additional privilege was conferred by the Baltimore and Ohio Railroad Company by setting the example of authorizing the stopping of trains at such points on rivers or streams as might be convenient for the proper introduction of the fish into the waters. I am very happy in being able to make public acknowledgment of this very great liberality.

---

* *List of railroads granting facilities in* 1877.

Atchison, Topeka and Santa Fé Railroad Company.
Atlantic and Pacific Railroad.
Alabama and Chattanooga Railroad.
Alabama Central Railroad.
Atlanta and Charlotte Air-Line Railway.
Atlantic and Great Western Railroad.
Baltimore and Ohio Railroad.
Baltimore and Potomac Railroad, and Alexandria and Fredericksburg.
Central Railroad of New Jersey.
Central Vermont Railroad.
Chesapeake and Ohio Railroad.
Chicago, Burlington and Quincy Railroad.
Chicago and Northwestern Railway Company.
Cleveland, Columbus, Cincinnati and Indianapolis Railway Company.
Connecticut River Railroad.
Denver Pacific Railway Company.
Fort Wayne, Jackson and Saginaw Railroad.
Georgia Railroad Company.
Houston and Texas Central Railway Company
Illinois Central Railroad Company.
Kansas Pacific Railway.
Louisville and Nashville, and South and North Alabama Railroad.
Lake Shore and Michigan Southern Railway Company.
Louisville, Cincinnati and Lexington Railroad.
Missouri, Kansas and Texas Railway.
Missouri and Pacific Railway.
Northern Central Railway Company.
New York, New Haven and Hartford Railroad Company.
Pennsylvania Railroad Company.
Philadelphia, Wilmington and Baltimore Railroad.
Richmond and Danville Railroad Company.
Richmond and Petersburg Railroad.
Richmond, Fredericksburg and Potomac Railroad Company.
Seaboard and Roanoke Railroad.
Saint Louis and San Francisco Railway.
Saint Louis, Iron Mountain and Southern Railway.
Vicksburg and Meridian Railroad.
W. C. Virginia Midland, and Great Southern Railroad Company
Western and Atlantic Railroad Company.
Wilmington and Weldon Railroad Company.
Wabash Railway.

To the express companies, too, especially the Adams and Southern companies, acknowledgments are due for waiving their privilege of controlling the extra freight on certain railroads. In one or two instances serious difficulty was experienced by agents of the express companies insisting upon the right to have the cans of the Commission delivered to them for transportation. This was done in one or two instances and resulted very disastrously in the entire destruction of the fish. Application to the president of the companies, however, secured from them instructions to their subordinates to waive all claims of the kind referred to.

Acknowledgments are also due to certain steamship companies plying between Boston, New York, and various points in Europe for assistance in transporting the messengers and the eggs of fish under their charge, free of expense. When contemplating the transmission of eggs of the California salmon and land-locked salmon and of whitefish to certain points in Europe, the agents of the French Transatlantic Steamship Company, of the Netherlands Steam Navigation Company, and of the North German Lloyds, in New York, agreed to transport the eggs sent abroad free of expense. By reference to a succeeding paragraph, in describing the history of operations connected with the attempted introduction of turbot and sole into the United States, it will be found that very important assistance was rendered by the Cunard line in giving to Mr. Mather, the agent of that transfer, a free passage for himself and fish from Liverpool to Boston. This was primarily through the instrumentality of Mr. J. G. Kidder of Boston, who was among the first to suggest the importance of this transfer and to offer his services in assisting it.

12.—LEGISLATION AND PROTECTION.

A very large part of the correspondence of the Commission is connected with inquiries relating to the jurisdiction of the United States and of the States over the fishing grounds, and the methods by which all parties can secure their rights.

A very decided antagonism exists in this country, as in Europe, between professional fishermen, who prosecute their work by different methods. Attention has been called in previous reports to the Parliamentary investigation in England into the relations between line-, beam trawl-, and net-fishing, as also between fishing by hand-line and trawl-line, and between seines, pounds, and drift-nets. The question as to who possesses jurisdiction over the fisheries proper along the coast of the United States, and in the navigable waters is yet unsettled. At present, the United States does not exercise any, but leaves to the States the enactment of laws on the subject. Some fishermen, aggrieved by the burden of State legislation, threaten to appeal to the Supreme Court for the decision of the question; and it is much to be hoped that before long a test case may be established, so that persons interested

may know whether to appeal for protection and relief to the States or to the general Government.

The subject is still more complicated by the text of the "Washington Treaty," in regard to fisheries, by which citizens of one of the contracting powers are given the privilege of fishing on the inshores of the other; and it is not yet determined whether either party has power to pass any laws restricting the fishery rights on the shores of the other. A case has arisen where the citizens of Massachusetts were interfered with while carrying on seine-fishing on the shores of Newfoundland, and a question of damages is still under jurisdiction. Of course, so far as the setting of traps or pounds obstructs navigation it is clear that the authorities of the United States have power to remove these or to require them to be removed under severe penalties; but so far no special question has been made as to fishing where the interests of navigation are not concerned.

At the Halifax convention great complaints were made by witnesses called in behalf of the provinces, of the use, by the Americans, of trawl- or long lines off their shores, these, in their opinion, tending to destroy the mother fish, while engaged in the act of spawning, and thus affect the supply. It was, however, stoutly maintained by others that these had no material influence upon the result, and that they were necessary to secure a proper harvest of the sea.

Legislation in the United States is being continually invoked for the removal of fish pounds and weirs, and in certain areas at the head of Buzzard's Bay and about Long Island protection has been granted by the State legislatures.

During the summer of 1877 an earnest appeal for the protection of the United States was received by the United States Commission from Block Island, signed by all its fishermen, and I reproduce this appeal in the Appendix to show the feeling on this subject and the general character of the objections to the trawling. Of course, having no jurisdiction in such matters, I can do no more than to publish it in the present case. I propose, in a general treatise on the plans and character of the American sea fisheries, to discuss this whole matter at length.

In regard to the protection of fish and the fishing in interior waters not navigable, it is of course very evident that the States must make the necessary provisions, and if the labors looking towards the introduction of the anadromous fish are to be prosecuted successfully, arrangements must be made for the protection of the fish, securing to them during certain periods free access to the headwaters of the streams and their return therefrom, as well as the establishment of a close time each week during the run, and the absolute cessation of fishing after a certain period. These very reasonable requirements are urged to protect the interest and rights of the many against the greed and senseless rapacity of the few.

The methods necessary for securing the upward run of the fish are

the removal of all unnecessary obstructions, the establishment of fish-ways or fish-ladders over such natural or artificial dams as cannot otherwise be ascended.

It is, however, not less necessary to provide for the return of the young fish to the sea. The most serious obstacle to this is found in the arrangements known as "fish-baskets," intended more particularly for the capture of eels descending the streams in autumn, but taking at the same time immense quantities of shad, alewives, and other valuable fish, including the salmon. This arrangement consists in the establishment of two walls of stone blocks or pebbles, laid up in the form of the letter V, the apex tending down the stream. At the apex is placed what is called a basket, which consists of a box in several compartments, each with a bottom of slats set obliquely. The descending fish that happen to be intercepted in the upper end of the V are carried down and poured into the slatted boxes. The large fish are retained, while some of the smallest pass through the openings. Shad, however, are so extremely delicate that the slightest blow or shock will kill them, and the baskets are sometimes filled with bushels of young shad not more than a few inches in length.

It is useless to undertake to stock rivers with shad or herring in which this objectionable practice is maintained. Fortunately, it is practicable only in waters shallow enough to permit putting up the side walls of stone; but, unfortunately, the Susquehanna, which was at one time one of the finest shad-streams in the United States, is particularly noted for the establishment of fish-baskets, owing to the succession of shallow places in the river traversed with rocky ledges, and having an ample supply of bowlders, furnishing material for the walls. It is quite safe to say that, more than anything else, it is to the presence of these fish-baskets in large numbers that the decrease and approximate extermination of shad in the Susquehanna is due, and that no efforts on the part of the States of Maryland and Virginia for the restoration of shad and herring will be of any avail unless accompanied by most stringent measures for destroying these obstructions.

Another very important subject, to which the attention of the proper authorities should be called, is the enormous drain upon the possible increase of the striped bass or rock-fish by the sale of the young in the markets. This fish, of which individuals weighing fifty to seventy pounds have formerly been seen in the market of Washington, is now rapidly being reduced in number and size, and by no cause, probably, so much as by the capture and sale of fish from six to twelve inches in length. It is more than probable that, if undisturbed, more than half the fish of this size would reach a weight of twenty pounds or more; and no more judicious measure could be enacted than that of imposing a heavy penalty upon any dealer for having in his possession, or offering for sale, striped bass of less than fifteen inches in length, or weighing less than from one to two pounds. Of course the capture by individuals of fish below the

legal limit could not be prevented, nor would it make much difference in the result. It is to the wholesale gathering in, by pounds and seines, of these young fish by the ton, that the decrease in their number is especially to be ascribed.

The Shad.

13.—WORK ACCOMPLISHED IN 1877.

Station on the Susquehanna River.—Reference has been made in previous reports to the difficulty of obtaining a sufficient supply of shad in the Southern waters of the United States to warrant the labor and expense of occupying them, the depletion of most of the streams having been carried to such an extent as to make it almost impossible to find enough spawning shad to commence the work of restoration.

Accordingly, in arranging the plans for 1877, it was determined to concentrate efforts upon the Susquehanna and Connecticut Rivers, in the hope of securing the needed material for the purpose. Another object in this selection of stations was to test, at one of them at least, the efficiency of the new method of Mr. T. B. Ferguson, fish commissioner of Maryland, constituting a radical change in the mode of hatching shad, and overcoming many difficulties attending the use of both the Green and the Brackett hatching-boxes. These, as already explained in previous reports, consist of boxes with wire-gauze bottoms of about one and a half square feet area, fastened in gangs to posts in a running stream. The eggs placed in these boxes receive the influence of the ever-changing current and are hatched out. The young fish also are kept in the boxes until the time for transportation arrives, generally within twenty-four hours after birth.

The protection of the eggs from their enemies is one of the chief factors in this form of apparatus. Many practical difficulties, however, have occurred in the use of these boxes. In streams where the spawning shad can be obtained at some distance above the mouth where there is a constant current, as in the Hudson and Connecticut, some of the principal difficulties are avoided, and the work can be prosecuted for the most part with comparatively little failure. Even here, however, the difficulty of reaching the boxes to give proper attention to the eggs and young fish, the danger arising from sudden freshets, from floating lumber, logs, &c., is very great, and there is usually a very considerable percentage of loss arising from casualties. The difficulties become very much greater, however, when the work is carried on in tidal waters where the current is mainly derived from the flow of the tide, which changes its direction twice a day, with a period of calm between. Even a gentle wind blowing against the tide will also neutralize the current and endanger the result. The boxes, which at one tide are floated in a given direction with the change, are brought round so as to float in an opposite one. In changing, they frequently become entangled, especially in stormy weather, and are upset and the contents spilled out—a result likely to happen at any time with a sudden blow and the conse-

quent agitation of the waves. The period also during which there is no current whatever is injurious to the eggs, and frequently produces serious casualties.

Another objection to the floating boxes is the small number of eggs that they can accommodate in tidal waters, 20,000 being quite a maximum for one. This would make it necessary to employ fifty boxes for the hatching of 1,000,000 eggs, which is by no means a large gathering even for a single day.

The attention of Mr. Ferguson, a gentleman of great mechanical ingenuity, was early directed to the question of the possibility of a more wholesale manipulation of the eggs of shad, and he ultimately devised an apparatus which promised to be of very great efficiency in this respect. In this method the work is done by an apparatus combined with steam machinery, by means of which the eggs receive the necessary mechanical agitation, being plunged up and down in the water, or placed in cones constantly supplied with a current of water coming in from below, and over-flowing at the top, in the latter case the water being derived from a tank at a higher elevation, which is kept filled by a steam-pump.

In addition to these advantages, the work is prosecuted under cover, and the persons engaged are protected from dangers and exposure consequent upon the old-fashioned method.

Early in the spring of 1877 Mr. Ferguson commenced his operations by fitting up three scows or stone boats, borrowed from the city of Baltimore for the purpose, each about 60 feet long and 20 feet broad. One was furnished with the necessary machinery for the work. An arrangement was made with him to hatch out all the fish eggs procured by the United States Fish Commission for transportation to distant waters, their shipment, however, being entirely under the direction of Mr. James W. Milner, the representative of the United States Fish Commission.

One of the three scows was fitted up for the accommodation of Mr. Milner and his party of messengers, and another for Mr. Ferguson's men, and the first locality selected was in the Northeast River at the head of Chesapeake Bay; but as soon as the large seines operated on the Eastern Shore of the bay were discontinued towards the close of the season, a station was taken in Spesutie Narrows, between Spesutie Islands and the Harford County shore, about six miles below the railroad bridge at Havre de Grace, as being more sheltered and more convenient to the center of operation of the gillers, upon whose catch the supply of spawn was dependent.

The work of shad-hatching commenced early in May, the eggs, as stated, being first obtained from fish taken in seines, but subsequently from those taken in gill-nets. The season closed on the Susquehanna on the 13th of June, up to which time there were distributed more than six millions of shad.

The result of this experiment was entirely satisfactory. At much less trouble and expense than usual, this large number of shad were handled

by the Commission, and distributed to appropriate waters, where, it is hoped, their presence will be indicated at the proper time.

Station on the Connecticut River.—The old station, on the Connecticut River, at South Hadley Falls, became the scene of the labors of the Commission after closing on the Susquehanna, the furniture and other equipment being loaded on a freight-car and taken directly through to their destination. A house in the vicinity of the fishery was hired for the accommodation of the party, and the first fishing commenced on the night of the 26th of June. The operations were continued here until the 4th of August, eggs being taken nearly every night, the entire number amounting to something over three millions.

As this station was within the jurisdiction of the State of Massachusetts, it was necessary to obtain permission from its commissioners to carry on operations, which was obligingly granted on the condition that they might nominate some one to be present during the season, to see that the regulations of the State were fully carried out. Mr. Charles G. Atkins was selected for this work, and had the superintendence of a certain portion, under the general direction of Mr. Milner, who had charge of the whole.

Here floating boxes were used entirely, and some of the difficulties referred to on a previous page, were experienced, especially in the interference of a raft of logs floating down the river over the spawning-ground.

For the purpose of studying the physiological condition of the eggs and young while in the hatching-boxes, the services of Mr. H. J. Rice of the Johns Hopkins University, Baltimore, were secured. This gentleman had been employed previously at Havre de Grace during the operations of the United States Fish Commission, and an account of his results has already been published in the general report of the Maryland Fish Commission. Mr. Atkins, too, made a great many interesting observations in regard to the hatching of eggs, &c.

The number of eggs procurable at South Hadley Falls not being so great as desired, Mr. Frank N. Clark was sent to Windsor Locks in Connecticut, to a station where it was said spawning shad were to be obtained in abundance, but the season was so far advanced that he did not consider it expedient to commence any work there. There is good reason to believe, however, that it will repay the effort if undertaken at the proper time.

A detailed statement, by Mr. Milner, of the shad-hatching operations during the year will be found in the Appendix, including an account of the precise disposition made of the fish from the several stations.

The Pacific Salmon.

The Columbia River or Clackamas Station.—A remarkable deficiency in the yield of salmon in the Clackamas River in 1876 aroused the persons employed in the canning trade on the river to use all practicable measures of relief. A company, entitled the Oregon and Washington

Fish Propagating Company, was incorporated for this purpose, with Mr. John Adair, jr., as president, Joseph G. Megler, secretary, and Henry ———, treasurer. The capital stock was placed at $30,000 in 600 shares.

At the request of the officers of this company, warmly indorsed by Senator Mitchell, of Oregon, I instructed Mr. Livingston Stone to anticipate the time of his usual visit to the McCloud River, and to proceed to the Columbia for the purpose of starting the enterprise. Accordingly, he reached Portland on the 11th of June, and had a consultation with the directors of the company. A visit by Mr. Stone, the year before, for a similar purpose, resulted in his choice of the Clackamas as the most suitable spot; but as this was not at the time satisfactory to the company, five weeks were spent in carefully examining all the localities along the river. It was found, however, that some objection applied to every other possible station. Thus the waters of the des Chutes, though abounding in salmon, could not be prepared for hatching purposes. Others had no fish, and others still were too distant and inaccessible. The Indian troubles prevented any recourse to the nearer waters of the Salmon River, or to the tributaries of the Upper Columbia.

One objection to the Clackamas was that fish found there were not believed to be the genuine Chenook salmon, but on finding that this was a mistake, and that the desired variety was actually the fish occurring there, it was finally concluded to fix upon the Clackamas, and Mr. Stone was authorized, on the 5th of July, by the treasurer to select it as the location. He accordingly located the hatching-station on the south bank of the Clackamas, just above the mouth of Clear Creek. The plans having been completed, their execution was placed in the hands of Mr. Waldo Hubbard, an employé of the Fish Commission, who carried them out with great promptness and efficiency, and, although encountering some unexpected difficulties, the hatching-house was finished with a capacity for a million eggs.

Various obstacles presented themselves from time to time, but finally 200,000 eggs were secured and placed in temporary boxes. Unfortunately, however, a sudden rise in the river carried away the rack across the Clackamas, the Indian trap used for a corral to confine the fish, and finally the eggs placed in the boxes. Vigorous efforts, however, succeeded in retrieving this disaster in part, but it was not until the 25th day of September that everything was completed and in working order.

Other preparations, however, had to be made for the purpose of protecting the buildings and apparatus from the sudden rise of the river; and for this a large boom was built which it is hoped will answer the purpose.

The total number of young salmon hatched out during the season was about one million, a portion of the eggs having been transferred from the McCloud River.

Mr. Stone found that the number of nets stretched across the river constituted a very great impediment to the ascent of the fish, making

it probable that unless this could be prohibited by law it would be useless to attempt artificial propagation. It is now understood that a law has been passed which will give the relief; and the predominant interest being in favor of protection, it is likely it will be duly exercised.

A full report by Mr. Stone, of his work on the Clackamas, will be found in the Appendix.

The McCloud River Station.—The success of the operations on the McCloud River during the year 1877 was equal to the average of that of the preceding years, although prosecuted under some especial embarrassments. A difficulty with the squatter, who claimed prior rights, gave much trouble to Mr. Stone, and made it necessary for him to secure the assistance of a guard of soldiers detailed by General McDowell for the purpose. This detail of a Lieutenant and four men, reached the United States fishery station on the 16th of August.

The extent of operations at the fishery was interfered with on account of the upward ascent of the fish being prevented by the nets for taking fish at the canning establishments near the mouth of the river, and it became necessary to invoke the action of the California Fish Commissioners in enforcing the State laws prohibiting such fishing after the first of September. Some of these persons were tried and on conviction fined to the amount of nearly a thousand dollars. This broke up the illegal action; but in the mean time the run of the fish for the season had nearly passed.

By the utilization of all the means at his command, as already stated, a fair supply was secured, the first eggs being taken on the 28th of August, and the last of the regular season on the 19th of September. The experiment, tried for the first time in 1876, of chartering a refrigerator car for the purpose of sending the eggs eastward, was again made in 1877, with perfect success. The car left Redding on the 2d day of October, for Sacramento, and reached Chicago on the 7th, the crates containing the eggs being forwarded thence by express. The car contained 39 crates for distribution in the United States, and 12, of 25,000 each, for Europe.

On the 7th of October the eggs for New Zealand and Australia were sent forward to San Francisco, and were shipped by the steamer of the 9th of October.

The necessity of keeping up a supply of fish in the Sacramento River was met by the introduction of two millions of fry, hatched at the McCloud establishment. Such action, if continued for a number of years, cannot fail, in addition to the natural product, to maintain the stock at a fair average. It is believed, indeed, that the increased number in the present supply of fish in the Sacramento, is derived from the young introduced by the United States Commission during its operations for several years past. Without this action the river would yield so small a number as to render it practically worthless as a salmon stream.

In general, the total loss of eggs in transportation did not exceed 2½

per cent., with the exception of those sent to Europe, of which mention will be made hereafter.

Nearly all the fish commissioners of the Eastern States reported the arrival of their quota in most admirable condition.

In the Appendix will be found the detailed report of Mr. Stone upon the work of 1877. In this is a very important series of indications of temperatures. From this it will be seen that during the season, when the eggs were being embryonized for shipment, namely, from August 28 to October, the temperature of the water varied from 48° to 58°, that of the air occasionally rising to 100°. The hatching was completed, however, with the water a few degrees lower.

The total yield of the season up to the 9th of October was a little over 7,000,000, about 1,000,000 more being taken afterward. The distribution of these eggs was made to twenty States, in addition to which a supply was sent to Germany, the Netherlands, England, France, Canada, Australia, and New Zealand. The total number of fish distributed from the various stations amounted to 6,983,000.

Foreign distribution of eggs of the Pacific salmon.—The very high estimation of the California salmon by the fish-breeders of the United States, based upon its hardiness, freedom from disease, rapidity of growth, voracity of feeding, &c., excited much attention among specialists in this line in Europe, and in the summer of 1876 application was made in behalf of Dr. Friedenthal, minister of agriculture of Germany, through the German commissioner at the Centennial, for the transmission of a supply of eggs of this fish. Similar requests were made by the officers of the Deutsche Fischerei-Verein, an institution standing far in advance of all others in Europe organized for the protection and improvement of the national fisheries.

It was impossible to meet this call in 1876, but in 1877 arrangements to that effect were made, after an extended correspondence. Mr. Fred Mather was selected to accompany these eggs to Europe, it being understood that his expenses were to be paid by the German Government and the Fisherei-Verein. No charge was made by the United States for the eggs, their donation being considered right and proper, in view of the fact that Germany had presented, in 1873, 250,000 eggs of the Rhine salmon to the United States.

It was arranged that Mr. Mather was to meet the eggs at Chicago, and that no portion of his expenses from that point to Germany and back to New York was to be chargeable to the United States.

On the 7th of October, 1877, a refrigerator car from California reached Chicago with its precious freight of salmon eggs, and Mr. Mather, who was in attendance, received two crates of eggs for England, to be sent to Frank Buckland; two crates for France, for the Société d' Acclimatation, Paris; two crates for the Deutsche Fischerei-Verein, Germany; two for Dr. Friedenthal, minister of agriculture in Germany; and four for

Holland, care of C. B. Bottemanne, Royal Zoological Garden, Amsterdam.

Each crate contained 25,000 eggs, packed according to the usual method. Mr. Mather accompanied these eggs to New York, and as the German steamer did not sail until the 13th of the month he thought it advisable to take them to his house in Newark, where they could be stored in a cellar and properly protected. He had arranged to repack these eggs according to a method of his own devising, and had transferred 25,000 to their new crates when he was instructed, by telegraph, not to interfere with the packing they had received, it being thought that the risk involved would be greater in making the change.

The vessel selected for the shipment was the Mosel, of the North German Lloyds, Captain Neinaber in command, the company having offered every facility for the carrying out of this important experiment. A supply of ice was procured, and the eggs were placed in the forward hatchway on the main deck, properly packed to prevent injury. The proposition to surround the eggs with a lot of straw was not carried out, owing to the fear on the part of the captain of danger from fire. Although notice of the probable time of the arrival of the vessel at Southampton was telegraphed from New York, the messenger of Mr. Buckland, for some reason, did not reach that place until after the steamer had left for Bremen, and his quota of eggs were accordingly added to those for Germany.

The vessel was met at Bremerhaven by Dr. O. Finsch, curator of the Bremen Museum, in behalf of the Deutsche Fisherei Verein; by Director Haack, for Hüningen; by Mr. Heck, of Amsterdam, and Mr. Schreiber, of Hameln, who took charge of their respective packages. Perhaps in consequence of the situation of the eggs on the ship, all except those that had been repacked by Mr. Mather were in bad condition, so much so, indeed, that but few of them survived. Of the 25,000 repacked for Germany, only 396 were lost, proving the efficiency of Mr. Mather's method. Nearly all the remaining eggs were dead, or died soon after being transferred to the hatching-houses, a small percentage alone yielding any fish. Considerable vexation was expressed, by the fish-culturists of Germany and Holland, in regard to what they considered the impracticable method of packing the eggs adopted by Mr. Stone; but there is every assurance that if they had been placed under more favorable circumstances in the vessel, they would have gone through safely, as will be seen by the account of the shipment to New Zealand of eggs packed in precisely the same way, which reached their destination in good condition, after a voyage of eight weeks instead of two, the percentage of loss being very trifling.

In the Appendix will be found a detailed account by Mr. Mather of his experiences.

Fifty thousand eggs were taken by Mr. Mather for the Société d'Ac-

climatation, Paris, from Chicago to New York, and forwarded by the French Transatlantic steamer, arriving in unsatisfactory condition.

It is proposed to renew the shipments of eggs of California salmon to Europe in 1878, when, it is hoped, the experience gained will be available in securing their safe delivery at their destination.

The Atlantic Salmon (*Salmo salar*).

The Bucksport, Maine, Station.—The cessation for the past year or two of operations at Bucksport looking towards securing eggs of the Atlantic salmon, has already been explained, on the ground of a desire to ascertain by the first experiment whether it would be possible to restore this fish to depleted waters, and to introduce them into streams where they had not previously occurred. No very positive results were presented in the early part of the year 1877, up to the time when it would be necessary to make proper provision for securing the parent fish. If, however, the salmon returns in any positive numbers to the waters which have been the subject of experiment hitherto, efforts will be made, with a suitable appropriation from Congress, to renew the work in 1878, on as large a scale as may be practicable.

Results obtained for labor of previous years.—It is, however, a fact, that in November of 1877, a mature female salmon was taken in the Delaware River, in the vicinity of Trenton, and presented by Mr. H. J. Reeder, one of the fish commissioners of Pennsylvania, to the United States Fish Commission. It is now on exhibition in the National Museum in the case devoted to the display of the results of artificial fish propagation. Mr. Reeder, in sending the specimen referred to, remarks that numerous rumors in regard to the occurrence of this fish in that river had previously come to his notice, and that the more authentic one was in regard to a salmon taken in a shad seine in the Delaware, and eaten as the first caught there. A second specimen was said to have been taken at Lambertsville, and another at Carpenter's Point, near Port Jervis, caught in a fish-basket, and weighing 8½ pounds. Other cases were heard of, but in less detail.

Mr. Reeder is of the opinion that the salmon recently taken in the Bushkill could not have been the progeny of the spawning of 1871, as those were hatched in the Hudson River and brought, ten thousand in number, to the Delaware, nearly all dying on the way. About one thousand were placed in the water in a weak and greatly enfeebled condition, and there is no reason to believe that any of them survived.

In 1872 the State commissioners hatched out a number of eggs in a spring run, near the Bushkill, and about 10,000 young fish were planted in that stream. In 1873, about 25,000 were hatched on the banks of the Delaware and turned directly into the river itself. Mr. Reeder thinks that those placed in the Delaware could not have gone into the Bushkill, and that consequently the hatching of 1872 must be considered as the starting point of the specimen captured.

The question, however, as to the precise origin of the fish sent by Mr. Reeder and the others referred to by him is complicated by the fact that in 1872 the Bureau of the German Fischerei-Verein made arrangements for the presentation to the United States Government of 250,000 eggs of the Rhine salmon, obtained at the imperial establishment at Hüningen, and I purchased 500,000 in addition from Mr. Schuster, of Freiburg. When these had been properly brought forward in the respective establishments of Hüningen and Freiburg, they were placed in charge of Mr. Rudolph Hessel, now the superintendent of the United States carp ponds in Washington, and transferred to New York. Owing to the unseasonable warmth of the winter and to the absence of ice, these eggs could not be kept down to a sufficiently low temperature, and on arriving at New York it was found that the greater part had perished. The remainder were taken to the establishment of Dr. J. H. Slack, at Bloomsbury, N. J., and by diligent care on the part of Mr. Hessel about 5,000 were saved and hatched out. These were placed in the Muscanetkong, a tributary of the Delaware, in the spring of 1873.

According to Dr. Hudson, a salmon, weighing 18½ pounds, was taken in a gill-net near the mouth of the Connecticut on the 8th of June, 1876, and sold in the Hartford market for the sum of $10. A few were also seen in the summer of 1877.

The results of the experiment were more satisfactory in the Merrimack River than in either the Delaware or the Connecticut, as a considerable number made their appearance at the Lawrence fishway early in June, and at Manchester on the 13th of June. Quite a large number in all were noted, and the commissioners of Massachusetts and New Hampshire are determined to press the business of restocking the Merrimack with great vigor. A full-grown salmon was seen at the Lawrence fishway on the 3d of October, representing a later run during that month.

The Land-locked Salmon.

Grand Lake Stream Station, Maine.—The work of gathering and forwarding the eggs of land-locked salmon, during the season of 1877–'78, was, as heretofore, in charge of Mr. Charles G. Atkins, at the establishment on Grand Lake Stream, in Eastern Maine, the methods being similar to those of previous years. A series of stakes and fine meshed nets was set on the gravelly shoals below the dam of the outlet of Grand Lake, enough to entrap the whole run of breeding-fish. The eggs were brought forward in the old hatching-house at the spring on a little brook, a tributary of Grand Lake Stream.

The report of Mr. Atkins, as submitted in the Appendix, will explain all the details connected with this work, illustrated by a diagram of the grounds.

As in previous years, the State commissioners of Massachusetts and Connecticut co-operated with the Commissioner of the United States in carrying on the work, the division of eggs being made *pro rata*. The

total number obtained was 2,159,000, the number distributed being about 1,400,000. The remainder were hatched out and restored to the water of Grand Lake Stream. The eggs for the most part reached their destination in good condition, and were successfully hatched out. The table accompanying Mr. Atkins's report shows the precise location of the planting of the entire lot. In addition to the distribution of land-locked salmon made to various portions of the United States, 25,000 were sent to the Deutsche Fisherei-Verein in Germany and 55,000 to the Société d'Acclimation in Paris. Unfortunately, both lots were apparently so far advanced in development that it was impossible to retard their hatching until their arrival at their destination, and consequently all perished.

Lake Ontario Station.—It is well known that not many years ago salmon abounded in Lake Ontario, and that there were many important fisheries for them both on the Canadian and American shores. Of late years they have been exterminated on the American side, and were nearly extinct on the Canadian at the time when Mr. Samuel Wilmot began his celebrated experiments at Newcastle. These fish were in the habit of entering the short rivers, tributaries of the lake, at the proper season, for the purpose of spawning, and after remaining a short time returned to the lake. It was formerly supposed that all these fish came up in the spring from the ocean, by way of the Saint Lawrence River, returning in the autumn or winter. But Mr. Wilmot quite reasonably insisted that they never left the waters of Lake Ontario, and were in every respect to be considered as land locked salmon, corresponding to those of Sebago Pond and various other ponds along the coast of Maine, as also in similar localities in Nova Scotia, New Brunswick, and Quebec.

Mr. Wilmot, from a single pair of breeding fish, occurring in a small stream, on which his hatching establishment is placed, and not more than a few feet across, now counts breeding fish by thousands. But the somewhat remarkable fact is developed that with all this certain increase in number but little impression has been made upon fish as an article for market purposes, it being found impossible to take them at the proper season. Mr. Wilmot's plan is now to place salmon in the waters of the north shore and in the interior, in the hope that in the future desirable river fisheries may be established. No increase in the number of salmon has been noted in the Upper Saint Lawrence, the fish being still taken, however, in considerable numbers in the lower part of the river. I have not been able to ascertain whether any are obtained as high up as Montreal and between that and the outlet of the lake.

Mr. Wilmot having very kindly offered to the United States Fish Commission 5,000 impregnated eggs from his hatching establishment at Newcastle, they were placed at the command of the New York fish commission, by which they were turned over to the New York Aquarium, and there hatched out. By the instructions of Mr. Roosevelt, 4,500 of these young fish were placed in Otsego Lake, at Cooperstown, in June, 1877. As this lake constitutes the headwaters of the Susquehanna River,

we may have here a new source of supply to that stream. It had been the original intention to place these fish in Skeneateles Lake, but for various reasons Otsego Lake was preferred.

Whitefish (*Coregonus albus.*)

Northville (*Mich.*) *Station.*—It not being convenient to undertake specially the gathering and artificial impregnation of the eggs of the whitefish, arrangements were made with Mr. Frank N. Clark, of Northville, Michigan, to secure and bring forward such a number of eggs as might be needed by the Commission to meet the comparatively small number of applications, the most important of these being from California, Nevada, and several foreign countries. Accordingly, 500,000 eggs were shipped to Mr. B. B. Redding for the California commissioners. The shipment of the eggs was quite successful, a comparatively small percentage failing to develop. The eggs were packed by Mr. Clark between layers of mosquito netting, and Mr. Redding reports that where the layer of netting was single the eggs were in good condition, but where they rested on a fold or turn they were generally killed, thus suggesting an important precaution under these circumstances. The young fish thus obtained were for the most part placed in Lake Tahoe.

Desirous of trying the experiment of the introduction of our whitefish, *Coregonus albus*, into Germany, I instructed Mr. Clark to put up and forward to Mr. Fred. Mather, for shipment to Germany, a package of 50,000 eggs. These were started on the 18th of January, 1878, and on the 21st Mr. Mather acknowledged their receipt at Newark. As no steamer was up for Germany until the 26th of January, Mr. Mather kept the eggs in his cellar at a temperature of 46°, a piece of ice being allowed to melt continually on the top of the box. The authorities of the North German Lloyds having, with their usual liberality, agreed to forward these eggs without expense, they were placed by Mr. Mather, on the 26th, in charge of the first officer on the Mosel, by whom they were put in a part of the vessel which, unfortunately, proved to be too warm for them, as, on their arrival in Germany, all were found to have perished.

Through the mediation of the United States Fish Commission, arrangements were made between the Government of New Zealand and Mr. Frank N. Clark for a supply direct of embryonized eggs of whitefish. This commission was satisfactorily executed by Mr. Clark, and the eggs duly placed on board the steamer at San Francisco, and reached their destination in good condition. A large percentage was hatched out, and the young placed in antipodal waters.

The European Marane Whitefish (*Coregonus maræna*).

The value of the Coregonus or whitefish as an article of food and as a subject for artificial propagation is becoming appreciated in Germany, as it is in the United States; and the German fish culturists are especially active in experiments and suggestions. A favorite species is what is known as *Madue Maræne* or *Coregonus Maræna* of (Bloch.) This is found

only in a few lakes in the provinces of Pomerania, Brandenburg, and Holstein, and for the most part in Madue Lake.

The most successful cultivator of this species is Mr. R. Eckardt, the proprietor of a flourishing fish-hatching establishment at Lübbinchen, near Guben, in Silesia. This gentleman, desirous of making some return in behalf of his compatriots for the good will of the United States Fish Commission, in supplying eggs of useful food fishes to Germany, offered to present one thousand embryonized eggs of this species, if he could be advised of the general result of the experiment. This being promised him, a package, said to contain a thousand, was received through the kind offices of the North German Lloyds, in New York, and sent by arrangement to the fish commissioners of Michigan, who promised, after hatching them out, to place the young in some isolated lake in that State, where their future could be followed. Of the number received, 409 were hatched out, and on the 14th of April, were placed in Lake Gardner, a small, deep lake in Otsego County, Michigan. There were believed to be no other whitefish, nor any predaceous fish of any kind in the lake. It is to be hoped that should this lake be found to contain any whitefish, the fact will be duly reported to the United States Fish Commission. This transmission of eggs was accompanied by special instructions as to treatment. Thus they were not to be transferred suddenly to new water nor to water of specially different temperature; but the box must be placed unopened in the water and allowed to remain in that condition for at least an hour. As the skin of the egg is very delicate, of course careful handling is required. In Germany the eggs hatch out from the end of February to the middle of March, this depending on the temperature.

Mr. Eckardt advised that the young fish be placed in the ditches or ponds within one or two days of hatching. In May or June, in Germany, the young fish are said to make their appearance on the shores of the lake.

The Carp (*Cyprinus carpio*).

The introduction of the best varieties of carp, particularly those reared in Germany, has, as is well known, been for many years a favorite object with the United States Fish Commission, this fish possessing many special qualities fitting it for great usefulness in certain portions of the United States. The carp, from having been cultivated for hundreds, and, perhaps, thousands of years as a domesticated fish, and being of all known fish the most readily propagated and reared, takes rank in this respect with poultry and domestic animals generally. It is maintained by German writers that a given area of carp ponds will furnish a vastly greater amount of animal food than can be obtained on the same ground from the cultivation of crops fed to domestic animals; this, too, at much less labor and expense. In some parts of Europe vast areas are occupied in the culture of carp, Prince Schwartzenburg of Austria having, it is said, no less than 20,000 acres occupied in this culture.

The propagation of this fish is prosecuted on every imaginable scale, from that just mentioned down to a tank holding not more than a few cubic feet. In China, indeed, it is said that carp are reared to a very great extent in ordinary washtubs and fed with vegetable refuse.

In Germany, again, there is a regular alternation on the same ground, from carp cultivation to that of the cereals or other plants, and after a certain number of years the ponds are drawn off, allowed to dry and seeded or planted until one or two crops are obtained, when the water is again turned on and the carp reintroduced.

There are several species of American *Catostomidæ* which might in all probability answer in some measure, if not fully, in place of the carp. Among them are especially the buffalo fish, a large sucker, the flesh of which is much esteemed. As, however, some special varieties of carp have been developed and had their instinct of domestication established, while experiments on our indigenous species are scarcely yet tried, there is no reason why time should be lost with the less proved species.

In carp culture quite a number of varieties are known. The species in its original condition is not very different in shape from a gold-fish, and is of an olivaceous color, and distinguished by four barbels about the mouth, these being inappreciable or wanting in the gold-fish. Where the carp is kept in ponds, and where its habits are necessarily sluggish, the body is thick and stout, and the fish tender and delicate. In running water, however, the back is sharper and the body more slender, the result of increased muscular activity consequent upon different surroundings. The two principal varieties of carp produced by cultivation are the mirror and the leather carp. In the mirror carp all the scales of the body have disappeared, with the exception of a few scales along the vertical outlines, and those along the lateral line. The leather carp goes a step beyond this, and is destitute of all scales excepting a few along the line of the back; sometimes they are entirely wanting. The difference between the two, however, is not very great, both being considered much superior to the scale carp, which is best known. It is stated that the cross between the *Cyprinus carpio* and the Prussian *C. carassius*, as also one between the gold-fish and *C. carassius*, are all known as carp; and the fact that they all represent the greater part of the fish of that name in France and England, has given the idea of the inferiority of the carp. It is only in Germany that the different branches are kept distinct and their comparative merits appreciated. The best of these are said to be of very superior quality, ranking with the European trout in point of price and estimation; indeed, it is on these in the interior of Germany that the population depend very largely for its supply of fish needed for church requirements and the general wants of the table.

As already stated, I have for a long time attached much importance to the introduction of carp into the United States of America, as supplying an often-expressed want of a fish for the South, representing the

more Northern trout, and capable of being kept and cultivated in ponds. In the carp this desideratum is amply met, with the additional advantage that the same water will furnish a much larger amount of fish-food in the aquatic plants, roots, seeds, &c., to be found, while feeding may be accomplished by means of leaves, seeds, pieces of cabbage, and lettuce, by crumbs of bread, or by boiled corn and potatoes, or other cheap substances. Of course, among fishes, as among land-animals, sustenance is derived either primarily or secondarily from the vegetable kingdom. The carnivorous trout and black bass find their food in the form of the *Cyprinidæ* or other fishes, or insects and worms, which either directly or indirectly have been fed from plants. In the case of these fish, therefore, we change, first, the vegetable substance into animal, and feed the animal to the carnivorous fish, to a very great disadvantage. In the case of the carp, the plant substance goes directly to the formation of the eatable fish, and produces a much larger yield of flesh.

The growth of the carp, in view of its sluggish, semi-domestic nature, is very rapid, and it is not at all uncommon for the fish to attain a weight of two or even three pounds by the end of the second year, this depending somewhat upon circumstances. In the coldest regions the fish buries itself in the mud during the winter, and of course experiences no growth during this time of seclusion. In more southern portions of the United States this hibernation would not take place, and the fish by feeding throughout the entire year would experience a proportional increase of weight.

There is no ditch, or pond, or mill-dam, or any muddy, boggy spot capable of being converted into a pond of more or less size, that will not answer for this fish. Except for unforeseen casualties, I fully believe that within ten years to come this fish will become, through the agency of the United States Fish Commission, widely known throughout the country and esteemed in proportion.

The earlier reports of the Fish Commission contain accounts of what has already been done in the matter of introducing the carp, and the results of several unsuccessful or unsatisfactory trials are recorded. Not discouraged, however, by failure, the experiment has been continued, and I am happy to announce as a result that a sufficient supply of the three principal varieties has been secured.

The first experiment by Mr. Hessel during the present year, or rather during the winter of 1876–'77, was not successful, the fish being all destroyed in consequence of a storm of unusual severity to which the vessel was exposed in its trip from Bremen to Baltimore. He, however, immediately returned to Europe, bringing a supply of fish to New York in the month of May. There being no suitable locality under the immediate direction of the United States Fish Commission, arrangements were made with Mr. T. B. Ferguson and the commissioners of Druid Hill Park for their accommodation in ponds prepared expressly for their re-

ception, in the vicinity of the State hatching-house in that park; and on the 26th of May Mr. Hessel placed there 227 naked and mirror carp and 118 common carp. These were placed in charge of Mr. Hessel, under the general superintendence of Mr. Ferguson.

The ponds originally constructed by the park commissioners not being sufficient to accommodate the fish, they authorized the excavation of several others, at an expense of $1,000, and it is expected that these will be finished at an early day. As, however, even with this extension, the quarters for the breeding-fish were not sufficient, the suggestion of Mr. Hessel that application be made to Congress for the use of the Babcock Lakes in the Monument Lot, in the city of Washington, was acted upon, and towards the end of the year authority was given by Congress for the use of the Monument Lot for the purpose in question, and an appropriation of $5,000 made for the proper construction and arrangement of the water under the direction of Colonel Casey, superintendent of Public Buildings and Grounds. This work has been commenced and will be finished probably in the course of the coming spring; and whenever it can be done, a portion of the carp and other fish will be brought over from Druid Hill Park ponds, so that the experiment may be carried on in the two localities.

The Monument Lot ponds contain about six acres each. They will be drained off and the bottom leveled and ditches prepared similar to those suggested in Mr. Hessel's article on carp ponds in a previous report. A low place, now perfectly bare at low water, and in the vicinity of the two ponds can, with little expense, be reclaimed and made to add another pond of twelve or fourteen acres.

It is proposed to establish on the island in the west pond some small inclosures for the breeding-fish.

Considerable discussion has arisen as to the person to whom the introduction of the carp into America is due; indeed, it is claimed that this was done many years ago. Certain fish-ponds on the Hudson River are said to have been emptied of their contents by a sudden freshet, and, as a consequence, the Hudson is now full of what is called the carp and sold as such in the New York market. I have not yet, however, been able to find a single fish among those sold as carp which is really any other than the common gold-fish, reverted to its original normal condition. Indeed, in the olivaceous fish caught in great numbers in the Hudson there are usually found precisely similar specimens of white, red, and all intermediate conditions. While, therefore, I cannot say that no genuine carp were transferred to the Hudson, none have come under my observation; and it has occurred to me as possible that the Prussian carp, *Cyprinus carassius*, L., may have been the one introduced, or possibly the hybrid progeny of this and the true carp may have been gradually mixed with the gold-fish.

Some years ago Mr. Poppe, of Sonoma, Cal., brought from Germany some half-dozen specimens of scale carp, and has since made a thriv-

ing business by the sale of fish for breeding purposes. Mr. Poppe has kindly sent me some specimens of his fish. These are scale carp, apparently somewhat hybridized; at least, they do not present the characteristics of the pure breed brought by Mr. Hessel. Information in regard to any other experiments in this direction will be gladly received, especially if accompanied by specimens of the fish for the identification of the variety.

The European Tench (*Tinca vulgaris*).

Fully appreciating the tenacity of life of the tench, and the readiness of its acclimatization in foreign waters, as shown by the prodigious success of experiments with it in Australia, I requested Mr. Hessel, on his return from the last trip to Europe, to bring with him as large a number as possible; and these have also been placed in Druid Hill Park. The especial value of this fish is in the fact that as the water in a given pond dries up or flows off, it buries itself in the mud, and if this is kept sufficiently moist it will remain in perfectly good condition, while, perhaps, the ground above it may become hard and parched, requiring only the return of the water to its bed to permit its emergence. Indeed, it is said that in some places when the pond is dry and the fish is needed, it is dug out like potatoes from a hill. The fish will be distributed together with the carp, as there is nothing incompatible in their occupying the same waters.

A few special varieties of what is known as the golden tench were obtained, and will be propagated; but they have no special value beyond their abnormal color.

The Golden Ide (*Idus melanotus* var. *auratus*).

A large cyprinoid fish in Germany, known as *Idus melanotus*, attaining sometimes a weight of three or four pounds, has, within a few years past, been developed into a golden or red variety, corresponding with that of the gold-fish, but much more beautiful in shape and larger in size. As compared with the gold-fish it has the merit of swimming about on the surface of the water, and being more active in its movements. Mr. Hessel brought with him on the trip just referred to, a large number of the ides, the increase from which will also be distributed in due course of time.

The Sea Herring (*Clupea elongata*).

The question of the propagation of the sea herring (*Clupea elongata*) is one of considerable economical importance, although less prominent in this country than in Europe, as its capture does not occupy so large a part of the American fisheries. Here its most important application is as fresh bait for cod, halibut, &c. The fact that herring eggs are very adhesive, and attach themselves firmly to all objects which they touch, makes it impossible to apply the same methods as with the salmon and the shad, the eggs of which are non-adhesive to each other or to other

substances, and can readily be manipulated by the approved apparatus. Indeed, it has been found that wherever the eggs of the herring adhere in bunches the central eggs almost always fail of development.

The details of the operation of spawning among the sea herring are not well ascertained, but probably are prosecuted as with most fishes, the fish, either in pairs or in masses of both sexes, coming together and discharging the eggs at intervals, accompanied by a discharge of the milt. This being done in the open sea, the eggs are immediately carried off by the current, and ultimately fall to the bottom, unless they happen to come in contact with some substance floating in the water. Where vessels are anchored on the spawning-grounds of the herring it is very common for the eggs to attach themselves to the cable, sometimes increasing its thickness many fold.

During a visit in 1872 to the spawning-grounds of the sea herring at the southern end of Grand Menan, I found, in working the dredge, that sea-weed and pebbles brought up at depths of from five to twenty or thirty fathoms or even more were thickly studded with single eggs of the sea herring, rarely more than two or three being close together. These circumstances were most favorable for development, while their adhesion saved them from many of the dangers of destruction by fishes, &c., to which floating eggs are liable. The experiment of artificial propagation was not tried in this connection, although a supply of eggs was taken to Eastport and their development carefully studied in the laboratory.

On the 13th of November, 1877, Mr. Vinal N. Edwards, an employé of the Fish Commission, while at Noman's Land, engaged in studying the natural history of the spawning cod, took the occasion to artificially impregnate a number of eggs of the sea herring and hatch them out in a floating hatching-box. These eggs hatched in eleven days, the young emerging on the 24th of November. He found the yolk-bag much more sessile than that of the shad. Where the eggs were in clusters they did not ripen, only when placed singly on sea-weed. Kelp seemed to be the best medium for their development.

Experiments were also made in 1877 by Dr. H. A. Meyer, of Kiel, on this same subject, and the results published by him in a Circular of the Deutsche Fisherei-Verein.

To make a success of the artificial impregnation of the herring it will be necessary to adopt some treatment quite different from that with the salmon and shad, and it is doubtful whether the work can ever be done on the same wholesale scale and with the same economy. Probably the best method will be to drop the eggs on glass plates or sheets of wire gauze, the former being preferable on account of the greater facility of keeping the eggs clean.

The specific gravity of the eggs of the herring, which sink to the bottom, is evidently much greater than that of the eggs of the mackerel or cod, which it is well known float persistently at the top. For a judicious

prosecution of the work of hatching various species of fish it will be very desirable to have careful experiments instituted beforehand on this subject. It is well known that the eggs of the shad, trout, and salmon are heavier than fresh water, as their tendency is to sink to the bottom of the vessels in which they are kept. Their specific gravity is probably quite constant in the same species, although possibly differing somewhat in the different stages of development.

Mr. Milner has furnished a memorandum to the effect that in five lots of eggs of the California salmon, tested on the 29th of January, 1878, and some of them well impregnated, the specific gravity varied from 1.07 to 1.09, two samples giving the first figure and three the second. He found that in brook trout treated on the same day, among which a few were hatching prematurely, the density of the two lots varied from 1.156 to 1.159, showing a very appreciably greater density in the latter. I would commend to persons who have facilities for making similar investigations, to determine the difference between the density of the unimpregnated egg, the freshly impregnated egg, and the same series of eggs at different stages of growth, including that of the recently hatched embryo.

The European Turbot and Sole (*Rhombus maximus* and *Solea vulgaris*).

It is a well-established fact that the United States, in the abundance and variety of first-class food-fishes is greatly in advance of any single country in Europe, even of Great Britain, since, while possessing the various species of the cod family, the halibut, mackerel, herring, &c., in common with them, America can show the Spanish mackerel, the pompano, the channel bass, the weak-fish, and many other species of eatable qualities. Any assertion of this superiority on the part of the United States is met by the assurance that in the lack of the turbot and sole, America is without the two finest of all species. There is no question as to the excellence of these fish, especially of the sole, although in the new Pole or Craig flounder, a deep-sea fish discovered by the United States Fish Commission in such enormous abundance off the coast of Massachusetts in 1877, we have what will measurably replace the turbot; and several of our species of flat fish are scarcely, if at all, inferior to the sole.

The importance of having these two European species in our own waters has, however, been suggested to the United States Fish Commission, and it was concluded to take such steps as might be possible to obtain them. Among the gentlemen particularly interested in this transfer was Mr. J. G. Kidder, of Boston, who kindly offered his services with the Cunard Steamship Line from Boston to secure free passage for the fish and their attendant from Liverpool to Boston. He accordingly obtained letters from the agent of the line at Boston to the directors in Liverpool which accomplished their desired object.

Reference has already been made to the agency of Mr. Fred Mather

in the transportation of California salmon to Europe. That gentleman was instructed to proceed to Liverpool and obtain a supply of the turbot and sole, suitable for transfer, to be brought back to Boston on the Cunard steamer, with such facilities as he could obtain on that occasion. A correspondence had been entered upon some time before with Mr. F. Moore, the accomplished curator of the Free Public Museum of Liverpool, who made many inquiries as to the proper localities and the best mode of obtaining these fish.

Mr. Mather reached Liverpool on the 17th of November, and, reporting himself to Mr. Moore, found that gentleman had invoked the assistance of the authorities of the great aquarium of Southport. Proceeding to this place, Mr. Mather was received very cordially by Mr. John Long, the superintendent of the aquarium; but owing to the inclemency of the weather it was impossible to obtain any number of fish, and in order to have a proper supply it was necessary to secure the further services of some of the fishermen. Unfortunately the weather, after Mr. Mather's arrival, proved to be exceptionally stormy, and the few fish obtained were so badly bruised that they died shortly after being introduced into the tanks of the Southport aquarium. There was some question in regard to Mr. Mather's free passage in the shipment of the fish, and it was not until the 3d of January that the shipment was actually made. This consisted of six turbot and twenty-six soles, the vessel upon which they were placed being the Siberia, of the Cunard line, Captain McKay commanding. Mr. Mather, with his precious charge, experienced a series of accidents on the voyage homeward. In the first place the tanks were found to have been placed in such proximity to the steam heating pipes that the water soon rose to a temperature of 72°, much higher than is suited to this fish. On arriving within sight of Cape Cod, on the 16th of January, only two soles survived, and after consultation with the captain as to a suitable place of deposit, it was concluded to place them overboard, and they were accordingly left at a point on the Stelwagen Bank, two miles off Nahant, in 18 fathoms of water, the surface temperature be ng 31°.

It is hoped that, as in the case of the shipment of California salmon, the experience thus gained will enable us to avoid a failure on another occasion. Mr. Mather is of the opinion that by keeping the temperature at as low a degree as possible one of the most serious dangers may be avoided. He does not recommend anything in the way of gravel or sand in the tanks, as the fish would be liable to abrasion, in the motion of the vessel. He also recommends that the fish, before such transportation, should be kept in captivity and fed for at least one month, as this will show whether the act of capturing has in any way injured the fish.

Anticipating the occasion of taking these fish from the wharf at Boston for deposit at some suitable point in the harbor, application was made to the Treasury Department for the service of the revenue-cutter,

and instructions were given to the collector of customs at Boston, Mr. C. B. Simmons, to supply this and such facilities as were required. Every assurance was received from Mr. Simmons of his willingness to co-operate; and the steamer, the revenue-cutter Grant, was in readiness on the arrival of the English steamer; but, as it proved, the deposit of the two surviving fish had already been made.

It is, of course, impossible to tell whether from a single pair of fish any yield may be expected. The fact is, however, now one of record, that soles have been actually transported and introduced into American waters. Mr. Mather's account of his experiences on this trip will be found in the Appendix.